SMART CITIES READINESS GUIDE

The planning manual for building tomorrow's cities today

SmartCitiesCouncil

LIVABILITY | WORKABILITY | SUSTAINABILITY

Smart Cities Council

SMART CITIES READINESS GUIDE®

The planning manual for building tomorrow's cities today

Acknowledgments

The Readiness Guide is, first and foremost, a collaborative effort. We are grateful for the expertise, the energy and the meticulous diligence of dozens of enthusiastic smart city advocates – subject matter experts from around the world, municipal government leaders and their staffs, technology advocates and business leaders.

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The Readiness Guide would also not have been possible without the help of the Council's Advisory Board, a collection of the world's foremost smart city thinkers, doers and visionaries. Our 60-plus Advisors are listed on page 364 of this Guide's Appendix.

Finally, we would like to thank the city mayors and their hardworking staffs who gave us real-world insights and provided us with critical early feedback. Their contributions represent the bridge between political infrastructure realities and 21st Century innovation. Special thanks to: Mayor Elizabeth Kautz, Burnsville, MN; Mayor Rawlings-Blake, Baltimore, MD; Mayor Jim Schmitt, Green Bay, WI; Mayor Kim McMillan, Clarksville, TN; Mayor Pedro Segarra, Hartford, CT; Mayor Jim Hovland, Edina, MN; Mayor Buddy Dyer, Orlando, FL; and Mayor Mike Rawlings, Dallas, TX.

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CHAPTER 1

INTRODUCTION TO SMART CITIES

Welcome to the Readiness Guide. This document was assembled with input from many of the world's leading smart city practitioners – the members and advisors of the Smart Cities Council. It will help you create a vision for the future of your own city. Equally important, it will help you build an action plan to get to that better future.

The first goal of the Readiness Guide is to give you a "vision" of a smart city, to help you understand how technology will transform the cities of tomorrow.

The second goal is to help you construct your own roadmap to that future. It suggests the goals to which you should aspire, the features and functions you should specify, the best practices that will gain you the maximum benefits for the minimum cost, at reduced risk.

The Readiness Guide is intended for mayors, city managers, city planners and their staffs. It helps cities help themselves by providing objective, vendor-neutral information to make confident, educated choices about the technologies that can transform a city.

Cities around the world are already making tremendous progress in achieving economic, environmental and social sustainability, in export-based initiatives and in the creation of 21st century jobs. All of these are excellent ways to improve city living standards and economies. The concept of smart cities doesn't compete with these efforts. Instead, smart city technologies can support and enhance work already underway.

In this chapter, we will define the smart city, explore its benefits and introduce the framework that underlies this Readiness Guide.

Taking a holistic view of 'city'

This introductory section defines smart cities and explores the trends that are driving this global phenomenon. It also discusses some of the barriers cities may face and strategies to overcome them.

Before we define the "smart" piece, however, we should first deal with the word "city." Real-world smart city examples are rarely a city in the strictest term. Many are more than a single city, such as a metropolitan region, a cluster of cities, counties and groups of counties, a collection of nearby towns or a regional coalition. Other examples are less than a full-scale city, such as districts, neighborhoods, townships, villages, campuses and military bases. Indeed, many municipalities are taking a neighborhood-by-neighborhood approach to modernization. This Guide is designed to address all of these human ecosystems.

Because it is in common use, we will continue to use "city" throughout this Guide. But we use it to mean all relevant examples big and small. Regardless of size, we are taking a comprehensive, holistic view that includes the entirety of human activity in an area, including city governments, schools, hospitals, infrastructure, resources, businesses and people. As you'll read, smart technologies have matured to the point that cities of all sizes can afford and benefit from their implementation. For example, new cloud computing offerings allow even the smallest city to affordably tap into enormous computing power. So the lessons of this Guide apply regardless of size – and you'll see real-world examples in the case studies featured throughout.

The definition of a smart city

A smart city uses information and communications technology (ICT) to enhance its livability, workability and sustainability. In simplest terms, there are three parts to that job: collecting, communicating and "crunching." First, a smart city ***collects*** information about itself through sensors, other devices and existing systems. Next, it ***communicates*** that data using wired or wireless networks. Third, it ***"crunches"*** (analyzes) that data to understand what's happening now and what's likely to happen next.

Collecting data. Smart devices are logically located throughout the city to measure and monitor conditions. For instance, smart meters can measure electricity, gas and water usage

THE THREE CORE FUNCTIONS OF A SMART CITY

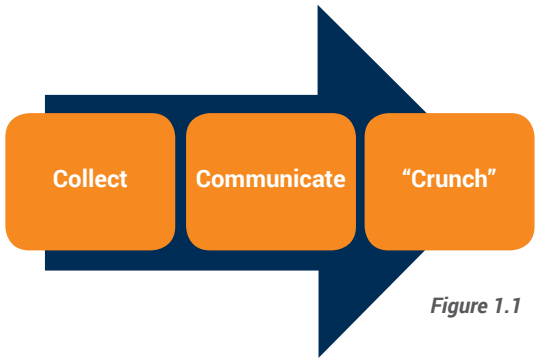


Figure 1.1

1. **Collect**
   information about current conditions across all responsibility areas (power, water, traffic, weather, buildings, etc.).

2. **Communicate**
   information, sometimes to other devices, sometimes to a control center and sometimes to servers running powerful software.

3. **Crunch**
   data, analyzing it to present information, to perfect (optimize) operations and to predict what might happen next.

with great accuracy. Smart traffic sensors can report on road conditions and congestion. Smart GPS gear can pinpoint the exact locations of the city's buses or the whereabouts of emergency crews. Automated weather stations can report conditions. And the mobile devices carried by many city dwellers are also sensors that can – when specifically authorized by their users to do so – collect their position, speed, where they cluster at different times of the day and the environmental conditions around them. Smart phones also gauge an always-local, perpetually renewable but inherently limited natural resource – radiofrequency spectrum – that smart cities depend on and will ultimately need to manage.

A smart city, then, is one that knows about itself and makes itself more known to its populace. No longer do we have to wonder if a street is congested – the street reports its condition. No longer do we have to wonder if we're losing water to leaks – the smart water network detects and reports leaks as soon as they occur. No longer do we have to guess the progress of the city's garbage trucks – the trucks report where they've been already and where they are headed next.

Communicating data. Once you've collected the data, you need to send it along. Smart cities typically mix and match a variety of wired and wireless communications pathways, from fiber-optic to cellular to cable. The ultimate goal is to have connectivity everywhere, to every person and every device. Interoperability is a key requirement.

Crunching data. After collecting and communicating the data, you analyze it for one of three purposes: 1) presenting, 2) perfecting or 3) predicting. If you've read about "analytics" or "Big Data," then you may already know about the astonishing things that become possible by analyzing large amounts of data. Importantly, analyzing data turns information into intelligence that helps people and machines to act and make better decisions. This begins a virtual cycle wherein data is made useful, people make use of that data to improve decisions and behavior, which in turn means more and better data is collected, thereby further improving decisions and behavior.

Presenting information tells us what's going on right now. In the aerospace and defense industries, they call this "situational awareness." Software monitors the huge flow of incoming data, then summarizes and visualizes it in a way that makes it easy for human operators to understand. For instance, a smart operations center can monitor all aspects of an emergency situation, including the actions and locations of police, fire, ambulances, traffic, downed power lines, closed streets and much more.

Perfecting operations uses the power of computers to optimize complex systems. For instance, balancing the supply and demand on an electricity network; or synchronizing traffic signals to minimize congestion; or selecting the ideal routes for a delivery fleet to minimize time

and fuel costs; or optimizing the energy usage of an entire high-rise to achieve maximum comfort at minimum cost; or to balance the grid with the optimal mix of renewable and traditional power sources at any given time.

Predicting what's next is perhaps the most exciting part of analytics. Singapore uses data to predict traffic jams while there is still time to minimize their effects. Rio de Janeiro predicts just where flooding will occur from a particular storm, so emergency crews and evacuation teams know just where to go.

Cities can derive benefit by collecting, communicating and analyzing information from a single department. But the greatest benefits come when data is connected with multiple departments and third parties. Many cities combine historic traffic data with information about population growth and business expansion to know when and where to add or subtract bus and train routes. Other cities correlate multiple data sources to predict crime the way we predict weather.

As we'll see in more detail, a smart city is a system of systems – water, power, transportation, emergency response, built environment, etc.– with each one affecting all the others. In the last few years, we've refined our ability to merge multiple data streams and mine them for amazing insights. It is those insights – presenting, perfecting and predicting – that enhance the livability, workability and sustainability of a smart city.

Smart cities collect, communicate and crunch data.
The city of Rio de Janeiro collects information from 30 different city departments about transportation, water, energy, weather and other conditions. Then it communicates those conditions to powerful computers, which crunch the data and present it in a unified control center the city developed with IBM. Not only does the city gain full situational awareness, it can even predict some conditions in advance, such as where floods will occur during severe storms. It can also develop actionable tasks based on modeled patterns, creating a competitive advantage for smart cities.

Figure 1.2

OTHER SMART CITY DEFINITIONS

The Council defines a smart city as one that "uses information and communications technology (ICT) to enhance its livability, workability and sustainability." Other organizations have their own definitions.

For instance, Forrester Research emphasizes the use of computing to monitor infrastructure and improve services: "The use of smart computing technologies to make the critical infrastructure components and services of a city – which include city administration, education, healthcare, public safety, real estate, transportation and utilities – more intelligent, interconnected and efficient."

The U.S. Office of Scientific and Technical Information also stresses infrastructure, explaining that "a city that monitors and integrates conditions of all of its critical infrastructures – including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings – can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens."

Meanwhile, in 2010 IBM's Journal of Research and Development paid particular attention to the wide range of smart devices that collect information, calling it "an instrumented, interconnected and intelligent city."

These and other definitions are valid and helpful understandings of what smart cities are. The Council stands behind its comprehensive definition. But we mention these others so that cities that have planned and invested under these and other models will understand that we share complementary, not competitive, views of the smart city.

> ***Livability, workability and sustainability are the goals.*** *Smart cities use information and communications technologies to achieve them. Seoul, South Korea – pictured here – is often cited as one of the world's most vibrant, sustainable cities.*

Figure 1.3

The drivers of smart cities

Powerful forces are converging to make smart cities a growing trend all around the world. It is valuable for city leaders to understand what's behind this momentum and how it will play out in their region. Chances are some of the pain points described below will hit close to home.

Growing urbanization. Cities deliver many benefits – greater employment opportunities, greater access to healthcare and education, and greater access to entertainment, culture and the arts. As a result, people are moving to cities at an unprecedented rate. Over 700 million people will be added to urban populations over the next 10 years. The United Nations projects that the world's cities will need to accommodate an additional 3 billion residents by the middle of the century. A recent UN report suggests that 40,000 new cities will be needed worldwide.

Growing stress. Today's cities face significant challenges – increasing populations, environmental and regulatory requirements, declining tax bases and budgets and increased costs – at the same time many are experiencing difficult growing pains ranging from pollution, crowding and sprawl to inadequate housing, high unemployment and rising crime rates.

Inadequate infrastructure. Urbanization is putting significant strain on city infrastructures that were, in most cases, built for populations a fraction of their current size. Much of the developed world has infrastructure that is near or past its design life, requiring massive upgrades. For instance, in 2013 the American Society of Civil Engineers gave the United States an overall grade of D+ for its infrastructure. Meanwhile, much of the developing world has missing or inadequate infrastructure, requiring massive build-outs. The 2012 blackout in India that left more than 600 million people without electricity is a prime example; the country has inadequate power generation to meet ever-increasing demand. The bottom line? McKinsey & Company estimates that cities will need to double their capital investment by 2025, to $20 trillion from today's $10 trillion per year.

Growing economic competition. The world has seen a rapid rise in competition between cities to secure the investments, jobs, businesses and talent for economic success. Increasingly, both businesses and individuals evaluate a city's "technology quotient" in deciding where to locate. A real challenge for cities with economies based on heavy industry is

Growing urbanization drives change.
Over 700 million people will be added to urban populations over the next 10 years. The United Nations projects that the world's cities will need to accommodate an additional 3 billion residents by the middle of the century. A recent UN report suggests that 40,000 new cities will be needed worldwide.

Figure 1.4

creating job opportunities that appeal to recent university graduates so they will stay and help build the kind of high-quality workforce that new industries, for instance those in technology, demand.

Growing expectations. Citizens are increasingly getting instant, anywhere, anytime, personalized access to information and services via mobile devices and computers. And they increasingly expect that same kind of access to city services. In fact, a May 2013 United Nations survey of over 560,000 citizens from 194 countries revealed their top priorities are a good education, better health-care and an honest and responsive government. We also know that people want to live in cities that can provide efficient transportation, high-band-width communications and healthy job markets.

Growing environmental challenges. Cities house half of the world's population but use two-thirds of the world's energy and generate three-fourths of the world's CO_2 emissions. If we are going to miti-gate climate change, it will have to happen in cities. Many regions and cities have aggressive climate and environmental goals – goals that cannot be reached without the help of smart tech-nologies. Smart cities are better able to address resiliency and adaptation to climate change

Rapidly improving technology capabilities. Many of the smart city drivers listed above are negatives – problems that demand solutions. There are

One-stop shopping for city services.
Citizens increasingly expect instant, anywhere, anytime personalized access to information -- and they want it optimized for whatever device they are using. The web portal pictured here is from the province of Quebec, Canada and uses technology from Council member Alphinat. Its goal is to give businesses "one-stop shopping" for virtually all of their needs – permits, licensing, taxes, etc. In many cities taking care of business needs requires dealing individually with numerous different city departments.

Figure 1.5

positive drivers as well, especially the rapid progress in technology. The costs of collecting, communicating and crunching data have plunged. What's more, much of the needed technology is already in place:

- Over the last decade, many regions have begun to modernize their electric power grids and, to a lesser extent, their water and gas networks. Hundreds of millions of smart meters and smart sensors are now in place, producing data of value to a smart city.

- With the arrival of smart thermostats and building management systems, there are now millions of buildings with some of the pieces needed to be smart, on the cusp of being able to 'talk' and 'listen.'

- The reduced costs of solar energy and renewables systems (distributed generation) is increasing adoption rapidly in homes and businesses. By balancing these new resources with the grid, cities can increase their energy sustainability.

- On the health and human services front, we're seeing better access to healthcare with in-home consultations via computer. Meanwhile most agencies are switching to electronic records and many are using analytics to improve results.

- Our highways and byways are becoming smarter thanks to intelligent transportation management software, roadway sensors and smart parking apps. Navigation apps and equipment display real-time traffic so users can find – and even be automatically pointed to – less congested alternatives. And we are seeing more electric vehicles on our roads which help reduce pollution and our dependence on oil.

- Over the last two decades, we have deployed high-bandwidth networks worldwide that connect one billion computers and four billion cell phones. These networks are already in place in almost all major cities and can be leveraged for smart city applications.

- An increasing number of cities are starting to benefit from a large network of Near-field Communication (NFC) equipped point of sales with the roll-out of contactless cards.

> ***Rapid progress in technology.***
> *An increasing number of cities are starting to benefit from technology that allows merchants to accept payments via smartphones and wallets.*
>
> *Figure 1.6*

Let's consider that final example in more detail. It's important to realize that today's ubiquitous smartphones are becoming both a "delivery platform" and a "sensor network" for smart city applications. The delivery platform is obvious – a smartphone is a great place for a resident to receive alerts and access city services. But today's smartphones can also be leveraged to collect information when the user agrees to share data. For instance, one smartphone launched in 2013 has the following sensors: a GPS locator, a microphone, a gyroscope, a light sensor, a camera, an accelerometer, a barometer, a thermometer, a magnetometer and a hygrometer.

"By the end of the decade, many infrastructure technologies – smart meters, intelligent traffic systems, building energy management – will be deployed across North America and Europe and, increasingly, in the rest of the world," says Navigant Research analyst Eric Woods. Once

Rapidly improving technology capabilities:

TFL SUCCESS WITH CONTACTLESS PAYMENTS POINTS THE WAY

Transport for London (TfL) first introduced contactless payments on London buses in 2012. They were extended in September 2014 to cover all modes of travel on the world's largest contactless pay-as-you-go network – covering bus, rail, Tube and tram.

The legacy Oyster smart card developed by Council member Cubic Transportation Systems helped set the stage for London to become the first major city in the world to accept contactless bank cards for payment. Since contactless was introduced, the uptake has steadily increased. As of February, 2015, around 500,000 contactless journeys are made every weekday, representing 10% of all pay-as-you-go trips.

Central to the seamless transition was the Cubic Tri-Reader 3, developed in conjunction with TfL and the first contactless smart card device compatible with all industry standard transportation schemes and contactless payment cards.

More than 20,000 of the readers were retrofitted ahead of the contactless launch with upgrades made to buses, gates, card readers and validators. Cubic also developed sophisticated front and middle office systems to link with TfL's own back office system for processing payments.

"This was a fantastic partnership endeavor and throughout the payments industry, it is clear the knock-on 'halo effect' produced by London's success has led to a boost in the wider acceptance of contactless across the board," noted John Hill, managing director, Cubic Transportation Systems Europe.

> ***Rapidly improving technology capabilities.*** *Bringing contactless bank card payment to London's entire transit network required innovation at a global scale and a readiness to engage with the mobile payments ecosystem.*
>
> ***Figure 1.7***

in place, that technology provides the basis for a wide range of innovative smart city applications and services.

Rapidly declining technology costs. Even as capabilities are climbing, technology costs are plummeting. Hardware costs are declining at a steady pace. But it is software costs that have plunged the most, thanks to four trends.

The first trend is the advent of inexpensive mobile apps and information services viewable by mobile phones. Those phones are so popular that millions of developers have turned their attention to building applications, many of which cost only a few dollars. Mobile technology has allowed citizens of developing countries to essentially leapfrog into 21st century expectations – and cities have to find ways to address them.

The second trend is the arrival of social media. Applications such as Facebook and Twitter act as free "platforms" to deliver alerts, updates or even small-scale apps. They also act as "listening posts" that help cities monitor citizen needs and preferences. In fact, companies such as IBM and Microsoft now have the capability to use machine intelligence to monitor social media and derive trends.

The third trend is the maturation of cloud computing. Cloud computing delivers powerful solutions via the Internet. Suppliers save money because they can build one solution and sell it to many different users, gaining tremendous economies of scale. Users save money because they don't have to buy and maintain giant data centers or hire and train large IT staffs. Only a few years ago, advanced applications were available only to the very biggest agencies and corporations. Today – thanks to cloud computing – they are not out of reach for even the smallest township. And they are available without a giant upfront investment, simply by paying a monthly fee.

The fourth trend is about the data. From an analytics perspective, we can now cost effectively handle the high volume, velocity and variety of data – e.g. Big Data.

And there's much more to come. The smart city is part of an even larger trend – the "Internet of Things" or "Internet of Everything." Technology provider Cisco estimates there were 200 million devices connected to the Internet in the year 2000. By 2012, that number had increased to 10 billion. A 2015 report from Cisco and DHL predicts there will be 50 billion devices connected to the Internet by 2020.

Clearly we are entering a remarkable new phase. Research firm IDC predicted in 2012 that the smart city market would grow by 27% year over year. Meanwhile, Navigant Research said it would hit $20 billion in worldwide sales by 2020. And a 2014 Cisco study predicted the Internet of Everything will be a $19 trillion global opportunity over the next decade: Private-sector firms can create as much as $14.4 trillion of value while cities, governments and other public-sector organizations can create $4.6 trillion.

No surprise the world's biggest corporations and brightest entrepreneurs are racing to bring their best ideas to this market. And the fierce competition is raising capabilities, increasing choice and lowering costs at a rapid pace, making smart cities more viable every day.

> ***The "Internet of Things."***
> *Cisco estimates there were 200 million devices connected to the Internet in the year 2000. By 2012, that number had increased to 10 billion. A 2015 report predicted there will be 50 billion by 2020.*
>
> *Figure 1.8*

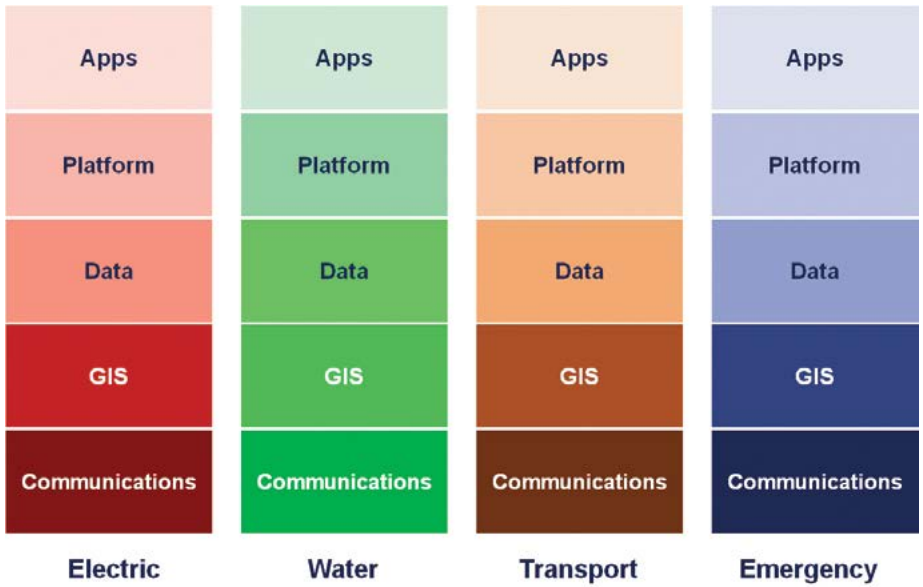
The barriers to smart cities

Despite the powerful drivers in favor, the path to smart cities has obstacles along the way. Members of the Smart Cities Council have worked on thousands of smart city projects all over the world. As they've collaborated with local governments certain consistent barriers have emerged.

Siloed, piecemeal implementations. Cities often tackle challenges in a piecemeal fashion, due to short-term financial constraints and long-term traditions that divide city functions into separate, "siloed" departments with little interaction. As a result, many projects are built to solve a single problem in a single department, creating "islands of automation" that duplicate expenses while making it difficult to share systems or data.

Building a smart city requires a system-wide view and an integrated, cross-departmental approach. The bad news: holistic thinking and collaborative work are hard. The good news: done right, they can save time and enable new services that were not possible in an isolated, siloed model. For instance, a city department can drastically cut the development time for a new application by re-using data and software modules already created by other departments. A municipal water utility can drastically cut the cost of a communications network by using one already built out for an electric utility. And a city can sometimes reduce overall information and communications technology (ICT) costs by as much as 25% just by implementing a master ICT architecture and technology roadmap.

This is not to suggest that cities must finance and implement dozens of investments at one time. In fact, it is entirely fine to begin with just one or two projects. What is critical is that these projects all fall into a larger, integrated



THE PROBLEM WITH "SILOED" CITIES

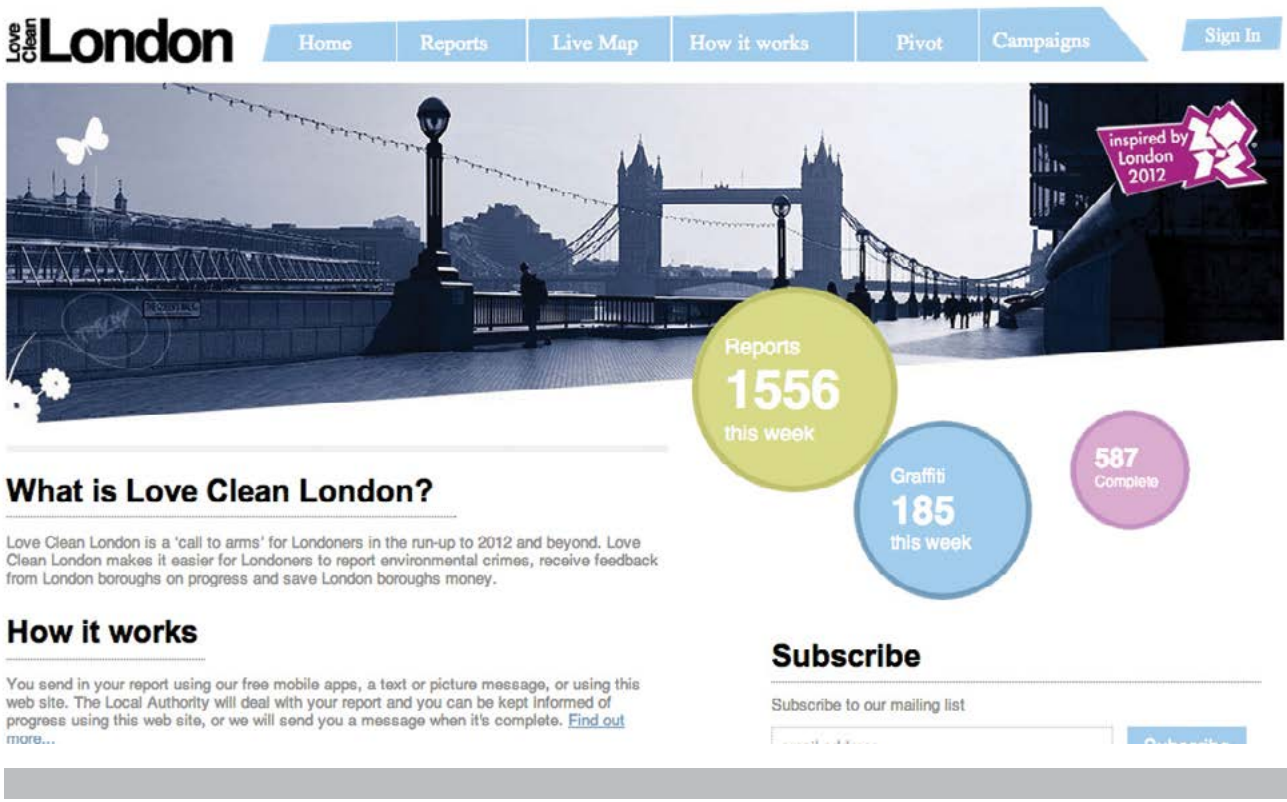
> ***Expensive redundancies.*** *Despite the fact that modern IT architectures make it possible to connect city departments and solutions today,, far too many cities still use a "siloed" approach to smart city applications. Individual departments build individual applications, with little regard to sharing costs, infrastructure and data. The result is expensive redundancies and unnecessary difficulties in coordinating between those isolated applications.*

Figure 1.9

plan so that city investments are not redundant. Silo avoidance depends on the use of widely adopted open international standards.

Most experts agree that technology will not be the gating factor for the smart city transformation. Instead, we will be limited by our human ability to coordinate and collaborate between departmental and technology silos.

Lack of financing. Tax revenues are shrinking in many cities, making infrastructure projects increasingly difficult to finance. In fact, some cities have been forced to implement austerity measures – such as furloughing employees one day a month or cutting back on travel and discretionary expenses. Yet if those cities remain old-fashioned while others modernize, they will suffer even more, since cities must now compete globally. Fortunately, new financial models are emerging. And payment innovations like e-Procurement or electronic benefits can help cities reduce costs and free up money to invest in infrastructure and other improvements. Some of them require little or no upfront capital from the city. Instead, the city "rents" its solution as it goes. And performance contracts and shared revenue models between the city and solution vendors provide cities with attractive financing solutions. What's more, many smart city solutions have a rapid payback so that they save money over the long run. In many cases, the technology can actually improve the city's economic return.



> ***A new view of city apps.***
> *Early city applications were inward-facing and intended just for city employees. Today, more and more cities are producing outward-facing apps. For example, to get citizens involved in cleaning up London before the 2012 Summer Olympics, the city worked with Council member Microsoft on the Love Clean London portal (above) and companion mobile app that gave citizens an easy way to alert authorities to litter and graffiti by texting or uploading images. It's still being used today.*
>
> *Figure 1.10*

The barriers to smart cities. *Despite the powerful drivers in favor, the path to smart cities has obstacles along the way. Sometimes it comes down to lack of a smart city visionary. Cities need a smart city champion — a mayor, a city manager, a planning director. Or it can come from outside city hall — civic or business leaders or a public-private partnership, for example.*

Figure 1.11

Lack of ICT know-how. Although industry has developed highly sophisticated ICT skills, few city governments have had the budget or the vision to push the state of the art. Since smart cities are essentially the injection of ICT into every phase of operations, this lack of ICT skills puts cities at a disadvantage. Fortunately, more and more applications are offered as a service. That is, they are hosted in the cloud (out on the Internet) where they have access to tremendous computing power, virtually unlimited storage and innovative software. Another plus is that the smart city sector has developed a large cadre of experienced global, regional and local consultants and service providers who are partnering with cities to deploy ICT solutions.

Lack of integrated services. To the extent cities applied ICT in the past, they applied it to their internal, siloed operations. The result has been a grab-bag of aging applications that only city employees can use. Although this was an acceptable practice in the last century, today we can and must allow citizen access and self-service. There is no reason that citizens who want, for instance, to open a restaurant should have to make multiple applications to multiple city departments. In a smart city, a single portal can gather all the data and parcel it out to the appropriate departments. Likewise, residents should have instant access to up-to-the-minute information about their energy and water usage, their taxes and fees, their social services programs and more. And ideas like Open Data not only improve transparency, they enforce a people-first perspective that is critical in smart cities

Lack of citizen engagement. The smart cities movement is often held back by a lack of clarity about what a smart city is and what it can do for citizens. As a result, many stakeholders are unaware of the smart city options that have found success already. Often, there is a communications issue. Cities should be wary of being too abstract with their smart city initiatives, recognize that citizens care about services that make their lives better, and adjust their engagement accordingly. Cities need to recognize when they need citizen and business awareness versus complete 'buy in.'

Remedying the citizen engagement challenge will require visionary leadership that paints a picture of the benefits technology can bring. In the U.S. in the late 2000s, several electric power utilities learned this lesson the hard way. They rolled out smart meters without explaining how customers would benefit. They suffered consumer backlash and resistance as a result.

Lack of a smart city visionary. Every parade needs a leader. Sometimes that leadership comes from an elected official – a mayor or council person who acts as the smart city champion. Smart city leadership can also come from elsewhere in the administration –

Engaging citizens:

HOW CAPE TOWN IS BECOMING A 'CITY OF OPPORTUNITY'

The City of Cape Town is achieving its vision of becoming a "City of Opportunity"—a united, efficient and inclusive city in which everyone has the opportunity to further their dreams.

The city is using Council member Microsoft's software to transform its infrastructure with a private cloud to standardize service delivery to all constituents. Cape Town engages its citizens through an eGovernment portal and accelerates opportunities, for example, by working with Microsoft BizSpark to support local startups to optimize public transport.

Taking advantage of the Microsoft CityNext initiative, Cape Town is using a Windows 8 app developed by local startup WhereIsMyTransport. To increase ridership the company developed the app for smartphones and also offers a text-based option for people using less-expensive "feature" phones so that citizens from all neighborhoods, and tourists, can access transit schedule information to optimize their movements around the city. The information gathered from the public's use of the apps is stored in Microsoft Azure for planners to design future transit services and infrastructure improvements.

Cape Town is also partnering with Microsoft-sponsored social programs such as the 4Afrika Initiative and YouthSpark to empower young people with opportunities for education, employment, and entrepreneurship.

> ***Engaging citizens.*** *Cape Town has been working with Microsoft to enable a "people first" approach to service delivery that supports its vision of providing the same opportunities for all citizens.*
>
> ***Figure 1.12***

a city manager or a planning director, for instance. Or it can come from outside city hall altogether with involvement from business leaders, civic organizations or public-private partnerships.

The benefits of smart cities

Now let's look at why it is so worthwhile to overcome those barriers and take advantage of the technology advances described earlier that allow you to re-imagine your city. With the right planning and investment, government leaders can make our cities more livable, more workable and more sustainable – both economically and environmentally. Let's examine those overall goals, which are the very purpose of becoming smart.

Enhanced livability means a better quality of life for city residents. In the smart city, people have access to a comfortable, clean, engaged, healthy and safe lifestyle. Some of the most highly valued aspects include inexpensive energy, convenient mass transit, good schools, faster emergency responses, clean water and air, low crime and access to diverse entertainment and cultural options.

Enhanced workability means accelerated economic development. Put another way, it means more jobs and better jobs and increased local GDP. In the smart city, people have access to the foundations of prosperity – the fundamental infrastructure services that let them compete in the world economy. Those services include broadband connectivity; clean, reliable, inexpensive energy; educational opportunities; affordable housing and commercial space; and efficient transportation.

Enhanced sustainability means giving people access to the resources they need without compromising the ability of future generations to meet their own needs. Merriam-Webster defines sustainability as a method of using a resource so that it is not depleted or permanently damaged. When the Council uses the term, it refers not only to the environment, but also to economic realities. Smart cities enable the efficient use of natural, human and economic resources and promote cost saving in times of austerity, and they are careful stewards of taxpayer dollars. It isn't about investing huge sums of money into new infrastructure, it's about making infrastructure do more and last longer for less.

Life is better in a smart city – better for people and better for businesses. In the chapters to come, we will discuss dozens of specific benefits that accrue to cities that embrace the smart city vision. But let's take a moment to summarize them by imagining a day in the life of a citizen in our smart city.

Smart cities enhance livability. *Residents have access to a comfortable, clean, engaged, healthy and safe lifestyle.*

Figure 1.13

Enhancing livability, workability and sustainability:

REVITALIZING D.C.'S RIVER WATERFRONT AND URBAN NEIGHBORHOODS

In a partnership among 19 federal and District of Columbia government agencies, the Anacostia Waterfront Initiative (AWI) is bringing communities together and residents to the doors of new businesses.

AWI is a trailblazing endeavor that is removing physical barriers and opening a gateway to the future by transforming a once disconnected and deficient urban environment.

Council member CH2M is working alongside the District Department of Transportation on this visionary urban revitalization, helping to transform neighborhoods in the nation's capital and create lasting legacies by amplifying their unique strengths.

The 30-year, $10 billion project is restoring the long-neglected Anacostia Waterfront, reconnecting neighborhoods and showcasing their historic and cultural identity.

Aimed to leverage private investment in the economy and provide a cleaner river environment, AWI offers residents and businesses blocks of revitalized urban areas through multimodal transportation, waterfront parks and recreation areas. Serving as the spine of the economic revitalization, the transportation infrastructure is connecting new mixed-use development areas along key corridors. The conversion of highways to urban boulevards, improved connectivity between neighborhoods and the elimination of regional travelers from local streets is improving development opportunities, commuter traffic flow and quality of life for local residents.

> ***Enhancing livability, workability and sustainability.*** *The Anacostia project in Washington, D.C. is transforming a once disconnected and deficient urban environment.*
>
> ***Figure 1.14***

AT A GLANCE: TRADITIONAL CITIES VS SMART CITIES

	The Problem	The Smart City Solution
Planning	• Ad hoc and decentralized • Cost savings aren't realized • Limited potential for scalability of investment	• Coordinated and holistic • Resources are shared • Cost savings are fully realized • Investments are scalable • Improved city planning and forecasting
Infrastructure	• Runs inefficiently • Costs more money and resources to run	• Optimized with cutting-edge technology • Saves money and resources • Improved service-level agreements • Built on open standards
System operators	• Guess at infrastructure conditions • React to problems • Can't deploy resources efficiently to address problems	• Enjoy real-time reporting on infrastructure conditions • Predict and prevent problems • Deploy resources more efficiently • Automate maintenance • Save money
ICT investments	• Piecemeal and siloed • Deliver suboptimal benefit • Don't realize economies of scale	• Centrally planned • Deployed across city departments and projects • Deliver optimal benefit • Provide maximum value and savings
Citizen engagement	• Limited, scattered online connection to citizens • Citizens can't make optimal use of city services (or easily find them)	• Complete and singular online presence • Citizens can easily find and use services • Citizens can participate in smart city initiatives • Two-way communications between government and people • Specialized services focused on the individual citizen • Citizens can both contribute to and access real-time intelligent city data and offer apps that use the data
Sharing data	• Departments and functions are siloed • Departments rarely share data and collaborate on initiatives	• Departments and functions are integrated and/or shared • Data is shared between departments and better correlated with other data services through open standards • Results are improved • Costs are cut

Figure 1.15

ADDITIONAL RESOURCES

Norfolk County utilizes a cloud-based information hub to transform the delivery of integrated public services
Utilizing the economic and social value of big data held by the Norfolk County Council and partner agencies, this Microsoft video explains how the hub will help create a local knowledge economy, improve education and attract investment.

Moving to a Smarter City
The Internet of Things (IoT) can help address many of the most pressing problems facing towns and cities today, from congestion and energy use to public safety. For a quick summary of ways IoT can do that, download this infographic from Council member Verizon.

Smart City Readiness Graphic
This infographic lhighlights drivers, challenges and steps for moving forward toward smarter cities. It is based on a survey of North American municipal leaders conducted by Cisco and the Smart Cities Council in September 2014.

The Smart Revolution
This white paper from Council member Black & Veatch presents the framework for Smart Integrated Infrastructure. From advancements through the smart evolution cycle to the role of smart analytics in planning for a smarter future, it addresses why the world as we know it is getting smarter and more integrated, the value and implications that brings society and how utilities and municipalities can prepare for it.

The Path to a Smarter City
A convergence is happening between smart grid platforms and smart city platforms. Learn in this video from Council member Silver Spring Networks about the opportunities that provides cities to take advantage of a common infrastructure to drive a whole host of compelling services.

CHAPTER 2

HOW TO USE THE READINESS GUIDE

The role of the Readiness Guide is to help you transition to a smart city, at your own pace and on your own terms. This chapter explains the Smart Cities Framework that supports that mission. We think you will find it a useful mechanism to understand the totality of a smart city and how the pieces work together.

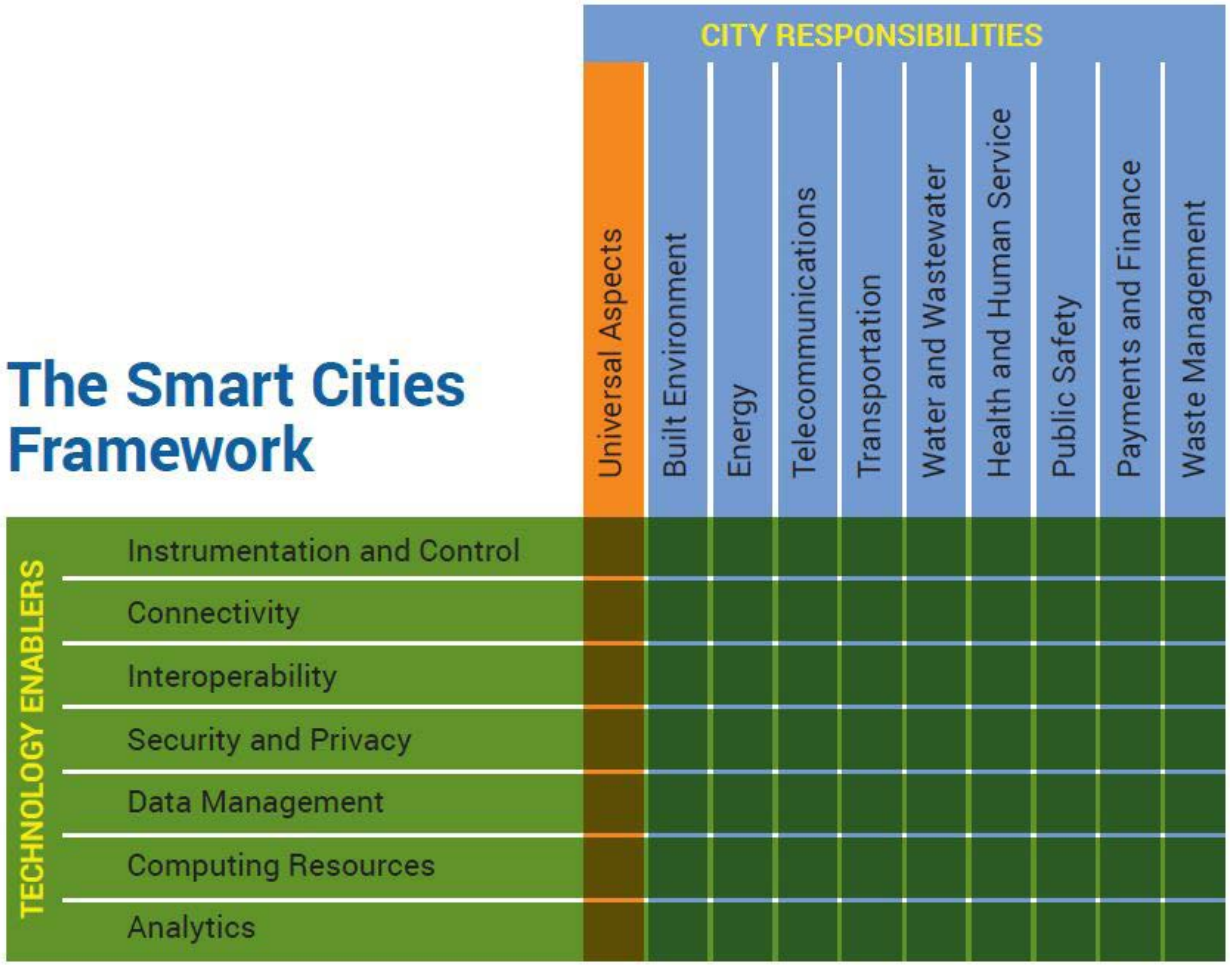
This chapter gives you what you need to construct a "target list" or "wish list" for your city. When you are ready to turn that list into an actual plan, you'll find guidance in Chapter 14, "Ideas to Action."

Our introduction defined the smart city as one that uses information and communications technology (ICT) to enhance livability, workability and sustainability. The Smart Cities Framework captures this relationship between a city's responsibilities (what it needs to accomplish for citizens) and its enablers (the smart technologies that can make those tasks easier).

THE SMART CITIES FRAMEWORK

> ***Aligning responsibilities and enablers.***
> *The vertical responsibilities denote essential services that cities require. The horizontal enablers are technology capabilities that improve those responsibilities.*

Figure 2.1



Smart city responsibilities

Cities have essential functions and services that must be available every day. Homes must have water, businesses must have power, waste must be collected, children must be educated and so on. In the Readiness Guide, we refer to these vertical city functions as *responsibilities.* Although not all of them fall under a city's direct control, all of them are essential to everyday life and commerce. The nine city responsibilities are:

1. **Built environment.** In the Readiness Guide, built environment refers to all of a city's buildings, parks and public spaces. Certain components of the built environment – including streets and utility infrastructure – are not emphasized here because they are treated in other responsibilities (transportation and energy).

2. **Energy.** The infrastructure to produce and deliver energy, primarily electricity and gas for powering virtually all services and needs, processes and comfort.

3. **Telecommunications.** This term can have several different meanings. The Readiness Guide uses the telecommunications responsibility to refer to communications for people and businesses. We use connectivity to refer to communications for devices.

4. **Transportation.** A city's roads, streets, bike paths, trail systems, vehicles, railways, subways, buses, bicycles, streetcars, ferries, air and maritime ports – any and every system that relates to citizen mobility.

5. **Health and human services.** The essential human services for the provision of health care, education and social services.

6. **Water and wastewater.** The infrastructure responsible for water – from collection to distribution, to use and finally reuse and recycling. Pipes, distribution centers, catchment areas, treatment facilities, pump stations, plants and even the water meters at private homes are all essential components of this responsibility. Water purity and cleanliness are also addressed here.

7. **Waste management.** The infrastructure responsible for the collection, distribution, reuse and recycling of waste materials.

8. **Public safety.** The infrastructure, agencies and personnel to keep citizens safe. Examples include police and fire departments, emergency and disaster prevention and management agencies, courts and corrections facilities.

Figure 2.2

9. **Payments and finance.** Payments link a payer and a payee and refer to all the key contributors involved: government services, merchants, consumers, businesses, banks, payment instruments providers, payment schemes. Payments sit at the heart of the economic activity in cities and form the core component of every economic flow including salaries, consumer spending, business procurement and taxes. They have become so systematic that they often go unnoticed.

Smart city enablers

Smart cities can radically improve all of the responsibilities through the power of ICT (information and communications technology). ICT can make buildings more efficient, water and energy more affordable, transportation quicker and neighborhoods safer. In the Readiness Guide, we refer to these transformative technologies and capabilities as *enablers.*

They put the "smart" in smart cities. The seven technology enablers are listed below.

1. Instrumentation and control is how a smart city monitors and controls conditions. Instrumentation provides the eyes and ears of a smart city. Examples include smart meters for electricity, water and gas; air quality sensors; closed circuit TV and video monitors and roadway sensors. Control systems provide remote management capabilities. Examples include switches, breakers and other devices that let operators measure, monitor and control from afar.

2. Connectivity is how the smart city's devices communicate with each other and with the control center. Connectivity ensures that data gets from where it is collected to where it is analyzed and used. Examples include citywide WiFi networks, RF mesh networks and cellular networks. (Note: When a cellular network communicates with devices, the Readiness Guide refers to it as connectivity. When it lets people communicate, the Guide uses the term telecommunications. These are arbitrary distinctions used only in the Guide to make it easier to distinguish between the two sides of communications – devices and people.)

3. Interoperability ensures that products and services from disparate providers can exchange information and work together seamlessly. Interoperability has many benefits. For one, it prevents the city from being "locked in" to just one proprietary supplier. For another, it gives the city more choice, since it can buy from any company that supports the city's chosen standards. For another, it lets the city build projects over time in phases, with confidence that all the pieces will work together in the end. Open standards are the key to interoperability.

4. Security and privacy are technologies, policies and practices that safeguard data, privacy and physical assets. Examples include the publishing of clear privacy rules and the implementation of a cybersecurity system. Security and privacy play a critical role in enabling smart cities because they build trust with people. Without trust, a city may have difficulty adopting new technologies and practices.

5. Data management is the process of storing, protecting and processing data while guaranteeing its accuracy, accessibility, reliability and timeliness. Data is king in a smart city. Proper management is essential to maintain data integrity and value. A citywide data management, transparency and sharing policy – including proper policies around access, authentication and authorization – is one step toward proper data management, as explained below.

6. Computing resources include 1) billions of computer "brains" of all sizes, from wrist watch components to server farms, 2) in those computers, a similar range of simple to very complex software, and 3) data, which has little value until it is communicated. Open standard software interfaces and data encodings enable digital communication. Most city data refers to things and phenomena where locations are important, so spatial standards are among the essential open standards that enable smart cities.

7. Analytics create value from the data that instrumentation provides. Examples include: forecasting crime the way we already forecast weather; analyzing electric power usage to know when and where to expand or adjust to accommodate demand; analyzing conditions to predict which equipment needs repair; automatically plotting the best route for a mass transit user, and creating personalized portals for every citizen by analyzing what they value most. And analytics that utilize data from across departments have tremendous potential to identify new insights and unique solutions to delivering services, thereby improving outcomes.

The role of dependencies in smart city planning

In the previous chapter we explored the dangers and pitfalls of siloed cities. Cities that don't coordinate their various departments at the technology planning level often end up with redundant investments in technologies, training and even personnel.

But there's an even deeper connection between smart city responsibilities that can't be overlooked. That's the matter of dependences. Since so many city systems, services and infrastructures are connected in one way or another, becoming smart in one area is often dependent on progress being made in another.

As cities develop long-term goals and plans, it is important to consider how desired improvements to the performance of a single responsibility may require improvements in a responsibility on which there is a dependency. For example, cities cannot expect to foster a healthy population if water systems cannot ensure water quality. Yet water systems rely heavily on energy systems to pump and move water through city infrastructure. So, as you plan projects to improve water infrastructure, be sure to examine any requirements that need to be addressed by electrical systems and the distribution grid. Think holistically to avoid having to make major system changes or unanticipated course corrections further into your smart city planning.

As you move through the chapters in this Guide, we will highlight dependencies that merit consideration. You'll come to realize that understanding dependencies is another reason to bring cross-departmental teams together early in your smart city planning process.

> ***The role of dependencies.*** *A healthy population is dependent in part on quality drinking water which, in turn, is dependent on energy systems that pump the water. Thinking holistically early in the smart city planning process will help avoid unexpected roadblocks later.*
>
> *Figure 2.3*

LIVING PlanIT BUILT SMART FROM THE GROUND UP

Council member Cisco is one of the high-tech companies partnering with the government of Portugal to invent and build a state-of-the-art smart city from the ground up. Located in the town of Paredes about two hours north of Lisbon, Portugal, the project is spearheaded by Portuguese company Living PlanIT. Situated on more than 4,000 acres, the community will take at least four years to complete at an estimated cost of $10 billion. It will eventually house about 225,000 people, many of whom will work for Living PlanIT's technology partners at new research and commercialization centers.

The city is designed as a living laboratory for new technologies. Data collection sensors will be added to virtually everything, from refrigerators to trash containers to traffic lights. Those sensors will monitor every aspect of urban life, including traffic flow, energy consumption, water use, waste processing, even the temperature of individual rooms. All these sensors will be connected to Living PlanIT's Urban OS (UOS), a middleware platform that is embedded in the fabric of buildings and infrastructure.

> ***A consortium led by the Living PlanIT company is creating a smart city from the ground up in northern Portugal.*** *Data collection sensors will be added to virtually everything, from refrigerators to trash containers to traffic lights.*
>
> *Figure 2.4*

Developing an intelligent city platform. *The city's digital control system will accommodate an expanding list of applications, from managing electricity demand to routing traffic to finding a parking spot, to name just a few.*

Figure 2.5

UOS will integrate with Council member Microsoft's Devices & Services Platform to enable city governments to deliver a comprehensive set of services. Cisco is acting as the master planner for information technology and communications design and architecture. Cisco is also building a cutting-edge data center at an estimated cost of $38 million.

The city's digital control system will accommodate an expanding list of applications, from managing electricity demand to routing traffic to finding a parking spot, to name just a few. In the event of a fire, for instance, sensors can pinpoint the location, alert people nearby, notify the fire station and manage the traffic lights so fire engines can reach the building as quickly as possible.

Or the control system might notice that the interior of a building is getting too hot. With its knowledge of the outside temperature plus the building's equipment and orientation, it could relay a command to darken the smart glass on the building's sunward side to reduce the sun's warming effect.

The consortium hopes to ultimately create a platform to enable a new generation of intelligent cities. "Software has transformed industries – medicine, education, science, finance, manufacturing," explains Steve Lewis, Living PlanIT's co-founder and CEO. "And software will transform our cities to achieve their economic, social and environmental potential."

The Readiness Guide structure

The Readiness Guide is comprised of multiple chapters. One chapter examines "universal" principles – enablers common to all responsibilities. The chapters that follow detail how individual city responsibilities – power, transportation, public safety, payments, etc. – should use the technology enablers. Two final chapters cover how to translate the Guide's theories into a roadmap.

Each chapter has three sections. The first section envisions what each responsibility could look like by the year 2030. The second section examines the benefits that arise from each target. Targets are goals – end points or outcomes a city should work toward. A third section provides a checklist of the relevant targets for that responsibility. You can use these checklists (and the summary checklist in the final chapter) to create a "wish list" that can inform and improve your smart city roadmap.

Scattered throughout are brief examples to show how cities are applying these theories in real life.

What this guide does NOT do. We've talked about what the Guide wants to do, but it's also important to acknowledge the things that are outside its scope.

The Guide does NOT suggest what your city's overall goals should be. Smart city technologies are a means to an end. Every city should decide for itself what ends it hopes to achieve. But whatever you're after, the targets described in this guide represent the best technical foundation for pursuing those goals.

The Guide does NOT propose which responsibilities should be prioritized. Every city has its own unique strengths and weaknesses, its own unique history and resources, its own unique preferences and aspirations. Some cities may choose to tackle transportation first, for instance, while others may feel that energy is more urgent.

The Guide does NOT pretend that its targets are set in stone. Change is continuous, and technology advances are famously unpredictable. The targets shown here are the best recommendations we can make today, as informed by a large contingent of the world's top experts. They will put cities on the right path, but cities will still need to make periodic evaluations and course corrections as technology evolves.

Figure 2.6

Roadmapping is how a city translates the theories of the Readiness Guide into a plan of action.

MALTA: WHY NOT A SMART ISLAND?

Located in the heart of the Mediterranean and known for its stable economy and pro-business government, Malta is a group of small islands 50 miles to the south of Sicily. Home to roughly 400,000 people, it has the highest population density in Europe, putting a genuine strain on power, gas, waste management and other essential services.

In 2008, the national energy and water providers partnered with Council members IBM, Itron and other suppliers to gradually roll out smart meters for all electric and water customers. The utilities are saving money by not employing meter readers. What's more, the metering data is integrated into new back-office applications for billing. It is also used for analytics that locate problems and determine when and whether to expand the grid.

So far, results have been very successful. For instance, the new smart water grid has increased theft detection, while also introducing new pricing options for customers that reward conservation.

With those smart grids in place, Malta has the foundational elements for a smart island. And the government is taking things even further in one corner. It is transforming an industrial park into a state-of-the-art information technology and media city. The goal of SmartCity Malta is to put everything a high-tech company needs to succeed in one place, including state-of-the-art ICT infrastructure along with a host of IT, media and production services. Melita, one of Europe's oldest cable operators, is providing a seamless broadband service for Malta with Council member Cisco's Universal Wi-Fi.

> ***The world's first smart island.*** *Thanks to its smart water and electricity networks, Malta is the world's first smart island. It is also the home of SmartCity Malta (shown here), a cutting edge development designed to attract high-tech industry.*

Figure 2.7

Conclusion

As you review the chapters that follow, you can use the checklists at the end of each one to note where your city is currently weak or strong. Once you've completed those assessments, you can transfer them to the summary checklist in the final chapter, Ideas to Action. With that summary in place, you'll be ready to build your smart city roadmap, using the tips and techniques provided in that last chapter.

The mission of the Smart Cities Council Readiness Guide is to set you on the path to becoming a city of the future – a smart city with enhanced livability, workability and sustainability. It will take patience to march through each chapter to compile your own "wish list" of essential features. And it will take leadership to build those features into a comprehensive smart city plan that has the support of the public.

But amazing advantages await those cities that make the effort. Their citizens will have a healthier, happier place to live along with better, higher-paying jobs. And all of that in a sustainable fashion that doesn't rob from the next generation.

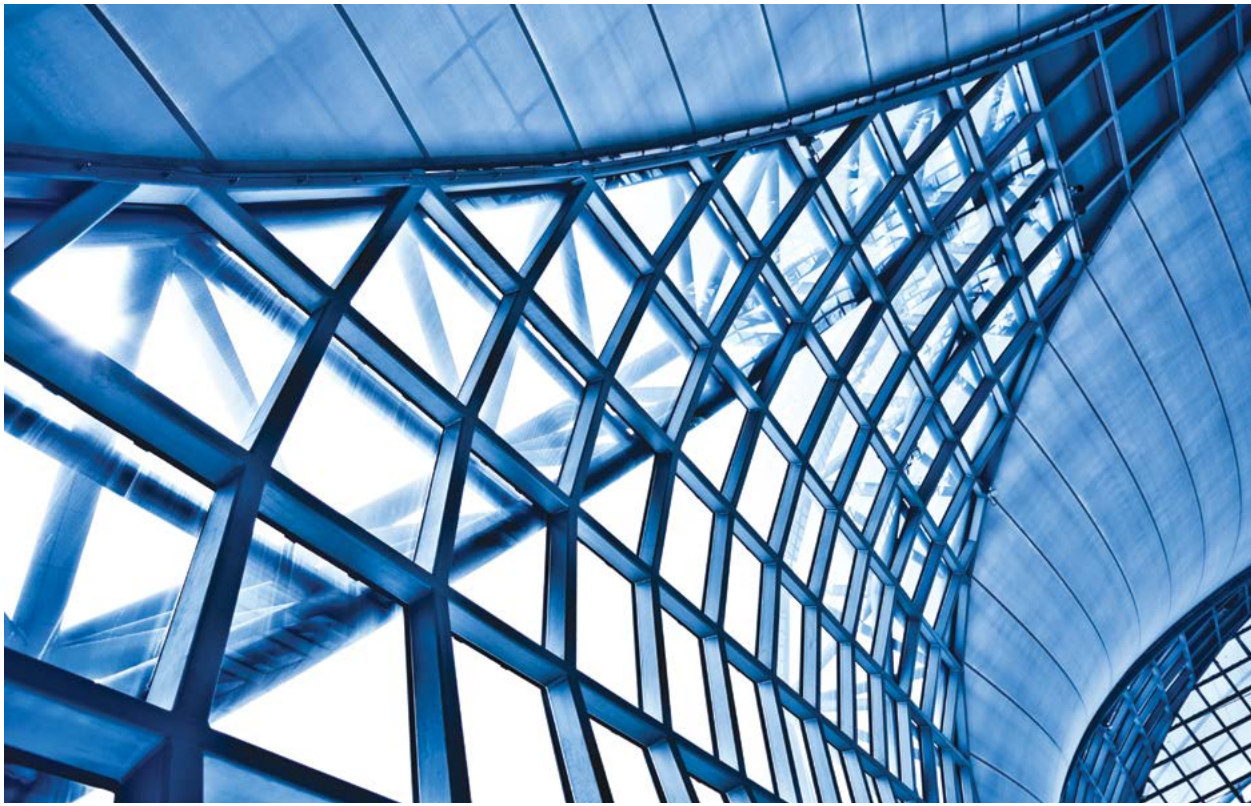


Figure 2.8

CHAPTER 3

SMART PEOPLE

A city isn't smart because it uses technology. A city is smart because it uses technology to make its citizens' lives better. This chapter focuses on the "secret sauce" that turns the idea of a smart city into reality – the people who live in the city, who work in the city and the people who have hopes and dreams for the kind of city they will leave for future generations.

Not so many years ago the idea of a smartwatch you could listen to music on or monitor your heart rate with would have seemed farfetched. And using your smartphone to find a parking spot and pay for it? Or a contactless card that means no more waiting in lines for tokens when you ride the subway?

Too often smart technologies are portrayed as a means to streamline, optimize, integrate, digitalize, systematize, consolidate and otherwise improve infrastructure. And that's certainly a part of what smart ciites are about. As more and more people move to urban centers and strain often inadequate or aging infrastructure, optimizing, integrating and the like become essential if cities are going to provide their citizens with basic needs -- energy, water and shelter among them.

But too often that citizen focus is not underscored often or loudly enough by well-meaning city leaders struggling to find affordable solutions to pressing urban problems.

This chapter will focus on how to bring all city stakeholders together to develop a vision for the city they want to live in – and the one they want their children and grandchildren to live in. It's about listening; about reaching out; about education and oftentimes it's about a new mindset at city hall that is more open, more transparent and more focused on inclusion.

For example, does your idea of listening to citizens consist of giving people a few minutes to speak during public meetings? And are they invited to speak only after you've nearly finalized your plans? If this is how your city "listens," you probably aren't hearing what is really important to your constituents – nor are you hearing from a truly broad cross-section of your city's population. And your projects may well suffer as a result.

In this chapter we'll discuss a new mindset and showcase some of the exciting and innovative ways smart cities are building two-way communications with their citizens and creating stronger initiatives as a result. But first, let's underscore some of the ways information and communication technologies (ICT) are improving citizens' lives in very deep and personal ways.

> ***Use innovative approaches to encourage broad participation in city decisions.***
> *Smart cities encourage all city stakeholders to develop a vision for the city they want to live in.*
>
> *Figure 3.1*

The human side of technology

Technology for technology's sake rarely serves a useful purpose. The magic in technology is how it can transform lives. Consider these examples:

- **Helping the blind navigate the city.** The smart stick is an idea that came from a conversation an engineering student had with her blind uncle about the challenges he faced getting around a city. Connecting to the Internet of Things, the smart stick guides the blind safely by accessing information from traffic lights, cross walks, buses and construction and weather reports. Sensors at stores let them know if the store is open, what it sells, where the entrance is, etc. The project, backed by Council member Cisco, was developed by a team from the University of Lorraine in France.

- **Making cities more accessible for all.** Accessible Way is an app developed by Council member IBM to enable citizens to report on mobility issues they spot as they go about their daily lives – roads and sidewalks, crosswalks, curbs, traffic and street lights and such in of need repair. Or when there aren't enough handicapped parking spaces or when road signs are confusing. With just a few taps, people can report the exact location and type of the problem, giving cities detailed information to improve mobility.

- **Improving the health of people at-risk.** Myanmar, which has an exceptionally high rate of infant mortality, is providing pregnant women with a free app from Council member Ooredoo that provides health alerts with care information and locations of medical services. In China, where the textile workforce is predominately uneducated young women, a mobile program from Council member Qualcomm provides access to health services and information. Both projects are improving lives for populations that have disproportionately suffered with poor health care.

- **Helping children learn to read, write and tell stories.** In Australia, children who couldn't sit still for even a few minutes dramatically improved their language abilities when the lessons were presented in video game form. A project from Council member Microsoft made it easy for teachers to tailor the game technology to teach specific skills and to encourage the youngsters to practice.

Using open data to improve lives

Smart cities can get more mileage out of their ICT investments when they use analytics to sift the data provided via sensors and other smart devices to surface useful information that can help citizens improve their lives and livehoods. We'll talk in more detail later about the open data movement. You can also download the Council's Smart Cities Open Data Guide for help getting your city started down the open data path. In this section we'll focus

The human side of technology.
The smart stick enables the blind to navigate cities more easily.

Figure 3.2

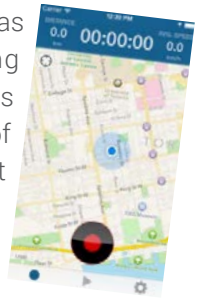
more on the benefits to citizens that can come from open data policies.

Opening or releasing data sets provides an opportunity for cities internally and the developer community externally to use the data to build web-based and smartphone applications. As the open data movement has snowballed, so too has the depth and breadth of apps available today.

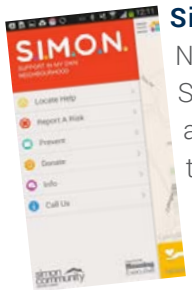
Consider just a few examples of common apps you can find in cities around the globe today:

- **Interactive crime maps** that help citizens see where crimes are occurring so they can take steps to be safer or be more vigilant and report suspicious behavior.
- **Traffic flow apps** help commuters find the fastest route to their destination and by doing helping relieve road congestion.
- **Air pollution alerts** inform people when air quality reaches a worrisome level, allowing them to take steps to stay safe..
- **Restaurant inspection apps** help citizens choose dining establishments that take food safety seriously and stay away from those that don't. By extension they provide an incentive for restaurants that have been lax with safety to do a better job.

Now let's look at a few city-specific apps. As you'll see, cities of all sizes are participating in the open data movement with apps that help residents and visitors alike in countless ways.



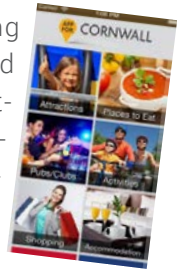
Toronto Cycling. This app has a dual purpose of enabling cyclists to track their rides with GPS and help the city of Toronto improve current cycling infrastructure and plan for future cycling investment.

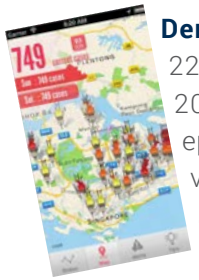


Simon. Developed by Belfast, Northern Ireland housing charity Simon, this app provides quick and easy access, at a local level, to services if someone is homeless or is at risk of becoming homeless and also gives community members a way to help individuals in need.

The Ferry App. Visitors to Seattle, Washington, often use car ferries that ply scenic Puget Sound. With this app, they won't rush to a ferry terminal only to learn their boat left 15 minutes earlier. Users can view ferry schedules, cameras and vessel positions and save favorite routes for quick access.

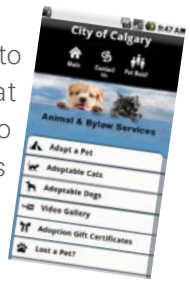
App for Cornwall. Boosting tourism in Cornwall, England is the intent of this smartphone app that provides information on attractions, activities, places to eat, pubs, clubs, shopping, accommodation and much more.





DengueLah. Singapore reported 22,318 dengue fever cases in 2013, making it the worst epidemic of the mosquito-borne viral disease since 2005, according to news reports. This app pinpoints dengue outbreaks in greater Singapore, based on data from the National Environment Agency.

Calgary Pets. People who want to adopt a pet or find one that they've lost can use this app to connect to the Animal Services Centre in Calgary, Alberta.



Smart Cities Apps Gallery

Browse through the Council's Apps Gallery for many more examples of smartphone apps developed by and for cities.

A day in your new urban life:

HOW SMART CITIES LEAD TO HAPPIER CITIZENS

It's Monday morning, a rare day off for Josie. But when the alarm on her smart wristphone chirps, she doesn't reach for the snooze button. "Too much to do today," she reminds herself. Peeking around her bedroom's solar curtain, she's pleased to see the sun shining brightly.

"Perfect," she decides. "I can bike over to the mall, drop off the bike and pick up a car when I'm done."

Josie doesn't actually own a bike or a car; living in a city with abundant share programs means she doesn't have to. And since the café she runs is only 10 blocks from her condo, she typically walks to work – or if the weather is really lousy hops on a bus. She's proud that her city has a smart transportation system that uses advanced technologies to streamline traffic flow – and that it works.

Wandering into the kitchen, Josie pours herself a cup of coffee that started brewing when her alarm went off. Between her smart wristphone and her smart thermostat, pretty much every creature comfort in her condo is automated. She told the system her preferences, of course, but from then on it took care of the details. If it notices her overriding the original settings, it quickly adapts to her new wishes. Her shower is programmed to run at the same temperature every day and her refrigerator sends an alert to her phone when she's running low on items she typically has on hand. She just brings up the list when she's at the grocery store.

She knows she'll miss her condo when she and Miguel move into the loft they found. But the condo is on the small side for two people. Though the loft is small too, it has transformable spaces thanks to "robot walls" that can be moved to create different spaces for different needs. Josie is especially happy with the new TeleWall. The high-definition bigscreen will let Miguel telecommute much of the time and she plans to use it for the online courses she's taking.

> ***Sensors and digitization will change lives.*** *Day-to-day living will become much more convenient in tomorrow's smart cities, thanks to the digitization of just about everything.*
>
> *Figure 3.3*

Continued on next page

Figure 3.4

After a quick trip to the roof to check on the garden she shares with the building's other tenants, she grabs her backpack and looks at a phone app to see the closest available bike-share. Turns out, there is one just around the corner. But if Josie had been running late or faced with rainy weather, she had only to enter her destination into her city transit app to get a route plan optimized for her preferences.

Jumping on her bike, she picks her destination from her favorites list and transfers her phone display to an overlay in her glasses. She instantly sees an alert from the city's traffic system warning of a downtown parade that threatens to jam up her usual route. She picks an alternate route calculated by the system and follows the directions as they appear in her glasses.

The purpose of her trip to the mall is to find something to wear to a party. But as she walks past the virtual city hall that occupies a small storefront near the mall entrance, she realizes she can take care of another item on her to-do list.

"This is pretty sweet," she says as she sits down in a private "closet" equipped with high-definition video equipment that allows her to interact with a remote city agent. She tells him she needs a permit for a street fair her cafe is going to participate in but doesn't know what it's called. The agent quickly finds the form she needs, transmits it to the touchscreen in front of her and Josie is able to fill it out and send it back within minutes. Before she leaves the agent mentions a new waste management system the city is testing at restaurants. It's "pay as you throw" – meaning the less they throw away and the more they recycle the lower their monthly bill. Josie likes the sound of that and signs up on the spot. She asks for daily updates. Since her trash and recycling bins are monitored by smart sensors, the city knows moment by moment how much trash Josie's cafe has accumulated. It can warn her when it looks like she'll exceed the goal she set for herself, while there is still time to improve.

She spends another hour trying on dresses suggested by the store's shopping service, which taps into a history of past purchases that Josie has rated and posted for just this purpose. Then glancing at her wrist, she realizes she has to get moving. She promised to take her grandmother to a medical appointment and doesn't want to be late. As she walks toward the mall exit on floors that harvest energy from her footsteps, she passes a car-share wall display that has embedded smart tags. She waves her wristphone at the wall to find the nearest electric car– and sees there's one fully-charged just two blocks away.

During the medical appointment, Josie is relieved to see the specialist her grandmother is seeing for the first time pull up electronic records that provide a complete view of her medical history. She's heard stories about elderly patients suffering harmful drug interactions because one doctor doesn't know what the other is prescribing.

When she finally gets home that evening, it is dinner time and Josie's hoping a robot will appear with a gourmet meal – but then she sees Miguel waiting for her with a pizza box and figures that's close enough.

Who sets the agenda?

So where do bright ideas that make cities smarter and citizens' lives better come from? Should elected officials develop a vision that they sell to residents? Or do citizens announce their needs and set priorities? Smart cities realize the answer is a combination of both.

The traditional top-down approach to city planning and decision-making tends to result either in improvements that are more iterative than innovative, or sweeping initiatives that get stuck. Plans that are developed using very limited input may miss out on unique viewpoints that can give the effort so much more strength. Further, since the entire project risk is on one person or a small group, these projects tend to avoid risk altogether, and therefore avoid making any dramatic improvement. Or, if the project is truly revolutionary, it may never get off the ground. There's always resistance to change, and even if the vision is good, some may try to stop it for political reasons if they can't claim at least part of the success as their own.

A top-down vision may also result in a city that few people want to live in. Do you really know what your residents want? Have you asked? An operations management lecturer at the University of Leeds decided to ask Boston residents what they wanted from a smart city,

> ***A bottom-up approach can be more inclusive.*** *Asked what they wanted from a smart city, workshop participants in Boston all wanted something that's more sustainable and livable, but they also wanted it to be recognizable.*

Figure 3.5

and the answer was a bit surprising. They said they wanted a smarter version of what they already have. Thinking of the place their grandchildren may eventually call home, the workshop participants all wanted something that's more sustainable and livable, but they also wanted it to be recognizable. They were concerned that only the rich and powerful have a say in shaping the city, and desperately wanted the smart city to enhance – not replace – the city that they know.

A bottom-up approach is typically much more innovative and inclusive. As Council member Oracle describes it, this approach turns citizens from end-users to begin-users. It brings together a wide variety of people with different backgrounds working toward a common interest. You will have groups of people trying different ideas. Some ideas will work; others won't. People adapt and will likely join together to work problems out. Eventually, the better ideas will float to the top, resulting in an imaginative vision that's not usually possible with centralized decision-making.

While this sounds ideal, it isn't a perfect model, either. With a large number of people acting spontaneously, this approach can be full of complexity. Their solutions may also

miss the mark if the participants aren't representative of the community as a whole. They may work for themselves instead of for everyone.

That last point demands more attention, as it's one of the biggest sources of risk and missed opportunities in smart cities projects. People in low-income neighborhoods are typically left out of bottom-up planning. As Rick Robinson, IT Director for Big Data and Smart Cities at Amey, points out, these people are not without a smart cities vision of their own. They just can't accomplish it on their own.

When people are left out of the discussion and the solution, they are deprived of the infrastructure and resources they need to succeed. It's not a case of charity. As cities become increasingly urban, the success of lower-income neighborhoods is the success of the city as a whole.

A smart city incorporates all communities and devotes attention to providing the necessary infrastructure in those neighborhoods that are falling behind. With populations swelling, providing equitable access and raising living standards of those typically left behind is the only way cities can become truly livable and sustainable.

An approach that mixes top-down with bottom-up brings together the best of both worlds and avoids common pitfalls.

Mixing top-down and bottom-up.
Communities need some governance; they just don't need heavy-handed governance.

Figure 3.6

Communities need some governance; they just don't need heavy-handed "my way or the highway" governance.

Under a light governance model, city leaders set guardrails for the citizens to work within.

Rigid rules are replaced with conditional models. Instead of restrictive rules that tell people what they can't do, leaders enable the community to come up with innovative solutions within certain boundaries while ensuring that everyone has a voice.

HOW CITIZENS CAME TOGETHER TO REBUILD CONSTITUCIÓN AFTER DEVASTATING EARTHQUAKE

After a devastating earthquake and tsunami leveled much of Constitución, Chile in 2010, residents came together and developed a new community master plan in just 90 days. And they did it largely without the Internet and without using tax revenue.

The Brickstarter blog profiled the warp-speed project, which is remarkable. Constitución finished its sweeping plan and built consensus in just three months. Here's how it happened:

Shortly after the disaster, leaders opened a community center in town and invited residents to stop by to not only see the progress being made, but also to help shape the work being done. Regular meetings were designed to put everyone in the city – from city officials and building experts to the citizens themselves – on the same level. The role of experts was completely redesigned. Experts worked as facilitators. They helped shape concepts from brainstorming sessions into workable ideas; they did not dictate what would be done.

Internet access was spotty, so while social media was used to solicit some ideas, it wasn't the primary vehicle. Weekly town meetings were. To make sure everyone knew about the meetings, organizers drove around town with a loudhailer inviting people to attend. The meetings were packed and lively. Residents congregated around whiteboards to sketch out ideas. The experts served as valuable resources to answer questions and help refine ideas. Passionate debate was not only allowed, but encouraged. Those heated discussions helped identify

> ***Building consensus.*** *After a devastating earthquake and tsunami, residents of Constitución finished a sweeping master plan for rebuilding their city and built support for it in just three months.*
>
> *Figure 3.7*

and shape priorities. And participation remained strong throughout the process. Often a rebuilding process like this has strong initial interest but rapidly loses steam.

The project was paid for by a forestry company – one of the biggest businesses in Constitución. Normally, that would be viewed as a huge liability. Instead, the company was just another participant in the discussions. It funded the work with no strings attached. Any unease about its potential influence quickly vanished due to the way it conducted itself. It ensured that it had no more of a voice than anyone else.

Within four years after the 50-foot (19-meter) tsunami washed away Constitución homes and businesses, nearly 500 new homes were built. So, too, were businesses and parks. There is a newly reconstructed foreshore, which gives the public more prime area to enjoy the water and also provides more protection should another tsunami ever hit.

Open space and recreation areas are a key feature of all the new housing developments. More riverfront areas were also turned into public walkways and parks. The city is also putting the finishing touches on its new cultural center.

Looking at its new downtown, which is truly something to envy, the city credits its hybrid planning approach. The disaster provided an incredible opportunity for the community to improve its livability and sustainability, and allowing the public to drive the process resulted in a true transformation that most likely wouldn't have been possible if it was driven by politics.

But the public also couldn't do it alone. The city started the process by preparing a very rough vision that it encouraged participants to attack. This jumpstarted the lively debates about the city's future.

Co-design is what the city called its approach: the city provided guidance and resources to help citizens achieve their vision. It also helped that people came together to discuss issues in public; in circumstances like this one, there's much to be said for talking face-to-face.

Empowering citizens

Empowering citizens means that they not only have a voice, but they're regarded as a key stakeholder helping shape a project. For citizens to be empowered, they also have to be engaged, and that may require a different mindset within city hall.

The business-as-usual approaches that cities have used for well over a 100 years to involve citizens aren't typically effective today, if they ever really were. Unless there's a hot-button issue, citizen participation in public meetings tends to be weak. And cities get little out of them, too. Public meetings tend be held near the end of the process, so forums on any controversial issue tend to be venting sessions where citizens yell at staff and elected leaders.

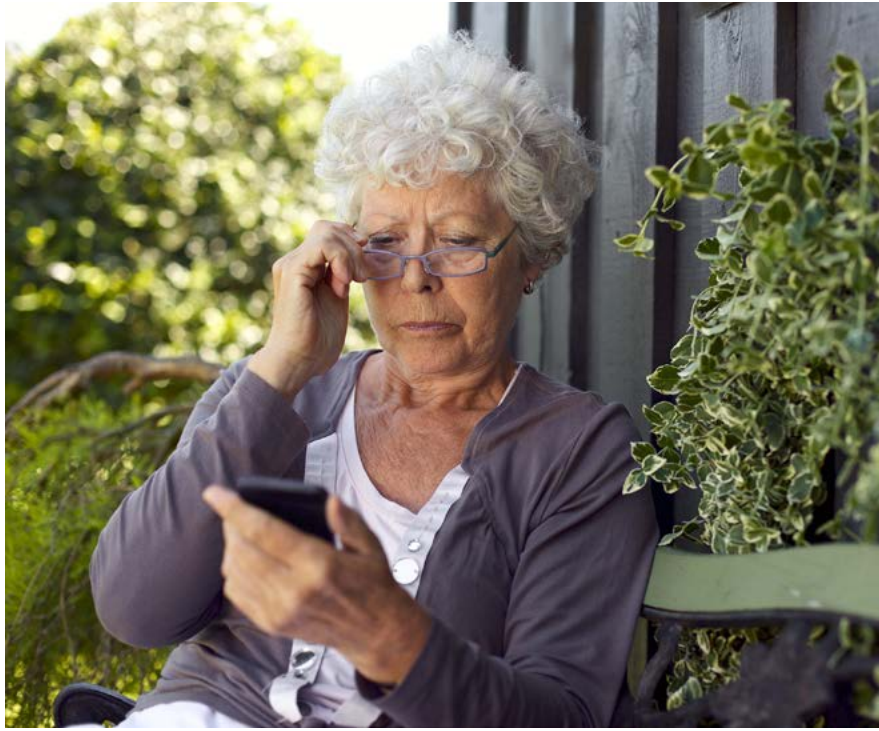
When you ask, the public is typically quite clear about why it doesn't participate in government more. Cary, North Carolina surveys its residents every other year about various topics and the so-called barriers to citizen involvement rarely change. Nearly half of residents say they simply don't have time to participate. It's not that they feel it's a waste of time – the survey shows most people believe they can make a difference in their communities – they just don't have the time to participate, don't know about the opportunities, or the meetings are at inconvenient times.

Cary is hardly unique, and if you try to put

yourself in your citizens' shoes, the problem becomes obvious. Most city meetings tend to be scheduled during the middle of the day or in the evening on a weeknight. How many people can afford to take off work to go to a committee meeting? Or if you spend all day working at a job, rush home to make dinner for the family and help the kids with their homework, would you have the energy to go to a council meeting at night and still be refreshed for work the next day?

Viewed from the perspective of citizens, it's pretty easy to see why the traditional public participation model doesn't work. And smart cities need to understand that if it doesn't work for their citizens, it won't work for them either.

The authors of "The Responsive City: Engaging Communities Through Data-Smart Governance" suggest many city staffers aren't particularly fond of public meetings either. For one, they can be painful. Either they are boring affairs attended by the same small group of people who complain about the same things, or they're very intense meetings where they are the focus of an angry mob. Says co-author Stephen Goldsmith, when you tell your staff to communicate more, they tend to think about doing more of the same thing they're already doing. But why would anyone want to conduct more of those dreaded meetings when there are so many more effective ways today to connect with ctizens?



> ***Use multiple communications tools.***
> *Technology has changed the way people communicate in their personal lives and it only makes sense that cities trying to engage citizens should reflect these changing preferences.*

Figure 3.8

Changing the engagement mindset

Today, building an engaged community requires communicating with citizens on their own terms.

- **Provide ample opportunities** for citizens to get involved in a time and manner that works for them.
- **Give updates early and often** so that people can be involved in the earliest stages, allowing them to help shape projects.
- **Use multiple communications tools** so citizens have a choice in how they want to interact with their city, for example, social media, text messages, online forums.
- **Continue the conversation** when the project is complete; share results and benefits so they can see their involvement was worthwhile.

Doing these things may require getting your city staff to think of citizen communication in a new way. The key is not just more communication; it's more effective communication which occurs when you put citizens' needs and preferences first. You'll see examples in the sections ahead.

Continuously pursue two-way communication with citizens:

CITIZENS HELP FORT COLLINS DESIGN ITS FUTURE

Like many cities in 2010, the recession hit the city of Fort Collins, Colorado. Officials didn't have a lot of money to spend revising its long-term city plan.

As then-Mayor Karen Weitkunat told The New York Times: "We could do an urban design plan, but we didn't have the money to pay for any of it. It put a reality check on what we were here to do."

But that didn't stop the city, already labeled an innovator for some of the things it has done in energy. Here's how the Times describes what happened when Fort Collins decided to rewrite the urban planning model:

> *"So Fort Collins reached out as it never had before, seeking volunteers and input, and, just as crucially, ideas about how to finance a new future in an age of limits. And those reaching back, including some people and organizations who had never participated in city planning, from arts groups and beer brewers to technology entrepreneurs and professors at Colorado State University, created the city's new vision of itself — an ambitious and comprehensive plan, even by the standards of bigger cities in more prosperous times.*
>
> *Democratized by necessity, the process led to goals that went beyond the predictable safe streets and commerce that planners might have otherwise emerged with. In a departure from the old command-down process — planners proposing, residents disposing in public planning meetings — ideas bubbled up in new ferment."*

> ***Continuously pursue two-way communication with citizens.*** *When the city of Fort Collins, hampered by budget constraints, took a new approach to long-range planning by reaching out to the community, it struck an interest with groups that had never before participated in city planning.*
>
> ***Figure 3.9***

Ideas that connect communities

The best communication method is one that meets the unique needs of a community. In the next section we'll talk about digital communications. But even in this day and age, cities are finding other effective ways to connect with citizens, and citizens to connect with each other. Below are examples both low-tech and high tech.

Events and "walkshops" bring people together in Vancouver, B.C. Vancouver, B.C. knew it had to get citizens involved if it had any hope of achieving its Greenest City in the World 2020 initiative. But stuffy meetings didn't seem the right way to build engagement, especially when the subject was the beautiful outdoors.

So the Vancouver Planning Commission and neighboring municipalities worked to bring engagement into the communities. The city of Burnaby held an environmental festival, full of music, food and family-oriented activities. Others organized "walkshops," a moving conversation that allows community members and planners to get to know a neighborhood better together. And the North Vancouver mayor organized a bike tour to help residents learn about new bikeways, cycling improvements and talk about future initiatives.

'**Doors open' days in Halifax, Nova Scotia.** Halifax hosts "Doors Open" days that invite citizens to explore historic buildings and more contemporary venues for free. Halifax native Hugh MacKay, who brought the idea to his city after seeing Doors Open events in other Canadian and European cities, told the Chronicle Herald that he was encouraged by a comment he heard during the 2013 event: "It was the remark of a recent immigrant to Canada who commented that nothing in his experience had ever demonstrated to him the openness of Canadian government so much as walking into city hall and being greeted by the mayor and welcomed to Doors Open."

Another view from El Jones, the Halifax poet laureate: "You can live in this city and never be in city hall and never be to Province House and particularly sometimes people feel that these spaces are these kind of official spaces that they aren't welcome in. I think it's very important for people to claim those spaces in their own cities and go into these places and say I have a right to be here and I'm going to look at what's on the walls and I'm going to be part of this city as well because it's mine."

Participatory budgeting in Porto Alegre, Brazil. Porto Alegre is credited with pioneering the concept of participatory budgeting back in the 1980s to empower people to participate in setting priorities for how public money should be spent to solve city challenges, from mobility to sanitation to education. Prior to 1989, Porto Alegre faced significant financial challenges from de-industrialization, in-migration, indebtedness and a poor revenue base. But thanks in part to participatory budgeting, the

> ***Doors open at city hall.***
> *City hall is a popular venue during the Halifax Doors Open days.*
>
> *Figure 3.10*

World Bank cites some spectacular achievements in the years that followed. Among them: Between 1989 and 1996, the percentage of the population served by the municipal sewage system rose from 46% to 85% and the number of children enrolled in public schools doubled.

Bringing young people into the thick of civic affairs in Salisbury, Maryland. Young people compete for seats on the Youth Civics Council – a student-inspired initiative that has each youth council member identify a community issue, develop a plan to address it and then present it to the city council. And the teens take it quite seriously, according to the local media. Here's an example: "Bennett High junior Ahmed Osman is focused on tourism, unemployment and recruiting businesses to locate in downtown Salisbury, and Davis has ideas designed to open up the Plaza to two-way traffic and encourage more businesses to open in that area in particular. Davis is also exploring the concept of city-county consolidation to reduce government costs."

Helping citizens help each other. If given the choice between stuffy and fun, nobody would choose stuffy. Photo contests and other creative competitions not only boost engagement, they can also result in truly innovative ideas. When given the opportunity to be artistic and creative, many will jump at it. The Burnaby Homeless Task Force, which serves part of Vancouver, B.C., got a group of quilters together to produce a piece that illustrated the wide diversity of the homeless population that relies on its service. The quilt was displayed at the library to help tell the story of its important mission in a new way. The project attracted the attention of Quilts Etc., a national bedding retailer, which has since supported a number of projects to draw attention to the homeless population and collect supplies for them.

> ***Encourage creativity.*** *Quilters in Burnaby, B.C. produced a quilt that called attention to the wide diversity of the homeless population.*
>
> *Figure 3.11*

Here's another example: Small communities often create tight bonds between neighbors, creating tight-knit community where they may share resources, such as tools or food. But a first-of-its-kind neighborhood near Austin, Texas, goes well beyond that. People who live there can also share electricity. Community First! Village is described as the world's first neighborhood powered by crowd-sourced energy. It's the work of an organization that's been working for years to reduce homelessness. By allowing people to donate energy, it removes one more large worry for cash-strapped residents.

Council Lead Partner Itron is helping sponsor the project and built the infrastructure for the donation system. People who want to donate have several options:

- **Pay for a certain amount of energy** that is sent to the Village or a specific home
- **Generate their own power** through solar panels and the like and donate that energy
- **Participate in conservation efforts**, including demand-response programs, and donate the energy they save

SANTA MONICA'S DATA DRIVEN WELL-BEING INDEX HELPS SHAPE CITY PRIORITIES

With a million-dollar grant from Bloomberg Philanthropies' Mayors Challenge, the city of Santa Monica, California set out to scientifically identify and assess the well-being of its residents.

Working with experts in the science of well-being, Santa Monica created the Wellbeing Index which brings together data from 100 distinct and wide-ranging data points to provide a comprehensive picture of how well city residents are doing so the city can make more informed decisions.

The data was analyzed to provide key findings across five areas – environment/place, health, economic opportunity, learning and community connectedness. Further breakdown identified well-being indicators based upon demographics such as geography, gender, age and ethnicity.

The findings are available on the city's Wellbeing Project website. A few key findings included:

- Strong civic engagement with large numbers of people voting (79%) and volunteering (38%)
- Yet 41% of residents feel their civic influence is limited and 36% feel disengaged from the city
- Seniors showed the highest level of personal well being and those ages 45- 54 years old the lowest
- One in five younger adults (ages 18- 24) reported loneliness all or most of the time; one in three reported concern about missing rent or mortgage payments

"In pioneering this innovation, we can more effectively improve the life experiences of our own residents, using an unprecedented level of data-driven knowledge about wellbeing to shape public policy," said Santa Monica Mayor Kevin McKeown.

> ***Applying the science of well-being to local governance.*** *Santa Monica's findings will provide a baseline the city can use to improve policies and focus resources to strengthen quality of life in the community.*
>
> ***Figure 3.12***

Engaging communities digitally

While face-to-face conversation is often preferable, it isn't always possible. Thankfully, technology is helping make it easier than ever to engage those who don't have the time or ability to participate in traditional meetings or public events.

Yet because social media is so ubiquitous and easy to use, there is a temptation to use it as an only source for engaging the public. That can be short sighted since social media only captures one segment of the population. In the U.S., for example, Facebook is by far the most popular social media platform. But even there, only 70% of adults who go online have Facebook accounts, according to the Pew Research Center. About a quarter of online adults use Twitter, LinkedIn or Pinterest.

Another Pew study found that social networks overall attract people who make less than $30,000 annually or more than $75,000; the middle-class is under-represented.

That's not to suggest cities shouldn't use social media in their engagement efforts – it can be quite valuable. But it's important to remember that the audience you'll reach is a subset of your community and therefore there are some limitations to the insights you glean.

Digital engagement efforts primarily work in two ways. Digital tools can help you measure what people in your community are thinking and they can help you create an online forum where people can share and debate ideas. We'll cover both in more depth.

Listening in on the social buzz

Whether or not your city is listening, people are talking about it, from the challenges they face on their morning commutes to encounters with city staff. These conversations are happening on social media. In fact, on Twitter alone, more than a half a billion tweets are sent each day. Enter social sentiment analysis.

Council member IBM has combined natural language capabilities with its data analysis platform to transform online conversations into real-time, instant polls. For example, IBM's Social Sentiment Index helped Bangalore and Mumbai find their respective sources of traffic headaches.

> ***Social media can be a valuable tool for engaging citizens.***
> *Social media and social sentiment analysis can help surface what people in your community are thinking, providing insights and alerting you to trends.*
>
> *Figure 3.13*

Sparking online discussions

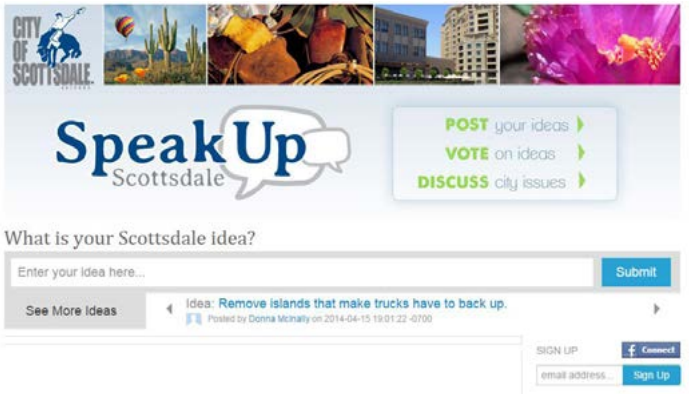
Online discussion forums aren't new, but they are experiencing something of a resurgence in the public sector. Cities are creating their own discussion forums as a way for citizens to post ideas and weigh in on city proposals and to encourage others to join the civic conversation.

The city of Reykjavík, which is home to about two-thirds of Iceland's residents, has had great success with online forums, which it uses to discuss everything from the budget to neighborhood issues. About 40% of residents use the online forum, and the city council has committed to discussing the top topics each month.

But you may not need an elaborate online discussion forum. Cities may find they get more public feedback simply by making it easier for citizens to contact them. The Sheriff's Office in Stearns County, Minn., saw a 500% increase in crime tips when it added a simple email contact form to its website. As its site drew more traffic, the number of people downloading crime prevention information more than doubled as well.

For online discussions to thrive, cities must commit to a two-way dialogue. If people ask questions or present ideas, someone from the city should respond. If citizens decide nobody is listening, they'll quickly lose interest.

SPEAK UP SCOTTSDALE



Scottsdale, Arizona launched Speak Up Scottsdale in 2012 to give citizens a way to present ideas and provide feedback. The website is a moderated discussion forum that also has the ability to launch polls and surveys.

The city has started open-ended discussions on everything from its vision statements to changes that would make its website more useful to the community. Residents can also start their own discussions, which have been wide ranging. When a resident starts a discussion, other citizens can vote on whether or not it's a high priority issue for them too.

One discussion thread led to safety improvements for pedestrians at a newly-expanded shopping center. The city quickly took notice after several other residents gave the initial post a thumbs up.

> ***Sparking online discussions.*** *Scottsdale city staff routinely respond to citizen comments in the Speak Up Scottsdale forum and provide updates on issues or ideas they propose.*
>
> *Figure 3.14*

Most ideas can't be implemented immediately, but city staff typically acknowledge the suggestion the same day it is posted and post follow-up messages in the discussion forum as they investigate the idea and come up with solutions.

One idea was for the city to encourage Internet service providers to bring gigabit Internet to the area; the city provides updates every few months on the progress it has been making.

Offer a citizen-centric portal for services

We've talked about how important it is for citizens to be involved in the pursuit and realization of a smart city. That's why it's crucial that cities create an integrated, comprehensive online portal for people to access their smart city services.

Today websites and mobile applications can recognize individual citizens and deliver personally tailored information to them. Such digital interactions with citizens allow smart cities to enhance their efficiency and effectiveness at the same time they heighten citizen satisfaction.

Until recently, it was far too expensive to personalize service for each resident. Today, however, the technology exists to personalize virtually every interaction. In the Web 1.0 world, digital governmental services typically meant a series of websites. Those sites were typically designed from the point of view of the government. It was up to the citizens to navigate their way around to find what they needed, a chore that was often time-consuming and frustrating.

Now we have the ability to create personalized customer portals and personalized outbound messages. More and more citizens are coming to expect personalization, since they receive it in so many other parts of their lives. And when these portals are designed with mobile in mind, it helps people capitalize on the timeliness of their personalized data

Personalized e-government services increase citizen satisfaction and compliance while reducing mistakes and misunderstandings that can occur when they are forced to dig up information on their own.

Next-generation eGovernment

Thanks to advanced technology, cities don't have to look far today for help providing a wide array of digital government – or eGovernment – services.

Council member Imex Systems, for example, helps cities turn a number of departmental systems into a single enterprise system for end-to-end service delivery. By doing so, public officials get a better understanding of citizens' interaction with the city. The eGov services that companies like Imex provide range from citizen portals to mobile payment systems to billing systems and cloud services.

Another example comes from Council member SunGard Public Sector, which offers a range of eGov services for not only cities, but also solutions specific to their public safety departments and courts. Additionally, SunGard's Click2Gov solution empowers citizens through interactive mapping capabilities, calendaring and self-service bill-pay options. And increasingly important in many cities today, Click2Gov supports multilingual communities, detecting and translating the user interface so language barriers don't interfere with access to city services.

> ***Next-gen eGovernment.*** *With 24/7 access to Click2Gov, residents can submit, track and receive responses for city services from the convenience of their home or office.*
>
> *Figure 3.15*

Offer an integrated citizen portal :

BOROUGH'S CITIZEN PORTAL CUTS COSTS, IMPROVES SERVICES

As a leader in public sector IT, the London Borough of Newham wanted to improve its service delivery and digital engagement with citizens, while reducing costs. By sharing services with the neighboring local authority of Havering, Newham is pioneering a transformation in both councils using a trio of technologies from Council member Microsoft – Dynamics CRM, SharePoint Server and BizTalk Server.

Its online portal service, which is available to every resident, will encourage more people to conduct transactions online rather than at council offices. With reusable technology, the platform will contribute to Newham and Havering's target of more than £11 million cashable savings between them, without cutting front-line services.

The council is starting with its most used citizen services in initiating greater digital engagement with residents. These include service requests for waste bins and recycling, parking enforcement and revenues and benefits.

Potential exists for other authorities – including the London Borough of Waltham Forest – to join them, further improving efficiency and providing high-quality customer service.

> ***Offer an integrated citizen portal for services.***
> *The Newham portal meets the challenge of delivering high-quality services with fewer resources, given the U.K.'s tight fiscal policies for local and regional government.*
>
> ***Figure 3.16***

Enable 24/7 engagement:

ONLINE SERVICES "FACTORY" ALLOWS CROSS-AGENCY ACCESS FOR CITIZENS

One of the roles of Direction Générale de Modernisation de l'État (DGME), the French agency responsible for modernization, is guiding French ministries and agencies in their e-government initiatives.

The problem DGME faced in the past was that many of its projects were built in silos with high associated costs. To respond to that challenge, DGME chose Council member Alphinat to develop an "online services factory" that allows delivery of cross-agency online services that focus on the needs of citizens and municipalities.

Alphinat's SmartGuide suite, combined with infrastructure and professional services from Bull, resulted in what's referred to as "My Online Services" -- a web-based, one-stop-shop capable of automating online service creation, deployment and maintenance while reducing custom coding and promoting reuse of components and existing ICT assets.

For the end-user, the measuring stick of success is its ease of use. In less than a year after its launch, three million accounts were created and the portal offers close to 1,300 forms, registers two million downloads per month and delivers a wide range of citizen-centric, cross-agency services such as change address declaration, voter registration, citizen census and grants requests.

And the objectives the DGME had set out in terms of quality of service to citizens have been met with convenient 24/7 access to government services that save time and eliminate redundant operations.

> ***Enable 24/7 engagement.*** *In less than a year after launch of the DGME online services factory, three million accounts were created giving citizens 24/7 access to a wide variety of services from multiple agencies.*
>
> *Figure 3.17*

Help citizens help themselves:

IN KANSAS CITY, RESIDENTIAL LEAK ALERTS ENHANCE CUSTOMER SERVICE

When Kansas City Board of Public Utilities (KC BPU) installed a water and electric AMI system in 2013, in addition to improving service and reliability, they hoped to empower customers to be wiser energy and water consumers. That goal prompted the Water Department staff to make residential leak detection a priority.

KC BPU uses Council member Elster's EnergyAxis to read 67,000 electric meters and 56,000 water meters. To help customers benefit from their AMI data, the Water Department implemented a residential leak-detection report.

With Elster's EnergyAxis metering system, KC BPU gets hourly readings of residential water consumption every day, which allows the utility to run a leak-detection report and quickly notify customers of suspected leak activity. Each day, Water Department staffers notify any customer whose consumption shows at least 25.2 cubic feet or 188.5 gallons of water running through the meter every hour for 24 consecutive hours.

For example, a lot of water – and money – will uselessly wash down the drain if the toilet flushing-mechanism's chain gets stuck beneath the flapper. That could easily amount to a residential water bill of $1,000 or more per month.

Between the leak-alert's program launch in September 2013 and April 2015, more than 1,500 customers – or 2.6% of the utility's 56,000 households served – had received a money-saving call from KC BPU.

> ***Help citizens help themselves.*** *Molly Sharp, KC PUB's AMI water analyst who runs the daily leak-detection report and calls customers, says almost everyone she reaches has the same response: surprise, then gratitude.*
>
> *Figure 3.18*

Supporting practices

No matter how integral technology targets are, a smart city vision will never be fully realized if those targets aren't planned, deployed and managed correctly. That's why we've identified what we're calling *supporting practices* for cities to consider as they plot a course towards the future. As you'll see in the pages ahead, these supporting practices are all dependent on people making smart decisions to get maximum value out of their technology investments.

We've already covered citizen engagement extensively, so in the pages ahead our focus will be the other two supporting practices.

1. Policy and leadership. This includes the management policies and leadership capabilities that cities use to plan for and support ICT investments. For example, ICT will benefit cities, their residents and businesses most when a comprehensive smart city plan has been created.

2. Finance and procurement. These practices help cities buy and pay for the technologies they need. Employing proven techniques can help a city get the right technology, at the right time, at the right price. One example is devel

oping an integrated procurement plan for technology across all city departments.

In the chart below you'll see supporting practices that will help cities realize the technology targets discussed in previous chapters. Unless otherwise noted, these supporting practices apply to every city responsibility area covered in this Guide. In the Ideas to Action chapter that follows this one, we will explore how cities can enact these policies to best achieve the technology targets and become smart cities.

SUPPORTING PRACTICES

Policy & Leadership	• Utilize a bottom-up approach to city planning and decision-making • Promote a comprehensive smart city plan • Encourage shared infrastructure • Cultivate a smart workforce • Encourage a culture of innovation
Finance & Procurement	• Adhere to a disciplined and integrated technology procurement plan • Consider all funding mechanism
Citizen Engagement	• Continuously pursue two-way communication with citizens on strategies for and benefits of ICT before and after deployment • Offer an integrated, personalized citizen portal for services • Disseminate timely information about public safety, public health, transportation and other services that impact the public

Figure 3.19

The role of city leadership

If citizens are empowered to set the agenda and craft solutions, what is there left for city leaders to do? A lot. To move cities forward, city leaders and staff need to partner with stakeholders – citizens, the business community, academia, nonprofits, other public agencies, etc. With a smart cities project, that may mean inspiring stakeholders by educating them on the possibilities and encouraging them to get involved. It also means guiding the project's implementation to ensure that it is done correctly, on time and at reasonable cost.

To fulfill this end of your partnership with your community, you need a comprehensive plan. This plan is by no means static; it should be continually evaluated and updated as you prepare for and travel on your smart cities journey. It also encompasses all work streams in every single responsibility and enabler discussed in this Readiness Guide. The plan organizes city efforts and resources across departments, identifies and articulates city priorities and plans action steps to achieve the recommended targets.

A comprehensive smart city plan calls for:

1. **Measurable targets** for livability, workability and sustainability
2. **Timely reports** of progress toward those targets.

> ***Partner with stakeholders.*** *With a smart cities project, that may mean inspiring stakeholders by educating them on the possibilities and encouraging them to get involved.*

Figure 3.20

This plan should be articulated in ways that citizens and other stakeholders will understand because they see its connection to their lives.

Arguably this may be the most important piece of the entire Readiness Guide since by definition a comprehensive plan will consider all the other aspects of an ICT-enabled smart city. A comprehensive plan sets the stage by:

Maximizing synergies and minimizing costs. Considering the big picture can help a city find ways to share infrastructure and share costs – doing away with unnecessary duplication of ICT investments.

Identifying the best places to start. Picking the "low-hanging fruit" – which are projects that have a big return for a relatively small investment in money and time – often makes most sense. If a city starts with those "big bang" projects, it can build momentum and public support. And it can potentially generate revenue for use on future projects.

Enabling cities to build separate projects. With a plan in place, you can be confident everything will work together in the end because you're adhering to principles and standards that ensure interoperability and collaboration. With such a framework a city

can move towards its targets one step at a time, knowing that individual projects will be compatible with each other, even if they are built separately at different times.

Increasing public support. Since a comprehensive plan promotes the future benefits and paints a picture of the future improvements in livability, workability and sustainability, it can dramatically increase public understanding and support. It can also help rally support and financing from the private sector.

Attracting talent and business. A smart city wants to woo today's mobile professionals and easy-to-relocate high-tech businesses, but both are increasingly choosy when deciding where to establish themselves. They are attracted to cities that have a strong, compelling vision for a better future and a path to get there, which is what your comprehensive plan lays out.

Emphasizing the need for change and change management. Smart cities are visionary projects. As with all such projects, organizations undertaking them will be most successful if they are good at articulating and fostering change. Comprehensive smart city plans promote "change management" strategies that ensure minimum negative impacts and maximum positive outcomes in their pursuit of a smart city.

Share infrastructure. It doesn't take someone from the city budget office to see the value in reducing needless duplication and redundant spending. And that's what can happen when cities recognize interdependencies between departments and the value of cross-coordination. Actively seeking ways to share ICT infrastructure between city departments – and having backup plans in place should problems occur – simply makes sense.

Beyond reducing redundant spending and effort, benefits of sharing infrastructure between departments can:

- Uncover wasteful duplication
- Surface potential synergies and new solution opportunities
- Reduce arguments and friction
- Unearth and enforce best practices citywide

Another big benefit of sharing infrastructure is that a city can improve overall results by bringing multiple minds and multiple viewpoints to the table. Additionally, future expansion and applications are fast-tracked when infrastructure is shared because computing and information assets are no longer stranded in separate "silos."

In some cases, it may also make sense for a smart city to explore the benefits of sharing its infrastructure with the private sector. For example, this is important when it comes to broadband and cellular connectivity. Often it is private sector operators who are best suited to deploy and maintain these networks with a high degree of reliability, security and coverage.

Share infrastructure.
Smart cities actively seek ways to share ICT infrastructure between city departments.

Figure 3.21

Working smarter

A key factor that can affect your ability to deliver on your smart city promises is your workforce. There are two components to this: 1) ensuring your staff has the skills that smart infrastructure deployments demand, and 2) making sure they see the big picture and can abandon silos to work together effectively.

Working smarter won't happen overnight. It involves serious long-term planning and careful consideration of the resources you need today, over the next year, and several years from now. ICT projects have a lifecycle and it's critical to have the right resources with the right knowledge at the right time. Because highly-trained workers are in high demand, it's important that you plan now so that you will have the resources when you need them.

Cultivating a smart workforce

For skilled ICT workers, you'll be competing not only with other cities and government agencies, but the private sector as well. To ensure you have the skilled workforce a smart city requires, developing policies and programs that cultivate that workforce will help. Building the skills necessary to install, maintain and optimize smart city technologies should be a priority.

> ***Cities need the right resources and the right knowledge at the right time.*** *Highly skilled workers are in big demand so planning ahead for training and recruitment is essential.*
>
> *Figure 3.22*

Many options exist for promoting a smart city workforce, and cities should find those that best fit their own needs and circumstances. For instance, you may choose to:

- Organize or partner with professional groups to identify skills needed
- Promote relevant licensing exams and continuing education curriculums
- Use a 'sustainable' designation for professionals
- Publish guidelines or create incentives to include smart technology topics in public and private education and workforce training

Encourage innovation in your city

In addition to an active campaign to train and groom a skilled ICT workforce inside city hall, cities that embrace and encourage a culture of innovation city-wde will attract businesses and talent drawn to that kind of environment.

Chief Innovation Officers and Chief Data Officers are becoming increasingly common in larger cities and can play a critical role in championing a city's "open for innovation" mantra. Whether it's hosting hackathons as New York City has been doing since 2009 or establishing an entrepreneur-in-residence program as San Francisco has, these are point people who can help foster a spirit of creativity and collaboration throughout city departments and also into the community-at-large.

On the next page, for example, read how a major South Korean retailer worked with transit authorities to launch an innovative virtual grocery store in a busy subway station.

Encourage innovation in your city:

MOBILE SHOPPING IN KOREA – BRINGING CONVENIENCE TO CONSUMERS

A major retailer in South Korea set a challenging goal: to become the number one grocery retailer without adding new physical stores. Instead, they created "virtual" stores, starting with the city's subway stations.

Displays at virtual stores are the same as physical stores. Wall-length billboards are installed in stations, designed to look like shelves and displaying images and prices of common products. Each sign includes a QR code; consumers shop by scanning products. Their order is then delivered within the day.

Workers in Korea typically work long hours and the strategy makes productive use of commuters' waiting time, while simultaneously saving shoppers' time spent going to the supermarket. It's the kind of innovation that can help cities attract and retain a talented, digitally savvy workforce and also show businesses that they support new ideas that benefit their citizens.

The retailer in this case not only helped consumers use their idle commute time by bringing the store to them. It has also become the number one player in the online market and second in physical stores.

> ***Encourage innovation in your city.*** *The shoppers in this Korean subway station are not looking at physical products. Instead, they are viewing a wall of life-like pictures. They scan the products they want, which are delivered to their homes.*
>
> *Figure 3.23*

What language are you speaking?

Communication is the overriding theme in this chapter. We've talked about various ways city leaders can engage the community in conversation and the information you should communicate. But the words you choose are also very important. If people misunderstand the plan or the progress the city is making toward it, your words can leave the community uninspired, gravely disappointed or both.

A new tool created by developer APQC with support from Council member Microsoft promotes common language to help eliminate miscommunication. The City Government Process Classification Framework was based on discussions APQC has had with more than 750 organizations over the past 30 years. The Excel worksheet defines processes and language uses throughout government services, including legislative, executive and judicial, as well as related city service providers, such as public safety, health, zoning and licensing.

APQC says the common framework helps take things that were difficult to understand or articulate and make them more transparent. Having an objective standard helps reduce the potential for conflict. Microsoft adds that it gives cities a head start in their improvement efforts, by clarifying where opportunities are, setting benchmarks, and communicating more clearly with all involved, including any vendors who will help execute the vision.

> ***Use a common language.***
> *A common language framework helps reduce the potential for conflict.*
>
> *Figure 3.24*

Tell a story

Most of us can remember plenty of stories we were told as children. You may have retold them to your own children. By contrast, how many college lectures do you remember? Stories have remarkable power to capture our attention and imagination.

Your smart cities vision may resonate more with the public and city staff if you present your concept with the elements of a story. Set the stage for your vision. What can be improved and why does it need to be improved? The plot is the approach you will use to address and solve the challenge. The climax is where you paint a picture of the future of the city where everything is running smoothly. And every story needs characters; don't forget yours. They are the people who live and work in the city.

But as you're busy telling your story, just don't forget to listen to others who are telling theirs.

HOW DO YOU TRANSFORM A CITY? TRY ASKING SOME MAYORS

That's exactly what Council member IBM did in conjunction with its Smarter Cities Challenge grant program, a multi-year, 100- plus city initiative designed to get them started on ambitious projects. IBM has donated millions of dollars in employees' time to work with city leaders.

As part of that effort, IBM harvested insights from participating mayors and put them in a report – How to Reinvent a City. Among the lessons for leaders from leaders:

Think like a CEO. When city leaders are trying to overcome inertia, it helps to radically rethink what a city is and does. Traditionally, mayors have defined their cities and their leadership roles within the parameters of politics and traditional public services. That's too narrow a view. Today, some of the more innovative leaders see their cities as businesses and themselves as chief executives.

Engage citizens and businesses on their terms. City leaders understand that citizen engagement is essential to understanding the wishes of their constituents – not to mention getting re-elected. But some of the typical methods yield unsatisfactory results. The public needs easy, open and continuous access to a wide variety of data and planning information, and people must be brought into a project early so they can participate in designing it.

Be bold and brave. Access to an abundance of data helps city leaders understand how things work and how they might work better, but unless mayors are bold they won't get big things done. Politics will get in the way. So it's essential for mayors to not only propose bold plans but to make it clear to those around them that they are deeply committed to making them work.

> ***Policy and leadership supporting practices.*** *Today, some of the more innovative leaders see their cities as businesses and themselves as chief executives.*
>
> *Figure 3.25*

Finance and procurement supporting practices

Let's face it: Implementing smart city technologies in an era when so many cities are budget-strapped is going to be a financial challenge. But it doesn't have to be an insurmountable one. Cities will need to get creative, though. In this section we'll discuss how to develop a solid procurement plan and how cities should look beyond traditional funding mechanisms for their technology needs.

Adhere to a disciplined and integrated technology procurement plan. There are two key words here: disciplined and integrated. First, a city's procurement plan for smart city technologies should include a disciplined business case that identifies and quantifies costs and benefits over the project lifetime. Secondly, all city departments need to be integrated in the procurement plan to ensure economies of scale, best practices, elimination of redundant purchases and interoperability.

It's also important to think of your procurement plan as a living document, one that includes (and regularly updates) a technology roadmap that identifies the optimal sequence of investments and implementations. Of course, cities should start with whatever project they want and be flexible about taking on new projects and changing plans as needed. The important thing is that smart city projects are deployed so that they work together.

Your procurement plan should favor interchangeable hardware and software from diverse vendors to stimulate innovation and competition and to allow for interoperable systems. The plan should also establish selection criteria that go beyond just the "lowest price." It prioritizes for solutions that are the:

- Least prone to obsolescence
- Most easily expanded to meet future needs
- Most resilient
- Most cost-effective
- Easiest to install and use
- Most relevant to addressing the objective

Adhering to a disciplined procurement plan can dramatically decrease overall costs. It can also greatly extend the life and value of the technologies purchased because the plan will include provisions to ensure interoperability and open standards.

Consider all funding mechanisms. Too often cities consider only a single "traditional" method to finance the technology it needs. In some regions, that method may be funding from the central government. In other parts of the world, it may be municipal bonds. But in an era when so many municipal budgets are already strained, you'll need to explore the widest possible range of funding mechanisms. And the results may surprise you.

There are dozens of different ways to finance infrastructure. Among them:

- Public/private partnerships
- Performance contracting
- Philanthropic grants
- Development bank loans
- Pay-as-you-go
- Sale/leaseback
- Revolving funds
- Guarantee schemes
- Utility incentives
- On-bill repayment through local utilities
- Local incentives and credit programs
- Reduced permitting time
- Density bonuses
- Pay-for-performance

To increase bargaining power, cities should also consider joint procurements and buying coalitions with other cities, states, regions, federal agencies and the military. By considering all financing options, a city may be able to afford smart city improvements years earlier than more traditional means might allow. The sooner installed, the sooner the city will realize the payback. For more on financing options, download the Council's Smart Cities Financing Guide. It provides detailed, expert analysis of 28 municipal finance tools for city leaders investing in the future.

ADDITIONAL RESOURCES

Pursuing two-way communication with citizens

Smart people are the real brains behind smart cities

Smart cities are powered by technology, but the real power comes from how citizens use it and how it makes their lives better. Read why a Schneider Electric exec says open data and a citizens-first mentality are keys to success for any smart cities initiative.

Attracting talent and business

Egyptian World Heritage site launches mobile portal to enhance and revitalize local tourism

Luxor, Egypt, wanted to make it easy for its approximately 12,000 daily visitors to find tour guides, hotels, restaurants, transportation and other services to assist its tourism industry. In 2012, the Egyptian Ministry of Communications and Information Technology launched the Luxor Mobile Portal, powered by Microsoft's cloud services.

Offering an integrated, personalized citizen portal for services

Polish cities' cloud-based web chat improves citizen access to services

Working with Council member IBM, eight cities in Poland have adopted a virtual web chat program to improve citizen services. The program developed by InteliWISE runs on the municipal websites and uses cloud-based virtual agents to help citizens instantly access information about government services without searching on the web or making a trip to city hall.

Engaging citizens on their terms

A virtual city hall in a shopping mall

Residents of Nice, France are remotely accessing city services confidentially and well beyond normal city hall operating hours – all from a popular shopping mall. The Nice Cote d'Azur Metropolitan Area and the city of Nice joined forces with Council member Cisco to launch a worldwide pilot of the 'virtual city hall cabin.'

Promoting a smart city workforce

Miami community sets the stage for far-reaching revitalization

Working with Microsoft after the economic downturn, local officials in Miami-Dade County, the city of Miami, and Miami-Dade County Public Schools recognized opportunities awaiting citizens and businesses in providing advanced technologies, training and job opportunities.

Disseminate timely information

Police departments find more reasons to be social

When big city media ignored the news from a suburban police department, it turned to social media to get timely information to citizens. Learn how Johns Creek (Georgia) Police are using SunGard Public Sector's platform to better connect with the community on everything from massive snow storm alerts to lost pets.

CHAPTER 4

UNIVERSAL ASPECTS OF A SMART CITY

Some of today's greatest cities benefitted from visionaries who – centuries ago – saw possibilities for civic betterment and made it happen. A compelling example comes from leaders back in the 1800s. Way before the phrase "urban sprawl" had entered our psyche, they committed to preserving vast amounts of open spaces for public use. Think of Hyde Park in London, Central Park jutting through Manhattan or Ueno Park in Tokyo. They are all testaments to leaders "thinking outside the box" a very long time ago.

Fast-forward a couple of centuries. It's your turn to make that same kind of lasting impact on your city. This chapter will help get you started. In many ways, it is the most important chapter in the Guide because it lays out the universal principles that should underlie every city responsibility, from water to power to public safety and all the rest. Get these right and you've set up your city for decades of success.

This chapter includes 17 goals — we call them "targets" — that will propel you down the smart city path. We refer to these 17 as "universal targets" because each of them applies to every city responsibility.

Here's an example: One of the targets is to use analytics to achieve full situational awareness. That means giving system operators a real-time, big-picture view of what's going on so they can spot problems early and act quickly to mitigate them. An example might be an accident that has a major thoroughfare blocked. Knowing about the accident in real time gives transit operators a chance to reroute buses.

But that situational awareness also has great value to public safety, to water, to energy, to... well, to virtually every city responsibility, hence their inclusion in this Universal chapter. (In later chapters, you'll read about targets that apply only to specific responsibilities – energy or transportation, for instance).

Before we drill down on the 17 universal targets, a quick refresher on key terms:

- **ICT** — information and communications technologies. The blanket term for the devices, software, standards and communications that make cities smart.
- **Instrumentation** – the devices used to collect data about city conditions. Examples include smart meters, occupancy sensors, temperature sensors, light detectors, pressure sensors and many more.
- **Responsibilities** – the everyday essential functions and services a city provides such as water, public safety, transportation, etc.
- **Enablers** – to enable is "to give power, means, competence or ability." By that token, enablers are the individual ICT components that allow city responsibilities to get smart. Examples include computing resources, data analytics and similar functionalities.
- **Targets** – goals for smart city efforts. A series of objectives that, taken together, form the foundation of an ICT-enabled smart city.

Before we go further, let's take a look at some of the amazing benefits that your citizens will gain once you start checking off the smart city targets recommended in this Guide.

> ***City visionaries.*** *Thanks to the work of visionary planners in the 1800s, Hyde Park remains a popular gathering spot in the middle of urban London.*

Figure 4.1

Benefits of realizing the universal targets

We've talked about the hurdles cities face on their smart city journey and how realizing targets will require commitment, planning and execution. *Now let's talk about the rewards!*

Because the 17 universal targets described here apply to every responsibility, the benefits highlighted below are also citywide in their application. We've organized the benefits by our three core smart city objectives – enhanced livability, workability and sustainability.

Livability

Livability will mean different things to different people because we all define quality of life in different ways. Yet the smart city benefits highlighted below have the potential to help everyone:

Revolutionizing people's relationship with their government. By providing instant, electronic access to the information people need, the services they require, and the interaction they want with officials, cities build citizen trust and satisfaction.

Improving city service by sharing data. Many of the most exciting city applications come from sharing data between departments. Or, in a similar fashion, by sharing data with outside developers who can innovate new applications. For instance, cities including Amsterdam, London, Philadelphia and San Francisco have instituted "Open Data" programs. They have resulted in hundreds of innovative applications, including trip planners, parking spot finders, bus locators, crime reporting and alerts, and business planning tools, to name just a few.

Enabling real-time alerts and real-time monitoring. Health and public safety are improved when citizens are alerted to fires, floods, air-quality issues, public disturbances, pipeline leaks, downed electricity lines, chemical spills, snowstorms and snow plows, metro lines, bus locations, etc.

Creating citywide situational awareness. When you are able to fully visualize your city's traffic, energy, gas and water networks, you can best ensure reliability and resiliency of those essential services.

Protecting personal privacy. People have a right to and great desire for privacy and that issue will certainly crop up when you start marching down the smart city path. The Guide's universal principles include recommendations on privacy.

> ***Revolutionizing people's relationship with their government.*** *By providing instant, electronic access to the information people need, when and where they need it, cities build new trust with their citizens.*

Figure 4.2

Workability

Workability means accelerated economic development.

Creating world-class infrastructure. Businesses weight the efficiency and reliability of city infrastructures when they make their investments. They have many options. Why locate in city A, when nearby city B has a more efficient transportation network, a more reliable and cost-effective energy grid, or a more advanced law enforcement program? Cities that have optimized their infrastructures are more attractive investment locations.

Protecting business from cybercrime. Hacking and theft are serious risks to businesses. A 2012 study reported that incidents of cybercrime doubled over the last three years, while their financial impact rose by 40%. Enforcing cybersecurity as described in this Guide will help city government achieve safety and resiliency, and create trust for companies contemplating a move to your city.

Unleashing innovation. Cities that free up their data via Open Data or similar programs will unleash the power of people on their data sets and benefit from new ideas. Data is a valuable and profitable resource that can fuel innovation and invention, thereby creating new businesses, revenue streams and jobs.

Creating a "recruiting tool" for attracting talent and jobs. Increasingly mobile businesses and professionals are attracted to cities that have a strong, compelling vision for a better future.

Supporting skills development. According to a 2012 study, despite the relatively high unemployment rate in the United States, 49% of employers reported having difficulty in filling science, technology, engineering and mathematics (STEM) jobs. City-supported skill development can be an enormous draw to businesses looking for specialized talent.

Sustainability

Sustainability is how smart cities provide necessary and desirable services in a way that doesn't deplete resources.

Reducing resource use through optimization. The optimization gains from analytics and improved planning mean that cities, their businesses and their residents consume fewer resources. By harnessing the power of ICT, smart cities can curb the theft of resources and deliver a better future for generations to come.

Enabling a broad selection of technology choices. Cities that pursue interoperability in their smart technology investments will save money by being able to pick from the widest variety of solutions possible.

> ***Creating world-class infrastructure.*** *Cities that have optimized their infrastructures – transportation, energy, etc.– will be more attractive to businesses.*
>
> *Figure 4.3*

Reducing resource use through optimization:

BAURU SCORES BIG WITH LED SIGNALS

Bauru, a town most famous among Brazilians as the city where soccer superstar Pelé grew up, is a busy college town and transportation hub located at the centre of São Paulo. But Pelé isn't the only bright light the town will ever know. Installation of over 2,000 LED traffic lights from Council member GE made their mark on the municipality's traffic and -- in a very substantial way -- on its coffers.

"When we began looking, we had high standards for a solution that would maximize both energy savings and the quality of light," said Marney Tadeu Antunes, commercial director for CPFL, Sao Paulo's utility provider.

In terms of savings, the new GTxTM LED signals will reduce energy consumption by a stunning 80% over incandescent bulbs, and they will last 10 times longer. That, coupled with significant reductions on maintenance costs, is expected to save the city more than $2 million over their 10-year lifespan, making the traffic signals superstars in their own right among city managers.

Low maintenance and high energy savings are just part of the bigger quality picture. One key reason for selecting GE's LED signals was reduction of the "sun-phantom effect," a frequent cause of false green or false red lights that can send a wrong signal to drivers and cause car accidents.

There is a large sloping avenue in Bauru, and by noon it was sometimes difficult to distinguish which color was indicated or even if the light was on. With the new GTx LED signals, colors are easily distinguished.

> ***Reducing resource use through optimization.*** *Bauru's new GTxTM LED signals will reduce energy consumption by a stunning 80% over incandescent bulbs, and they will last 10 times longer.*
>
> *Figure 4.4*

Reducing duplication of effort. When smart city efforts are confined to departmental silos, functions are needlessly repeated. This unnecessary duplication may range from market research to community outreach to technical design to security planning to staff training to procurement processes to designing user interfaces and much more. Agreeing in advance on universal principles takes care of these things once, for use in all departments.

Reducing costs through infrastructure sharing. Some early smart city efforts have overlooked the potential to share costs. Here are just a few of the elements that can often be purchased or designed just once and reused many times: geographical information systems (GIS); communications networks; cybersecurity designs and implementations; database management systems; enterprise service buses; workforce and field crew management architecture, and operations centers. Additionally, in some cases costs can be reduced by partnering with private sector providers (operators) who have already deployed networks and services.

Reducing costs by re-using software modules. By realizing the targets in this Guide, cities can construct their applications in a way that creates a collaborative and secure environment, makes it easy to share code modules between different applications, minimizing expensive programming.

Increasing economies of scale. By agreeing on universal standards and specifications, cities can often lower their purchasing costs while increasing interoperability. Otherwise, each city department makes its own small, slightly different order with diminished bargaining power.

Embedding best practices. By way of example, consider something as crucial as cybersecurity. Now suppose that every department is responsible on its own for researching, planning and implementing that security. It's not hard to recognize that some departments will not have the skills and resources to do the best possible job. By contrast, if the city adopts a universal security framework, it can be assured that the individual departmental implementations will be state-of-the-art.

Enabling better financial forecasting. Financial forecasting is an important discipline and it can be greatly enhanced with the help of the data flowing from smart cities. Combining and correlating growth projections, depreciation and historic operating patterns can improve cities' 5-, 10- and 20-year plans. And by monitoring key performance indicators, cities can measure their progress and their return on investment.

Squeezing the maximum value from city assets. Electronically monitoring the actual condition of assets at every moment helps predict when they will need maintenance in time to prevent breakdowns. With device management and asset optimization, cities will save money while still ensuring the reliability of their technology deployments.

> ***Squeezing maximum value from assetss.*** *Electronically monitoring the condition of assets helps predict when maintenance is needed.*

Figure 4.5

Using computer simulations to plan with great precision. Thanks to computer modeling and simulations, cities can test assumptions, try different scenarios and make mistakes in the simulations instead of costly mistakes in real life. Many experts predict that smart city technologies will change the very nature of planning – from a once-in-a-decade activity based on estimates to an ongoing process based upon real-time data.

How to use this chapter (and the ones that follow)

The goal of the Readiness Guide is to help you make two key decisions: 1) where you want to end up and 2) where you should start.

This chapter and those that follow will help you with the first issue. They suggest the targets at which you should aim. Your only job is to review those targets and determine a) whether they apply to your city and b) how far along you are already.

When it comes to which ones apply, we are biased – we think every target in this Guide is essential to the long-term success of a smart city. Not to be overly dramatic, but you ignore these targets – especially the universal targets – at your own peril.

The universal targets are highlighted on the checklist you'll see on the next page (and again at the end of the chapter). Each target is explained in detail on the pages that follow. When it comes to how far along you are, you can use the column at the far right of the checklist to record your estimate. You'll use that estimate of progress in the final chapter, Ideas to Action, where you will set your priorities.

> ***Universal targets.*** *Knowing where you are strong and weak will help you choose where to point your smart city efforts first.*

Figure 4.6

Knowing where you are strong and weak will help you choose where to point your smart city efforts first.

You don't have to over-think the process. Nor do you have to become an expert in every target. When you have gone through all the chapters and completed the consolidated target list in the final chapter, you will be handing it to specialists to build detailed project plans. You can count on their expertise for the details.

A few large cities will hand their target list to in-house staff. But most cities will use outside experts. Either way, your job is to hand those experts your "wish list" – your prioritized target list. That list will tell them, in general terms, where you want to start and where you want to end up.

So don't feel overwhelmed as you read through the targets. Your job is not to solve all of these issues. That's where the experts come in. Your job is to know which issues need a solution and to decide which issues to tackle first.

If you have further questions about targets and checklists, reach out to the Smart Cities Council via the website or the contact information in the appendix.

And now, on to the universal targets. As you read through each one, jump to a checklist to record your assessment of your city's progress. After completing this chapter and the ones that follow, use the summary checklist in the final chapter to combine your results into one document.

UNIVERSAL TARGETS

TECHNOLOGY

Enabler	Universal Targets How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress None	Partial	Over 50%	Complete
Instrumentation & Control	Implement optimal instrumentation	☐	☐	☐	☐
Connectivity	Connect devices with citywide, multi-service communications	☐	☐	☐	☐
Interoperability	Adhere to open standards	☐	☐	☐	☐
	Use open integration architectures and loosely coupled interfaces	☐	☐	☐	☐
	Prioritize use of legacy investments	☐	☐	☐	☐
Security & Privacy	Publish privacy rules	☐	☐	☐	☐
	Create a security framework	☐	☐	☐	☐
	Implement cybersecurity	☐	☐	☐	☐
Data Management	Create a citywide data management, transparency and sharing policy	☐	☐	☐	☐
Computing Resources	Consider a cloud computing framework	☐	☐	☐	☐
	Use an open innovation platform	☐	☐	☐	☐
	Have access to a central GIS	☐	☐	☐	☐
	Have access to comprehensive device management	☐	☐	☐	☐
Analytics	Achieve full situational awareness	☐	☐	☐	☐
	Achieve operational optimization	☐	☐	☐	☐
	Achieve asset optimization	☐	☐	☐	☐
	Pursue predictive analytics	☐	☐	☐	☐

Figure 4.7

Instrumentation and control

Instrumentation is the bedrock of smart cities. It provides the key source of data that allows a city to make informed decisions on how to reduce costs and allocate funding. In energy, instrumentation may mean smart meters that measure energy flow. In transportation it may mean embedded devices in roads and highways that measure traffic.

Implement optimal instrumentation. The purpose of this target is two-fold. 1) We use instrumentation to gather information about city conditions. 2) We use control devices to take action remotely — for instance, to throw a switch or open a valve. Becoming smart is all about having the right data to work with to make better decisions. So the overarching goal is ***optimal*** instrumentation and control.

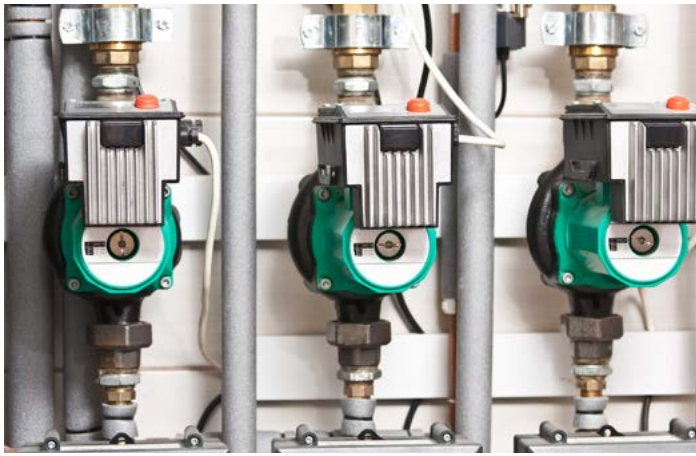
Optimal is the key word here. The ideal smart city will have exactly the devices it needs, exactly where needed. In many responsibility areas, optimal may mean a device at every end point. In water, for instance, it may mean a smart water meter at every customer premise. In other cases, it may mean a sensor "every so often" – as frequently as needed to generate enough data to provide a full picture of what's going on.

Three issues are worth mentioning as they apply to instrumentation; these three will be addressed in more detail later in the chapter:

1. **Privacy and security** — Given the amount of data generated, cities must be absolutely vigilant about respecting privacy and implementing security.

2. **Legacy devices** — Your city may already have lots of data available without the need for additional instrumentation immediately. For instance, anonymous cell phone GPS data can tell you where people are, or how fast they are moving on roadways. Key intersections may already have traffic sensors. Streetlights may already detect ambient light. Water, power or gas utilities may already have smart meters. You may decide to add additional sensors – especially now that prices are plummeting – but it's often possible to get started with the data you are getting already.

3. **Connectivity** — In smart cities, instrumentation needs to be connectible. Having sensors that need to be checked manually is not optimal – for instance, you wouldn't want to have to send a technician to every water pump in your city.



> ***Implement optimal instrumentation.***
> *Optimal instrumentation is what creates the data critical to a smart city.*
>
> ***Figure 4.8***

Implementing optimal instrumentation creates the data critical to a smart city. It is also the first step in connecting city infrastructure to the "Internet of Things," which is described next in the connectivity discussion.

Optimal instrumentation:

HOW SMART WASTEWATER MANAGEMENT SAVED AN INDIANA CITY MILLIONS

South Bend, Indiana had a serious problem: wastewater spilling into the St. Joseph River and welling up in basements. The city's wastewater pipes and treatment facilities just couldn't handle the volume.

The city was looking at an estimate of $120 million for a daunting infrastructure upgrade. Instead, it entered a public-private partnership with Notre Dame University, local tech company EmNet and Smart Cities Council member IBM to come up with a new way to monitor and control its wastewater collection system. The new approach cost the city 1/20th of the initial estimate – a much more budget-friendly $6 million.

The integration of IBM technology with smart valves and sensors from business partner EmNet helped the city to be proactive in its wastewater management, avoiding additional infrastructure investments while improving public health. Meanwhile, Notre Dame students came up with innovative apps to allow residents to report flooding, social media tools that collect information on water systems and more. As a result, the technology and research made it possible to automate what had been manual and labor-intensive data collection.

With the new system in place, the city is now able to monitor and actively control its wastewater collection system, which has helped cut down on sewer back-ups and overflows.

> ***Implementation and control.*** *An innovative, affordable solution for South Bend's maxed-out wastewater system uses smart sensors (instrumentation) plus smart valves (control) plus smart software from Council member IBM.*
>
> *Figure 4.9*

Connectivity

Take a moment to consider the incredible ways technology has changed our lives in the last four decades – microprocessors, ATMs, the World Wide Web, email, Google maps, smartphones and iPads to name a few. Clearly we've been on a connectivity roll for a while. And it's not going to stop. Today we are entering the Internet of Things (IoT) era where people talk to devices and devices talk to each other. This helps explains why connectivity is such a robust smart city enabler, and why machine-to-machine communications is all the buzz these days.

Connect devices with citywide, multi-service communications. Above we discussed gathering data through optimal instrumentation. Once those instruments are generating information, they need to be connected so they can communicate to provide data, as well as be able to receive orders.

The target, therefore, is to connect all devices to a citywide communications system. In rare cases, cities use a single communications network for all device connectivity. In most cases, cities use a variety of communications channels, including cellular, fiber, WiFi, powerline and RF mesh.

But it's not enough to have just any communications system. It's critical to have systems that are reliable and secure, based on open standards, high data rates and able to offer real-time communications to those devices that need it.

Most cities will have multiple communications systems, because no single network can realistically support every single application now and into the future. To save costs, cities ought to give strong consideration to the following approaches:

- **Minimize the number of networks supported at city expense.** To the extent that the city or its utilities need their own private networks, they should try to establish multi-purpose networks rather than a collection of single-purpose communications networks.
- **Investigate the viability of existing public networks** before building your own private network. For instance, existing cellular networks have the capacity to support smart grids, smart traffic management and smart water networks.
- **Encourage cross-departmental planning and design** to learn whether multiple departments can share a single network.
- **Investigate policies and incentives that encourage the private sector** to invest in building and maintaining citywide networks.
- **Prioritize technologies and tools that can manage "hybrid" (mixed) networks.** Tools exist that can merge different communications technologies, even old analog technologies such as radio.

Connecting instrumentation and control devices allows a city to feed data into analytical programs that greatly improve outcomes, minimize resource use and save money, as we will cover in detail later.

Connect devices. *Multi-service communications systems can carry messages for multiple applications from multiple sources.*

Figure 4.10

Citywide communications:

ONE NETWORK RUNS THREE METERS — WATER, HEAT, GAS

Tianjin Eco-City is a flagship collaborative project between Singapore and China. Established in 2007, it is built on the vision of being "a thriving city which is socially harmonious, environmentally friendly and resource-efficient." Located in the city's Binhai New District, the community will cover a land area of about 30 square kilometers. When completed in 2020, it will house approximately 350,000 residents.

Tianjin has some of China's strictest building energy-efficiency standards. Each apartment comes with an underground parking space, and government officials say that charging stations and subsidies for electric cars are planned.

In June 2013, Council member Itron completed the installation of 25,000 smart meters for water, heat and gas. The pilot project measures, collects and analyzes data from the meters to produce actionable intelligence. For instance, residents see graphical data to learn about their energy and water usage. It also helps simplify the billing process and provides detailed consumption information which reduces billing disputes.

"With this project, Itron is providing China's only unified platform that manages water, heat and gas data together under one system," said Mingus Yu, general manager, Water and Heat, for Itron in China. "Through this successful deployment, Itron is demonstrating its commitment to supporting the Chinese government's smart city plan."

Both Singapore and China see Tianjin as a way to demonstrate their commitment to sustainability.

> ***Minimize the number of networks.*** *The comprehensive solution that Itron deployed in Tianjin, China measures, collects and analyzes data from water, heat and gas meters, using a single communications system.*
>
> *Figure 4.11*

Interoperability

Interoperability ensures the technologies you deploy work well together. There are three interoperability targets:

Adhere to open standards. If you hope to achieve your smart city goals, different technologies from different vendors must be able to work together. In particular, they must be able to exchange information. Adhering to standards helps to guarantee that the products you buy can use predefined mechanisms to talk to each other.

And you don't want just any standards, you want "open" standards – standards that have been defined by an industry group and published for all to use. This contrasts with "proprietary" standards, which typically come from a single vendor who retains control over who can use them and when they will change.

Open standards help cities control both their expenses and their risk. They allow cities to mix and match products from different vendors without jeopardizing the ability to exchange data. Put another way, open standards contribute to interoperability, choice and flexibility. They also make maintenance easier, because there are communities of specialists trained in published standards, such as those from Council advisors

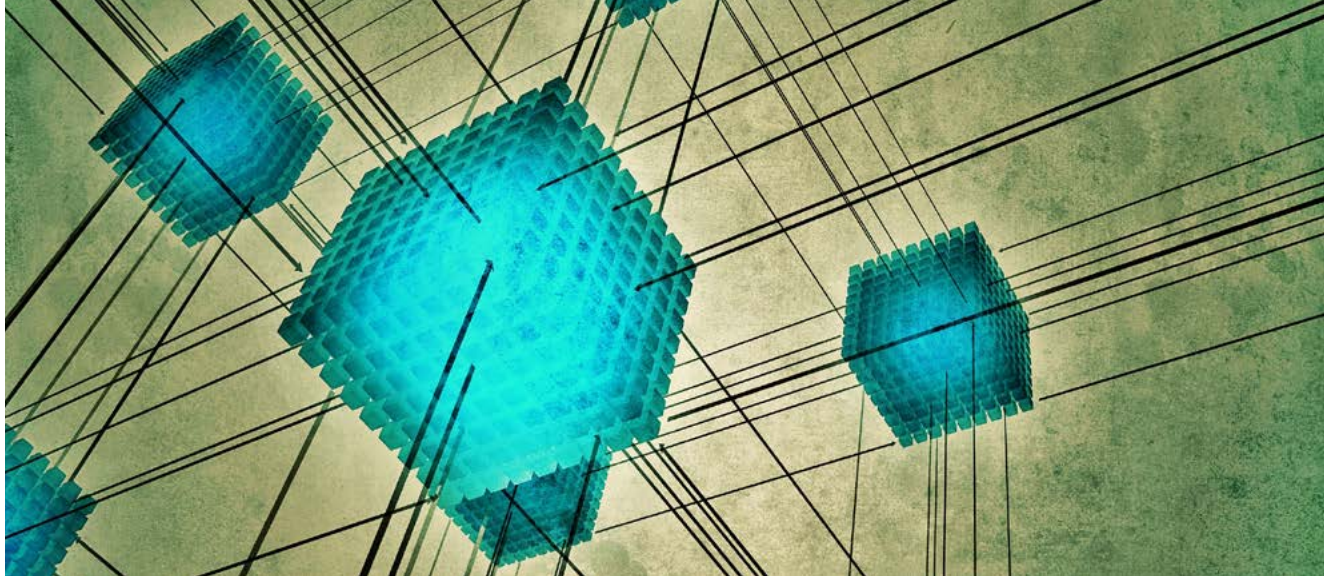


Figure 4.12

the International Electrotechnical Commission (IEC), the Institute of Electrical and Electronics Engineers (IEEE), the International Telecommunication Union (ITU), the American National Standards Institute (ANSI) and many others including 3GPP for 3G/4G and the WiFi Alliance. The Open Geospatial Consortium (OGC) – also a Council advisor – provides open standards for sharing spatial information, indoor and outdoor, and for communicating with sensors of all types

Although open standards are absolutely essential to the long-term success of a smart city, putting them into practice can be challenging. There are hundreds if not thousands of standards that apply to one aspect or another of urban life. The best advice is to leave the heavy lifting to the experts. When you get to the project planning phase (as described in the final chapter), select suppliers with a public, proven commitment to open standards. Give them the task of selecting the best ones to use, subject to the oversight of your project manager or systems integrator.

When it comes to the smart grid portion, there is happily some good news. The IEC has undertaken the job of creating a free Smart Grid Standards Mapping Tool that makes it far easier to discover and choose between standards. Using either a diagram or a list, you can drill down to a specific aspect, then see a list of all the standards that relate. The IEC lists not just its own standards, but those from other organizations as well.

Use open integration architectures and loosely coupled interfaces to facilitate sharing of data and reuse of code. This gets a bit technical, but the important thing to understand is that you can build your applications in a way that makes it easy to reuse code "modules," saving time and expense. Systems that are "loosely coupled" don't have components that are dependent on each other, theoretically making it easier to swap them in and out. Open integration architectures are enhanced by methodologies such as service-oriented architecture (SOA) and enterprise service bus (ESB). Benefits include:

- **Faster software implementations** because they can be assembled in part from previously written modules
- **More robust implementations** because the city can have standardized tools and best practices
- **Greater scalability** because the loose coupling that is part of an open integration architecture allows for high availability, fault tolerance and load balancing — techniques that allow systems to deal with huge amounts of data
- **Easier changes** because you alter only the affected module(s), not the entire application, and because changing one module has minimal impact on the rest of the system

OPEN INTEGRATION ARCHITECTURE SYSTEM

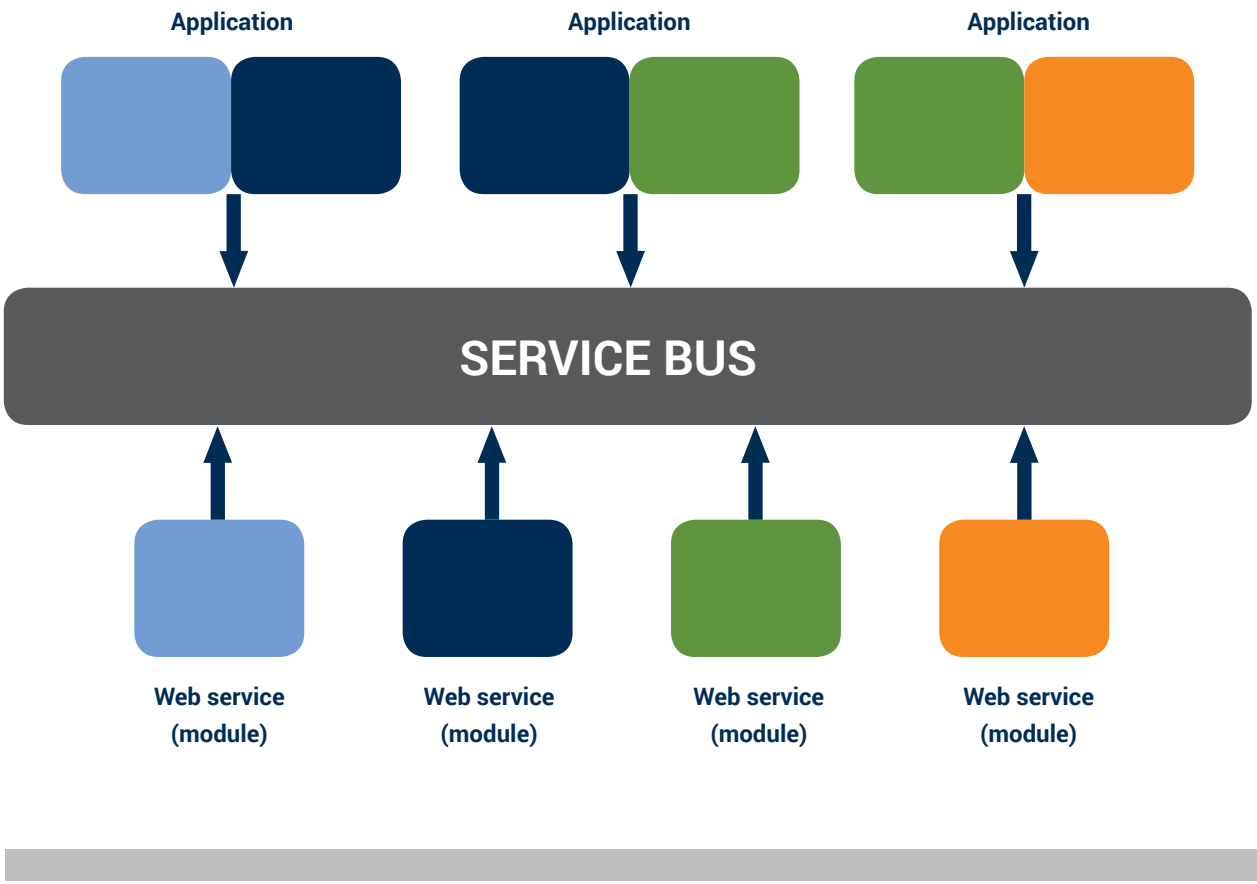


Figure 4.13

Figure 4.14

Prioritize legacy investments. No city can afford to rip out its current infrastructure and replace everything from scratch. Priority must go to making the most of existing investments. Typically, that means retrofitting existing assets — streets, buildings, equipment — with sensors and communications.

Fortunately, a wave of new, low-cost technologies makes it possible to connect legacy assets. In the area of emergency response, it is now possible to integrate old, analog radios with state-of-the-art IP-based communications, stitching them together into a seamless network. Likewise, a city government can often find ways to continue using old software by sending its data to new software modules that add value on top. Likewise, an electric power utility doesn't have to replace its old transformers, it can simply add transformer monitors to report on their conditions.

Security and privacy

One of the greatest challenges for smart city leaders is to reassure residents that their rights will be respected and their data protected. This section highlights three important targets that address those issues.

Publish privacy rules. Make it a priority to produce clear privacy policies that are easily accessible. The rules should balance residents' desire for privacy and control with the ability to gain access to data to provide better services. They should stipulate:

- **Which data sets** are owned by which stakeholders
- **What rights and protections** are afforded by ownership
- **Which data sets are private** (requiring authorization prior to sharing)
- **Which data sets can be shared** with the city or authorized third parties
- **How data can be shared** if defined protocols for making information anonymous are followed

Publishing privacy rules can save time, money and headaches. It can also unleash innovation. Entrepreneurs are more comfortable building new products and services if they know the rules in advance and they know those rules will apply equally to their competition.

It's one thing to have privacy rules. It's another to ensure that residents and businesses know about them — and yet another to actively enforce them in collaboration with national and state/province level authorities.

A 2013 column in the Boston Globe titled "The Too-Smart City" garnered a lot of attention. It took a "big brother is watching" slant on the smart cities movement: "A city tracking its citizens, even for helpful reasons, encroaches on the personal liberty we count on in public spaces."

Cities and cultures will have different priorities for privacy. There are several sources of guidance on privacy rules that cities may want to review. As you will see, you don't need to invent your privacy guidelines from scratch. There are several sources of helpful examples, including:

* European Union Privacy Directive
* Electronic Privacy Information Center (EPIC)
* International Association of Privacy Professionals
* Criminal Justice Information Services
* Federal Information Processing Standard
* Office of the Information and Privacy Commissioner of Ontario, Canada

Figure 4.15

Publish privacy rules:

CALIFORNIA UTILITY TAKES LESSONS FROM CANADA FOR ITS PRIVACY FRAMEWORK

The city of San Diego, California's municipal utility in 2012 launched a Privacy by Design smart grid initiative in conjunction with Ontario, Canada Privacy Commissioner Ann Cavoukian, a recognized champion of consumer privacy safeguards.

"Our cross-border partnership with SDG&E follows similar successful alliances forged with other organizations globally, as well as in my jurisdiction of Ontario, Canada, to build in Privacy by Design," said Cavoukian. "Privacy is a fundamental right of every energy customer, and I am very pleased to be working with SDG&E to ensure that our innovative privacy framework is an integral part of the smart grid deployment."

Developed by Dr. Cavoukian, Privacy by Design has been made an international standard, and is a practical solution for ensuring privacy that can be designed into the ever-growing and systemic efforts of ICT, and of large-scale networked data systems, as the default condition.

> ***Publish privacy rules.*** *Cities can turn to several established systems to get started. For instance, the Privacy by Design system, originally developed in Ontario, Canada, is based on seven fundamental principles.*

Figure 4.16

The 7 Foundational Principles

1. Proactive not Reactive; Preventative not Remedial

The Privacy by Design (PbD) approach is characterized by proactive rather than reactive measures. It anticipates and prevents privacy invasive events before they happen. PbD does not wait for privacy risks to materialize, nor does it offer remedies for resolving privacy infractions once they have occurred — it aims to prevent them from occurring. In short, Privacy by Design comes before-the-fact, not after.

2. Privacy as the Default Setting

We can all be certain of one thing — the default rules! Privacy by Design seeks to deliver the maximum degree of privacy by ensuring that personal data are automatically protected in any given IT system or business practice. If an individual does nothing, their privacy still remains intact. No action is required on the part of the individual to protect their privacy — it is built into the system, by default.

3. Privacy Embedded into Design

Privacy by Design is embedded into the design and architecture of IT systems and business practices. It is not bolted on as an add-on, after the fact. The result is that privacy becomes an essential component of the core functionality being delivered. Privacy is integral to the system, without diminishing functionality.

4. Full Functionality — Positive-Sum, not Zero-Sum

Privacy by Design seeks to accommodate all legitimate interests and objectives in a positive-sum "win-win" manner, not through a dated, zero-sum approach, where unnecessary trade-offs are made. Privacy by Design avoids the pretense of false dichotomies, such as privacy vs. security, demonstrating that it is possible to have both.

5. End-to-End Security — Full Lifecycle Protection

Privacy by Design, having been embedded into the system prior to the first element of information being collected, extends securely throughout the entire lifecycle of the data involved — strong security measures are essential to privacy, from start to finish. This ensures that all data are securely retained, and then securely destroyed at the end of the process, in a timely fashion. Thus, Privacy by Design ensures cradle to grave, secure lifecycle management of information, end-to-end.

6. Visibility and Transparency — Keep Open

Privacy by Design seeks to assure all stakeholders that whatever the business practice or technology involved, it is in fact, operating according to the stated promises and objectives, subject to independent verification. Its component parts and operations remain visible and transparent, to users and providers alike. Remember, trust but verify.

7. Respect for User Privacy — Keep it User-Centric

Above all, Privacy by Design requires architects and operators to keep the interests of the individual uppermost by offering such measures as strong privacy defaults, appropriate notice, and empowering user-friendly options. Keep it user-centric.

Create a security plan that designs security into smart systems from the beginning, and continually assesses risks thereafter. A smart city's security policy and risk management framework must be comprehensive, encompassing the cybersecurity as well as the physical security of all assets — from massive infrastructure to tiny mobile devices.

Data privacy depends upon the security of the systems that store data. Highly secure systems are operated by authorized people only, and produce reliable, predictable results. Systems that are "insecure" are unreliable, highly vulnerable to attack, and subject to major data breaches.

New smart city capabilities — with everything from energy infrastructure to employee cell phones connected on the Internet — add tremendous connectivity, generate a lot of data, and offer great promise. But they also create what security experts call "an expanded attack surface," which introduces significant new cyber vulnerabilities.

Cities need an expert, comprehensive security plan at the heart of all smart city systems development. Cybersecurity must be "baked-in" throughout the system, starting in the design phase, not merely added afterward around the perimeter.

This plan should encompass data, applications, devices and communications systems at minimum. It should have a strong identity access management component; cyber defense-in-depth security controls; "human factor" security awareness training; and a strong trustworthy computing foundation.

It's best not let each individual city department to come up with its own security plan. Instead, leverage the best cybersecurity resources available to your city (internal and external) to come up with one security standard that everyone must meet.

But even with the best experts and strongest security plan, no city is immune from cyber attack. Therefore it is also extremely important to monitor breaking cyber threats and new vulnerabilities, constantly; and to have detailed disaster response and system restoration plans in place.

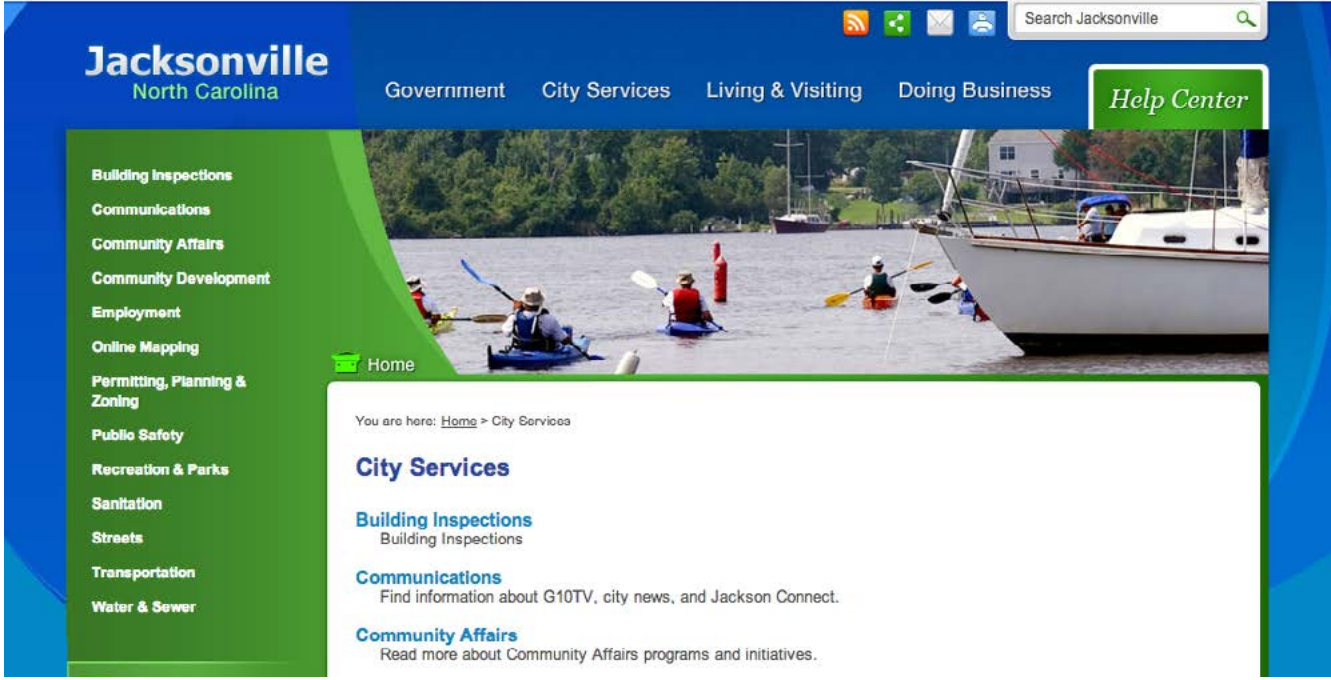
An aggressive cybersecurity plan, with security control requirements all participating smart city departments must meet, can greatly reduce the risk of attack, and mitigate adverse consequences should one occur. And, perhaps more important, it can build the kind of trust and confidence in smart city systems (and their privacy controls) that can lead to wide adoption.

> ***Create a security plan that designs security into smart systems from the beginning, and continually assesses risks thereafter.***
> *It's important to remember that (like privacy) security requirements specified during the design phase must be continually updated to counter new threats and to ensure they remain in compliance.*

Figure 4.17

Create a citywide security policy:

HOW JACKSONVILLE MADE ITS VIRTUAL ENVIRONMENT MORE SECURE



Jacksonville is the 14th largest city in North Carolina and home to more than 70,000 residents. Jacksonville's Information Technology Services (ITS) department provides citywide support for all computer, phone, security and geographic information systems through its operations center for over 500 end users.

As the city's workers became more and more dependent on the ITS department, Jacksonville's IT director Earl Bunting along with other city officials, decided it was time to refresh the department's infrastructure to ensure it remained fully functional at all times. It also wanted to give employees access to needed materials, but in a secure fashion.

Jacksonville decided to upgrade to a Virtualization Experience Infrastructure (VXI) from Council member Cisco, which supports Jacksonville's operations centers. The approach goes beyond traditional virtual desktops to deliver next-generation virtual workspaces by unifying virtual desktops, voice and video.

While Jacksonville citizens and employees have seen a number of benefits from the upgrade, the solution has also helped Jacksonville's virtual environment become more secure. "Our IT department no longer has to waste time monitoring for threats," says Bunting. "VXI has made our environment increasingly secure and protected us from the growing number of online threats that comes with such a large number of users."

> ***Create a citywide security policy that continually assesses risks.***
> *Upgrading its ICT infrastructure provided many benefits for Jacksonville, North Carolina, including better protection from the growing number of online threats.*
>
> *Figure 4.18*

Data management

The streams of data that smart cities collect create enormous opportunities, but also require special handling. Smart cities treat public data as a citywide asset. That data needs to be accessible to other systems and stakeholders including, where possible, the research community to help ensure that the analytic environment is always current. Citizens, of course, will expect full access to their own data. These requirements demand a citywide policy.

As we move forward, city data will be used by multiple applications from multiple departments. And it may be used by outside developers as the foundation for useful services to benefit residents. An error in master data can cause errors in all the applications that use it. In a similar fashion, an error in releasing data to those not authorized can cause a cascade of problems.

Many types of city-managed data become infrastructure on which companies and others can build wealth. A "spatial data infrastructure," for example, enables city players to freely use and add to street and landscape data as well as 3D building models, point-of-interest data and weather data.

One more time for emphasis: ***A smart city's most precious resource is the data it produces.*** Avoid squandering or endangering that valuable commodity by failing to carefully define a thorough data policy, as explained below.

> ***Create a citywide data management, tranparency and sharing policy.***
> *A citywide policy makes it much easier to enforce privacy, security and best practices.*
>
> *Figure 4.19*

Create a citywide data management, transparency and sharing policy. Ideally, cities should build a master plan and an information data model that spells out how data is governed, stored and made accessible. Best practices call for a clear governance directive that a) establishes the chain of authority and control over data assets and b) spells out who makes access decisions and who determines accountability. The citywide data management policy defines a city information model for all entities and assets that preserves relationships, attributes and behaviors.

This citywide policy should cover both private and public data and ensure that data from each department is made available to others. It must also align with the policies in the security and privacy targets discussed previously. It is important for data to be stored on secure, reliable and scalable systems long enough to enable the dependable pattern analysis and reliable forecasting explained in the analytics target later in this Guide.

A citywide data management plan will increase the city's agility (ability to quickly build new applications as needed) and accuracy (by ensuring everyone is working with correct data). It can also lower costs by reducing errors and eliminating unnecessary duplication. A citywide plan also makes it much easier to enforce privacy, security and best practices.

Computing resources

Keeping up with ever-advancing computing technologies in an era of budget constraints can put city leaders between the proverbial rock and hard place. But smart cities find a way – and sometimes find the more advanced solution is more budget-friendly too. Even so, there is a right way and a wrong way to pursue your computing objectives, as you'll discover in reading about the four targets in this section.

Consider a cloud computing framework.
There are many ways to deploy computers, but most cities should consider cloud computing first. It is the computing framework best equipped to deliver efficiency and optimization.

Cloud computing is the practice of using a network of remote servers to store, manage and process data. Typically those servers are accessed via the Internet. Please note that cloud computing can be delivered as a service from a third party – sometimes called "hosted solutions" or "software-as-a-service" (SaaS). Or it can be built and operated by a city using the same architectural principles as third-party providers.

Cloud computing provides a common, shared foundation across departments and across different computer systems. Consider these attributes:

- **Identity services** for consistent and secure single sign-on
- **Virtualization** for seamless application portability. Virtualization is the creation of a virtual (rather than actual) version of something, such as an operating system. A single server can run as multiple "virtual" computers with different operating systems, for instance.
- **Management functions** for full visibility and control
- **Scalability** to support millions of data collection points
- **Industry-standard frameworks** and languages for writing applications

Applications and services reside in the cloud, where they are accessible from any device. Additionally, those applications and services are typically built with an event-triggered enterprise service bus architecture that provides a structured method for combining loosely coupled software components. As we discussed earlier in the interoperability target, this approach makes it easy to share data and reuse software code between departments.

The benefits of cloud computing are many:

- **Growth** – It becomes easier to add computing power in small increments
- **Power** – It's typically less costly and simpler to scale up computing services
- **Reliability** – If one computer crashes, others can easily pick up the slack
- **Cost** – It becomes possible to mix and match hardware from different vendors, increasing choice and thus driving down expenditures. In addition, many third-party providers will "rent" software to cities for a monthly charge, with little or no upfront cost.
- **Advanced features** – Smaller cities can gain the same functionality as their larger cousins by tapping into cloud offerings from third parties. The provider sells the service to many different customers, allowing it to enjoy economies of scale that make it possible to create advanced features. Smaller cities would never be able to afford the large ICT staff and server farm required to host such applications on their own.

Cloud computing may not be an immediate option for every city. Cities that have already made large investments in other approaches may settle on a hybrid computing model. And cities in geographies with a cultural emphasis on centralization may prefer a centralized computing model.

Consider cloud computing:

BARCELONA REALIZES VISION OF INNOVATIVE CITY GOVERNANCE WITH CLOUD, DEVICES AND APPS

Barcelona, Spain has a global reputation for innovation. Many of the technological solutions that the city has adopted in recent years are at the leading edge of city management.

Council member Microsoft is a close partner in this effort. It has helped the city drive new services for citizens and visitors and create and support new technology-based companies and entrepreneurs, while also enabling the city government to reduce costs through new cloud computing services and devices.

In 2011, Barcelona began to use Windows Azure cloud-based services to make information available to citizens, which could be easily accessed over the Internet.

The main driver for adoption of a public cloud was better management of the public data that is collected by the city's municipal operations and recordkeeping practices.

In addition to storing data in the cloud for others to analyze, the Barcelona City Council is harnessing the opportunities that city data presents through Big Data and analytics solutions. Having gained confidence in the scalability and security features of Windows Azure, the City Council embarked on an Open Data initiative intended to standardize digital formats and streamline data analysis.

The ultimate goal of the initiative is to promote economic growth by encouraging data sharing between city government and the private sector.

> ***Consider cloud computing.*** *Barcelona has utilized the power of the Microsoft Windows Azure cloud -based platform to help businesses be more productive and to draw more visitors to the city.*
>
> *Figure 4.20*

- **Establish an open innovation platform - Open Data.** Today's Open Data movement represents one of the most powerful opportunities cities have to connect with citizens in meaningful, life-impacting ways. The move to make public data freely accessible to anyone who wants to use it for legitimate purposes has been referred to as "the big bang" for all of the Big Data that cities are amassing today. U.S. President Barack Obama characterizes Open Data as "the new default for government information." Keep in mind that Open Data doesn't work well unless it is discoverable, assessable and usable through open data encodings and open software interfaces.

However you label it, by making raw public information easy to access, you allow city employees, utilities, citizens and third-party developers to create innovative applications and services for the benefit of the city and its residents.

Most of this information has been collected at taxpayer expense. And most of it is available to the public in theory. Until recently, however, it could not be accessed in a useful way. (You can't build a data-based application if you have to go city hall and pull it out of paper files.)

New York City has been one of several leaders in the Open Data movement. In September 2013, officials there announced that since the launch of its Open Data portal in 2011, the city has opened up more than 1,100 data sets from over 60 agencies. These data sets total more than 600 million rows and have received more than 2.8 million views. NYC also announced a city-wide plan to unlock all of its public data by 2018.

NYC, of course, is not alone. Government agencies around the world are embracing Open Data, providing dozens if not hundreds of applications that take advantage of city data. These applications range from:

- **Transit planning apps** that show the best way to travel
- **Crime reporting apps** that show trouble spots
- **Street monitoring apps** that pinpoint potholes and problems
- **Mapping apps** for first responders
- **Location apps** that show where to find ATMs, hotspots, day care centers, urgent care centers, government offices, parks, meeting spaces, etc.

Clearly Open Data and similar innovation platforms can improve public services in countless ways. It can also make government agencies more accountable, generate new revenue streams and help to stimulate economic growth.

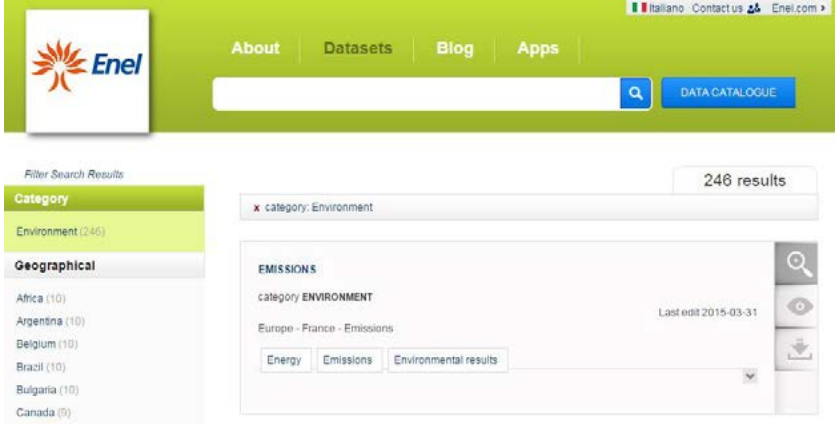
But cities often confront stumbling blocks on the road to an Open Data environment. Two that may be most challenging:

1. Governance and privacy issues. Who owns the data, who controls it, what safeguards are in place to protect personal information when a city decides to open its data for public consumption? Open Data policies must be clarified in the broader data management, transparency and sharing policy discussed earlier.

2. Non-standard data formats. Rather than spending taxpayer dollars to reinvent the wheel in every city, one of the promises of Open Data is the ability to share apps between cities. But that requires cities to use the same data schema, which is often not the case. However there is an initiative underway involving seven major U.S. cities – Boston, Chicago, Los Angeles, New York City, Philadelphia, San Francisco and Seattle – to create a database of standardized Open Data applications.

Fortunately, help is at hand for cities that want to join the Open Data movement, as you'll read on the next page.

OPEN DATA: HOW TO GET STARTED



There's no single path to an Open Data initiative, but most cities will want to take these three steps:

Create a team of Open Data advocates: You'll want a team that includes personnel from a number of departments, including but not limited to: IT, communications/media and managers from departments with data sets with citizen appeal – for example, public safety, transit, public health. Perhaps most important is to have executive-level representation on the team – the city manager or mayor, for instance.

Develop an Open Data policy: First, develop an Open Data policy that is included in and consistent with the city's broader data management, transparency and sharing policy. Second, create an Open Data policy roadmap that outlines your goals, which data sets you will start with (this can be expanded once you've tried a few pilots), where and how you will make them available (a new web portal, on your existing city website, etc.) and what needs to get done by when and by whom. Third, smart city planners should emphasize the importance of open software interfaces and open data encodings, preferably open interfaces and encodings that implement freely usable global interface and encoding standards. These enable technical interoperability between diverse systems, which enables Open Data policies to work.

Choose your first project: Typically the safest approach is to choose a relatively small, low-cost pilot project to get some experience, work out any problems and get a success under your belt. You may want to take the approach that other cities have found successful and reach out to your local developer community via contests and hackathons. They'll likely have ideas about which data sets would make useful apps. Another route is to analyze what kinds of information is most requested by members of the public.

Once a city opens up its data, citizens and businesses start to rely on it. They may even have their business

> ***Establish an open innovation platform.*** *Italian utility giant Enel has championed the Open Data movement, opening its corporate data in the spirit of increasing transparency, favoring technological innovation and improving the market it operates in. Council member Enel is also at the helm of Flexiciency, a European initiative to use smart meter data to its fullest potential*
>
> *Figure 4.21*

and revenue streams depend on it. Cities should make sure their Open Data implementation offers a 24x7x365 availability in a secure manner. As such, a choice for Open Data becomes a core responsibility of the city, reflected in a strong information back bone.

Useful Open Data resources

There are many places to turn for ideas and inspiration on Open Data initiatives. The Council's free Smart Cities Open Data Guide is a good place to start and our Apps Gallery showcases many examples of apps created by and for cities using Open Data.

Other useful resources include:

City Forward is a free, web-based platform that enables users to view and interact with publicly available city data about cities and metropolitan areas around the world. On the site, which is a philanthropic donation of services and technology from Council member IBM, users can search for data by city, subject or source.

Code for America (CfA) runs a fellowship program designed to leverage technology and government data to make cities run better. Among the apps developed by CfA's fellows are Boston's adopt-a-hydrant app and Honolulu's tsunami warning app.

Data-Smart City Solutions – an initiative by the Ash Center at Harvard Kennedy School and powered by Bloomberg Philanthropies – features news and trends in civic data. It's a helpful resource if you want to see what other cities are doing with Open Data.

Data.gov showcases examples of cities and developers working together to improve the lives of city residents.

Open Data Platform formed in 2015 to open up the back end of open data projects. More than a dozen companies have joined the association at the outset, including Council members IBM, GE and Verizon. Association members will use the same basic platform for their open data solutions, providing a wide range of benefits for cities undertaking open data projects.

You may also want to visit:

- The Open Data Foundation
- World Bank's Data page
- Open Data Commons

Freeing London's data.
The London Datastore was established in 2010 by the Greater London Authority (GLA) with the goal of "freeing London's data" so the world at large could use it as they saw fit. Some people see Open Data as part and parcel with the move to greater transparency. The idea is that information collected at public expense should be available to all, except where release would infringe privacy or commercial confidentiality. But the success of London's experiment shows that it is also a way to garner a long list of useful applications for government, for business and for everyday citizens, usually at zero expense to the city.

Figure 4.22

Establish an Open Data platform:

HOW EDMONTON REDUCES CONSTRUCTION SEASON ANGST

Street construction projects are a big deal for businesses in the area where the construction is occurring, for citizens who need to get from Point A to Point B in a timely fashion and for neighborhood residents who must endure the noise.

Edmonton, Canada enjoys a very short period of warm weather when all construction projects seem to take place, thus at any given point during this time, the number of active projects is quite large. As Council advisor Center for Technology in Government (CTG) put it, "Edmonton is known for its two seasons: Winter and Road Construction. It makes perfect sense that one of its flagship Open Data initiatives would involve releasing street construction data."

And that's what Edmonton did. The city website presents construction project information using both static and interactive maps. The interactive map allows users to click on a blue dot and bring up a description of the project at that location. A local developer also took the information and created a mobile app for smartphones.

As a result of the new tools, CTG reported use of the data set has increased substantially. From its launch in April 2012, monthly views increased to over 1,200, then declined gradually to less than 250 by mid-October, when the construction season was largely over.

> ***Establish an Open Data platform.*** *The construction season in Edmonton, Canada, is short and intense. An Open Data initiative has helped citizens cope with the disruptions.*
>
> *Figure 4.23*

Have access to a central GIS.
The Houston, Texas public works department GIS is available online. The rendering above shows water main locations. Having a GIS that maps all of a city's assets and location information is a big contributor to what makes a smart city smart.

Figure 4.24

Have access to a central GIS. A geographic information system (GIS) that maps all of the city's assets and location information is a big contributor to what makes a smart city smart. Most cities will want to implement a single, central GIS system so that data from one department (traffic alerts, for instance) can be shared with others (such as emergency responders). Some cities even share the cost of GIS services with outside organizations, such as utilities and phone companies.

What GIS enables users to do is combine many layers of data – all linked by their geographic location (latitude and longitudinal coordinates) so that greater insights into issues can be discerned. For example, by layering one dataset on school facilities (building locations) with another dataset of the transfer routes for trucks carrying hazardous wastes through a city (street routes), you can reconfigure the travel routes to avoid such sensitive sites.

In another example, Council member DNV GL combined customer survey data on appliances, the propensity of electric consumers to participate in a demand response program offered by their utility, and electric usage data by zip code with the physical locations of the utility service territory to identify the potential for reducing peak at specific geographic points around the system. Such data can also be used to target pilot programs or marketing campaigns for maximum effect. In short, GIS provides a way to get much more value out of data from different sources, and display results visually on a map for quick recognition of solutions.

GIS is tailor-made for smart cities. To name just a few of the great applications of this technology, cities can use GIS to:

- **Map crime data** to aid their public safety work
- **Locate pipes, pumps, cables** and other assets to help better monitor and analyze the efficacy of their water infrastructure

- **Maximize traffic flow** and share helpful traffic maps with the public

- **Conduct better environmental impact assessments** for their buildings and parks

There are also many benefits to cities with GIS:

- **Spatial decision-making** is greatly improved

- **Efficiency gains** accrue through more intelligent maintenance scheduling and delivery routes

- **Improved accuracy of essential records** such as property boundaries and locations of key assets

- **Resiliency** is boosted through improved situational awareness in times of stress

Everything in a city has a location. In a smart city, location information is being used and produced for countless purposes by countless different systems. Cities need to encourage use of open standards that provide seamless communication of geographic information between different systems. Open interface and encoding standards prevent vendor lock-in and enable systems of many kinds to share all types of geographic information. Most GISs implement open encoding and interface standards that enable them to "talk to" other GISs as well as diverse mobile devices, emergency response systems, smart grids, sensor webs, smart vehicles and more.

Application developers discover countless opportunities for innovation when cities provide access to 3D urban models, address data, elevation data, zoning, bus routes etc. via encodings and interfaces that implement open standards.

Have access to comprehensive network and device management. Eventually cities could have hundreds of thousands or even millions of small devices connected to their networks. That's a lot of devices! Smart cities (or their suppliers) will need a robust device management platform that handles tasks such as device detection and registration, device configuration, device connection and disconnection, device security, device troubleshooting and device updates and upgrades. Such a platform is able to support virtually any kind of device, and it can span multiple communications networks.

Being able to manage devices remotely and with computer assistance offers significant benefits. Among them:

- **Cities can save time,** improve their infrastructure security and quickly and easily implement any necessary software upgrades

> ***Have access to comprehensive network and device management.*** *Cities can save time, improve security and easily and quickly upgrade software via device management.*

Figure 4.25

- **Cost savings accrue** to cities through the central management of their devices

- **It is easier to enforce consistency** and compliance with the city's data management, security and privacy policies

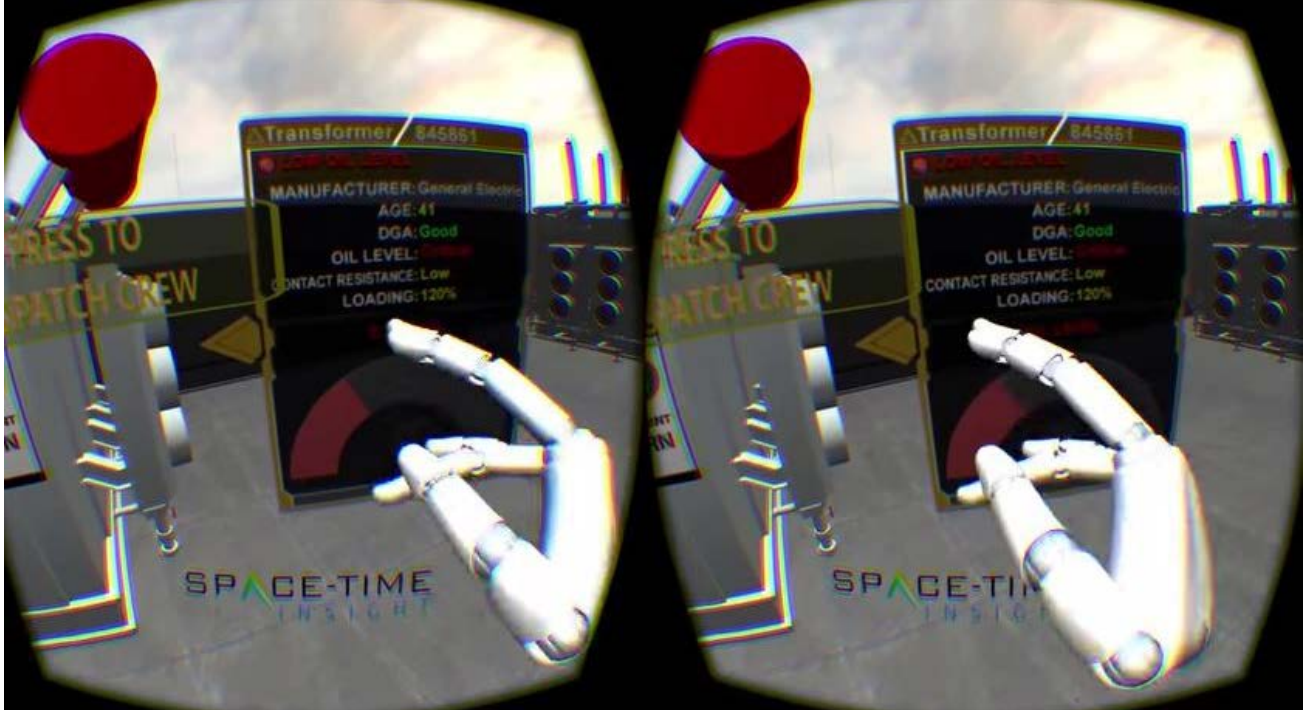
Analytics

We don't want to diminish the importance of the other enablers. But truth be told, analytics is a ***super enabler.*** Analytics takes massive quantities of data and turns it into actionable intelligence that enhances livability, workability and sustainability in very direct ways. In this section we'll cover three targets that let cities tap into the full power of analytics.

Achieve full situational awareness. Gain full knowledge of what is going on throughout the city.

This situational awareness can be delivered in many ways. From "dashboards" to visualizations to command and control centers and to alerts delivered to computers or phones. The exact method of delivery depends on the unique circumstances of your city.

In most cities, this kind of awareness doesn't happen today. If you consider systems such as energy, water, traffic, policing and emergency response, you'll recognize that today's operators are often "flying blind." They may know general parameters, but they don't know precisely what is going on at every point throughout the system. One example is an electric utility that has not yet deployed smart meters or other sensing technologies across the electric grid. If power is out in a neighborhood, the utility may not know it until a customer calls in. Same story with transit operators, who may not get a heads-up that a bus has been disabled in an accident until the driver has a chance to make a call.



Achieve full situational awareness.
To help utility managers understand what happens when big data is combined with virtual reality to improve situational awareness, Council member Space-Time Insight outfitted attendees at an industry conference with Oculus Rift VR headsets that allowed them to experience a power substation as if they were actually walking through it. During the demonstration, they could "virtually" check the status of equipment and take immediate, corrective action when necessary. Using real-time visual analytics software provides actionable insight into big data for faster, more informed decisions.

Figure 4.26

Achieve operational optimization.
Smart cities combine data from sensors and subsystems with computing power to determine the best path forward.

Figure 4.27

Giving operators full situational awareness has a long list of benefits. One is safety – for instance, we don't want police officers or firefighters sent into danger without a full picture of what they're getting into. A second is reliability and resiliency – for instance, utility workers can restore outages much more quickly if they aren't waiting for someone to call in and report them. And third is efficiency – a full picture of the entire system makes it much easier to make the correct choices and trade-offs. Additionally, operating budgets, staff and shift requirements can be reduced through mobile and remote monitoring and control technologies.

Achieve operational optimization. Taking steps to arrive at the best decisions (including financial decisions) for the overall system.
A simple definition is "the process of making something as good as possible." It implies balancing tradeoffs to achieve the best results. Today, infrastructure and system optimization – if it occurs at all – happens without the ability to truly see the big picture. But in the smart city of tomorrow, optimization will have data from many sensors and subsystems plus the computer power to analyze all of that input to find the best path forward.

As you can see, infrastructure and system operational optimization offers many benefits.

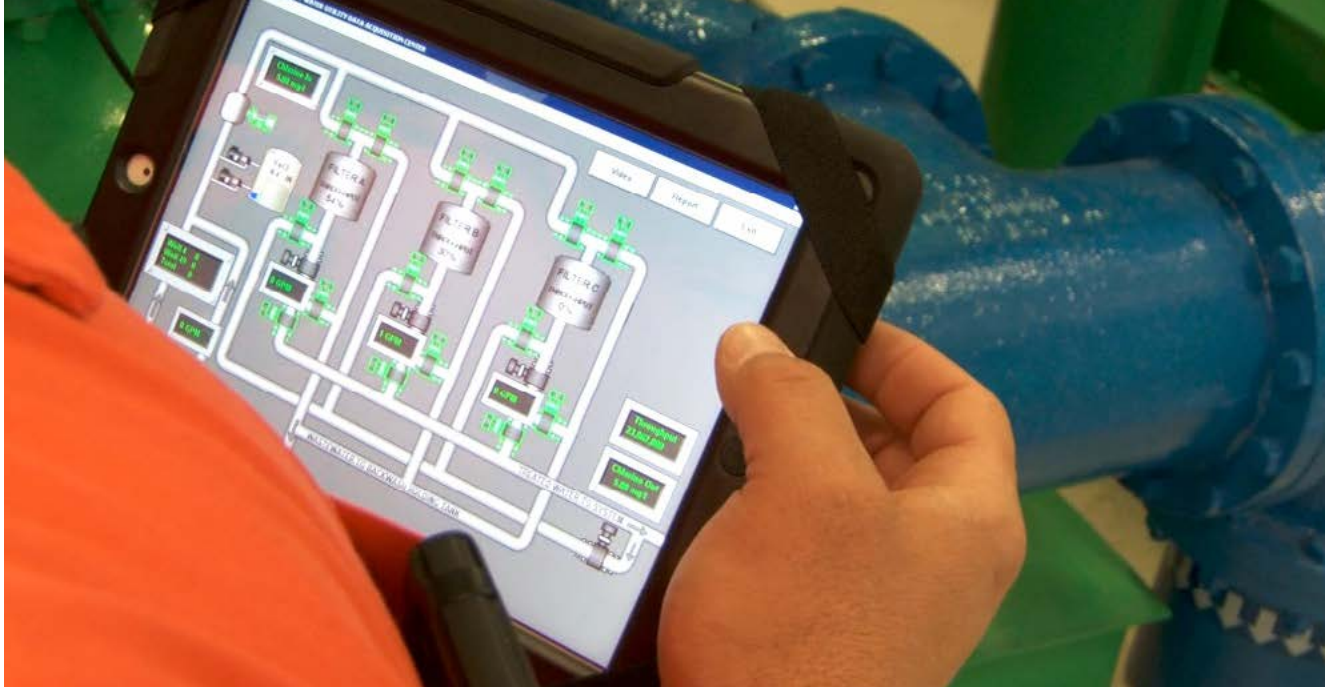
For instance, in energy and water scenarios it:

- Provides for the efficient generation, distribution, consumption and reporting of resources, both in the aggregate and at the individual business/citizen level
- Strikes an optimal balance between asset and citizen needs and health
- Enables the application of learning in the continuous maintenance, tuning and commissioning of assets

Bottom line, operational optimization delivers cost saving, resource saving and better outcomes to cities and people.

Achieve operational optimization:

A SMART CITY AT THE FOOT OF THE SIERRA NEVADA MOUNTAINS



Carson City is the capital of the state of Nevada. Its Public Works Department is responsible for taking care of the city's water, wastewater, transportation, landfill, fleet, environmental and renewable power systems. In order to achieve its goals, the department created an infrastructure revolving around the capabilities of its people and technology from Council member Schneider Electric.

Carson City has created a totally integrated management system that controls the city's water and wastewater system. The solution also includes management of the department's solar plants that provide up to 748,000 kWh of clean power annually. The department even maintains the city's traffic lights. "What we've created here is a smarter Carson City. One with a complete solution that involves the Wonderware® System Platform running the Wonderware mobile reporting application with SmartGlance on virtual machines. The solution provides our team with communications over wireless platforms that include both standard and mobile monitoring and control," says James Jacklett, Electrical/Signal Supervisor at Carson City Public Works Department.

The ability of the department's engineers and operators to use mobile devices to control the water, wastewater, energy and transportation systems has allowed Carson City to become more efficient by making sure that people are always on the move. The solution provides management with instant access to key performance indicators and critical process information right on their mobile devices. Leveraging virtualization, tablets and smartphones to increase the efficiency of its operators and management has resulted in increased situational awareness, a higher level of operational readiness and a 15% reduction in man hours.

> ***Achieve operational optimization.*** *Carson City Public Works officials say leveraging virtualization, tablets and smartphones to increase the efficiency of its operators and management has resulted in a higher level of operational readiness.*
>
> ***Figure 4.28***

Achieve asset optimization. Smart cities gain the maximum lifetime value from all of their assets by applying advanced analytics to the data gathered from their instrumentation. In other words, city assets – roads, power poles, transformers, pumps and so on – are equipped with sensors and instrumentation that report their condition. Then asset management systems can analyze that data to optimize asset performance and maximize their lifetime value.

Even a medium-sized city can save tens of millions of dollars over time through asset optimization. For instance, a city can service its buses based on their actual condition not on a guess or an average or fixed schedule – sometimes referred to as "condition-based" or "predictive" maintenance.

Likewise, a city can replace or upgrade only the equipment that actually needs it, whether water pumps or bridges. Doing that extends the useful life of assets that may be past their design life on paper but are still performing well in real life.

Good asset management systems can also determine the "criticality" of an asset, so the city can accurately prioritize which assets need attention first because of the impact their failure would have on the system as a whole.

Pursue predictive analytics. As we've said, smart cities can pull data pieces together to analyze what is happening in real time and make operational decisions. But the value of that data doesn't end there. Through predictive analytics cities can get a glimpse of what's going to happen next – from where crime is most likely to occur to where streetlights are going to fail to where traffic congestion will stall the morning commute.

With predictive analytics you can uncover patterns and associations you might not discover as quickly otherwise. Schools, for instance, might use analytics to identify patterns in dropout rates and then which students are at-risk and which retention strategies might prove effective.

Here's another example: Data scientists at the U.S. Department of Energy's Pacific Northwest National Laboratory, a Council member, have created a social media analysis tool capable of analyzing billions of tweets and other social media messages in just seconds. The idea is to discover patterns and make sense of the data and ultimately to surface useful information that can enhance public safety and health. An increasing number of messages on social media about social unrest could provide early warning that can help authorities protect citizens from riots or other disturbances.

> ***Pursue predictive analytics.***
> *Cities can get more from the data they collect through predictive analytics, which predict what is likely to happen next.*
>
> ***Figure 4.29***

UNIVERSAL TARGETS

TECHNOLOGY

Enabler	Universal Targets How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress None	Partial	Over 50%	Complete
Instrumentation & Control	Implement optimal instrumentation	☐	☐	☐	☐
Connectivity	Connect devices with citywide, multi-service communications	☐	☐	☐	☐
Interoperability	Adhere to open standards	☐	☐	☐	☐
	Use open integration architectures and loosely coupled interfaces	☐	☐	☐	☐
	Prioritize use of legacy investments	☐	☐	☐	☐
Security & Privacy	Publish privacy rules	☐	☐	☐	☐
	Create a security framework	☐	☐	☐	☐
	Implement cybersecurity	☐	☐	☐	☐
Data Management	Create a citywide data management, transparency and sharing policy	☐	☐	☐	☐
Computing Resources	Consider a cloud computing framework	☐	☐	☐	☐
	Use an open innovation platform	☐	☐	☐	☐
	Have access to a central GIS	☐	☐	☐	☐
	Have access to comprehensive device management	☐	☐	☐	☐
Analytics	Achieve full situational awareness	☐	☐	☐	☐
	Achieve operational optimization	☐	☐	☐	☐
	Achieve asset optimization	☐	☐	☐	☐
	Pursue predictive analytics	☐	☐	☐	☐

Figure 4.30

ADDITIONAL RESOURCES

Target: Use open integration architectures
Arkansas integrates 30 systems for better social and healthcare delivery
Using advanced technologies from Council member IBM, Arkansas Department of Human Services is using a service-oriented architecture to integrate 30 different systems, a first step toward modernizing the way it delivers services.

Objective: Enhance workability
Buenos Aires launches initiative to support investors, generate jobs
Buenos Aires officials created a department dedicated to businesses and, working with Microsoft partner Accendo, deployed a custom solution that helped streamlined processes, reducing the time needed for a project to meet formal requirements by more than 65%.

Target: Consider cloud computing
How the cloud helps a South Korean port city diversify its economy
Busan is South Korea's second largest city and the fifth-largest container-handling port in the world. It turned to Council member Cisco to develop a cloud-based platform designed to spur innovation, economic growth and a modern workforce.

Target: Achieve operational optimization
City of Charlotte facilitates tourism planning processes with event permitting solution
With a big convention on the way, Charlotte, North Carolina, knew it was time to replace its manual processes for event permitting. The city chose a cloud-based solution from Council member Microsoft that automates event requests, work-flows and the like.

Target: Achieve asset optimization
Boston pilots asset management platform to keep the street lights on
Leveraging the Maximo solution from IBM, Boston's Public Works Department is piloting an asset management platform with predictive analytics capabilities to better coordinate repair and maintenance of the city's 60,000 street lights.

Objective: Revolutionizing people's relationship with their government
City uses IT solutions and programs to support government, citizens, youth
Working with the Microsoft CityNext initiative, Buenos Aires is developing technology to streamline local government, improve information access and citizen-centric services, and empower youth to build a better future. This video explains how.

Target: Pursue predictive analytics
What is Predictive Data Science?
Predictive data science is the next level of insights to be delivered by combining innovative data sources with state-of-the-art analytical methods. Learn more in this video from Council member TROVE.

CHAPTER 5

BUILT ENVIRONMENT

The built environment is an essential piece of the smart city puzzle. Buildings are the biggest single source of carbon emissions, accounting for about 40% of the world's carbon footprint, according to the World Business Council for Sustainable Development. Buildings are energy hogs too, eating up nearly half of all energy consumed in the United States. Any city serious about livability, workability and sustainability must raise the "intelligence quotient" of its built environment.

This chapter will give city leaders and planners the tools to make the built environment part of the solution. It begins by defining the terms and explaining how buildings interact with information and communications technologies (ICT). It turns next to the way smart buildings create benefits for a city. Finally, it lists the technology targets that allow a city to achieve those benefits. As we go along, we'll pause for brief case studies from around the world.

Key definitions

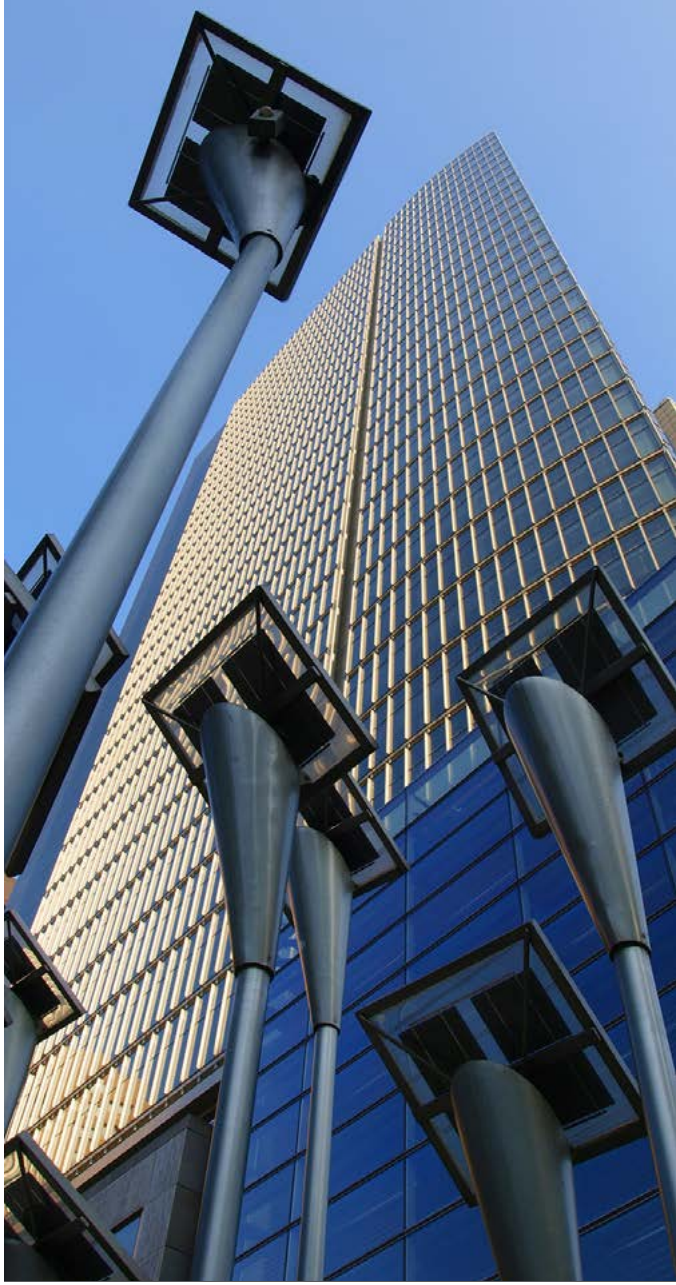
The term 'built environment' encompasses all human-made infrastructures. It refers to buildings, of course, but also to parks, stadiums and public spaces. However, three aspects of the built environment – streets, energy infrastructure and water infrastructure – are not emphasized here because they are addressed in separate chapters.

Buildings are a prominent part of every city, from private homes to offices, factories, stores, schools, hotels, restaurants and theaters. 'Smart buildings' is the common shorthand for structures empowered by ICT. Smart buildings use sensors, meters, systems and software to monitor and control a wide range of building functions – lighting, energy, water, HVAC, communications, video monitoring, intrusion detection, elevator monitoring and fire safety among them.

Why make buildings smarter? In its June 2013 Global Sustainability Perspective, real estate developer Jones Lang LaSalle put it this way: "Advances in smart building technology are enabling a new era in building energy efficiency and carbon footprint reduction, yielding a return on investment for building owners within one to two years. We can now perform real-time remote monitoring and control of entire portfolios of buildings, leading to dramatic improvements in building performance and meaningful energy savings."

> ***Built environment encompasses all human-made infrastructures.*** *Smart buildings use sensors, meters, systems and software to monitor and control a wide range of building functions – lighting, energy, water, HVAC, communications, video monitoring, intrusion detection, elevator monitoring and fire safety among them.*

Figure 5.1



Achieve operational optimization:

SUN LIFE STADIUM USES DATA ANALYTICS TO SCORE WITH FANS

Sports franchises everywhere are competing for eyeballs with big-screen HDTVs, all manner of mobile devices and other venues broadcasting games. So officials at Florida's Sun Life Stadium – home of the Miami Dolphins football team – considered ways to make the game-day experience for fans even better. They decided to borrow some smart cities technologies.

"The goal was to save our fans time by alleviating friction points, and on the monetary side, to enable a more efficient business that would lessen the need to raise ticket prices and provide the resources to invest in the future," explained Jim Rushton, the Chief Revenue Officer. "It was a clear mandate for a new way of doing business."

One solution the stadium settled on was using data analytics to optimize operations and traffic flow – long lines being one of the "friction points" Rushton mentioned.

Working with Smart Cities Council member IBM and leveraging the IBM Intelligent Operations Center, data is streamed in real time from stadium point-of-sale systems, turnstile scans at gates, weather feeds and other sources. The stadium's command center integrates all the data sources into a common control room console. The combination of real-time monitoring with business rules and intelligent controls enables stadium officials to optimize the operations and traffic flow.

> ***Achieve operational optimization.*** *Officials at Sun Life Stadium used smart city technologies to optimize operations and traffic flow. Among many other benefits, the effort has reduced long lines.*
>
> *Figure 5.2*

The city-building connection

In most cities, the built environment is a patchwork of private and city-owned buildings. But even though a city government may own only a small fraction of the buildings, it can hold great sway over all buildings in its jurisdiction. For instance, it can:

Lead by example and ensure that its own buildings adhere to the targets explained in this chapter, unleashing the power of ICT in public buildings.

Create and enforce codes and standards that embody the changes it wants

Create incentives for owners to make their buildings smart

Educate residents through public awareness and outreach campaigns

Provide support and guidance by giving access to advice and trained staff via web, phone or in person

The methods cities adopt for driving change in built environments will vary, of course, but leaders pursuing a smart cities agenda will want smart buildings as an action item.

So what are the technology and best practices targets that enable a smarter built environment? This chapter will discuss how targets introduced in the Universal chapter apply to the built environment. But first, a quick look at dependencies in the built environment and then the benefits an intelligent built environment provides.

Dependencies within the built environment

Improvements in the built environment will need to be planned with an understanding of dependencies on other city systems and services. If we limit our dependency list to just three other systems for the sake of simplicity, it is easy to see that buildings rely on services from energy, communications and water systems.

The connection is pretty straightforward. Commercial, industrial and residential building systems alike all require electricity and/or natural gas. Many will be adding electric vehicle charging stations in the years ahead, which is something cities need to take into consideration. Building occupants require potable water and wastewater removal. And reliable communications are a requirement today for business and industry as well as residents.

Benefits of realizing the targets

Here are just a few of the ways an intelligent built environment can enhance livability, workability and sustainability.

Livability

Improving occupant comfort. With full situational awareness and optimization of building conditions, a smart building can tailor light, heat and cooling to each area or even to each individual. Since most people spend nearly all of their time indoors, improving that environment improves their comfort quotient.

Enhancing occupant safety. ICT can greatly improve safety and security via access cards, video monitoring, fire and smoke alarms and similar means. Full situational awareness means that building operators have a complete picture of their building and its environs, and are able to respond to issues or threats in real time as well as optimize day-to-day building management. In some cases, these systems can even correct problems remotely and automatically.

Improving occupant health. Indoor air can be more polluted than the air outdoors. Smart buildings monitor air conditions to ensure that

Improving occupant comfort:

FUTURE OF HOUSING? UTILITY TURNS TO CROWDSOURCING TO SOLICIT IDEAS

What will homes of 2040 be like? What should they be like?

Council member Enel, a forward-thinking Italian utility, turned to the wisdom of the masses to uncover truly transformational ideas that will result in the homes of the future today.

Through its subsidiary Ampla in Brazil, it launched a crowdsourcing platform that will aid in the sharing and selection of ideas for building an efficient, smart and sustainable home.

Enel solicited ideas for what it's calling the NO.V.A. house. NO.V.A. is short for a Brazilian Portuguese phrase that means "we are living tomorrow." Ideas for the house have come from all over the world.

The house will be built in Niterói, located across the bay from Rio de Janeiro. How it will be designed and the features it will have will be decided in part by ideas submitted through a special website.

While environmental impact and energy conservation are important considerations, they aren't the only ones. In addition to green architecture and design ideas, the team behind the house looked for suggestions to improve the quality of life of the people who might live in it. The site also took suggestions for improving urban mobility, healthy lifestyles and social connections.

Once complete, the house designed by the masses will become a research laboratory that will study energy efficiency and the impact of technology on everyday lives.

> ***Improving occupant comfort.***
> *The idea behind the crowdsourcing effort is to get people thinking about how a house could fit the way they actually live, rather than simply building homes the way its always been done.*
>
> *Figure 5.3*

occupants aren't exposed to high levels of carbon dioxide, radon, chemicals or other potential health hazards.

Providing convenience and "remote control" capabilities. Who hasn't left for vacation only to wonder if you remembered to activate the burglar alarm? Thanks to advances in ICT, remote control capabilities can remotely monitor and manage security and energy systems from afar using a computer, tablet or smartphone.

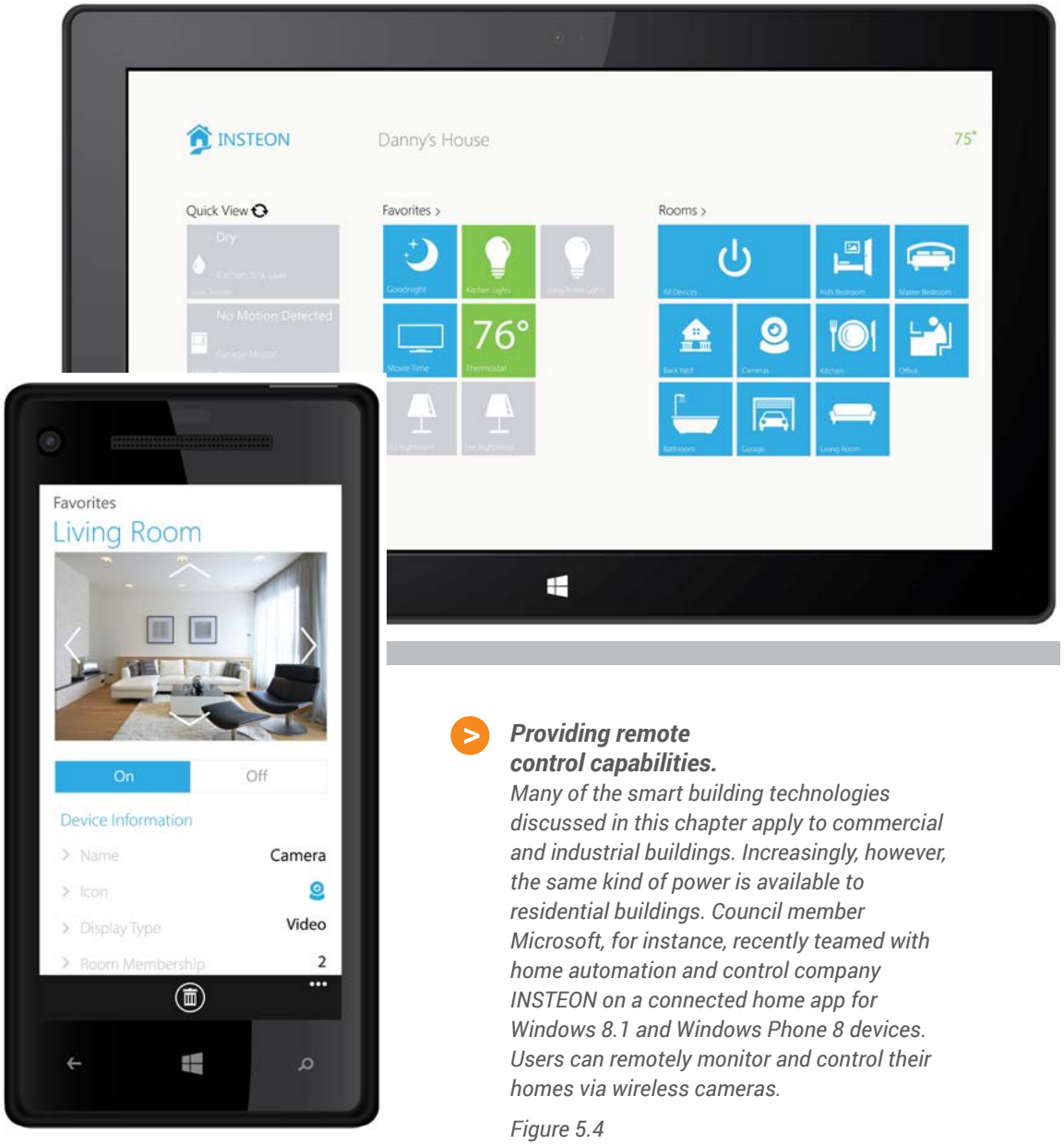
Workability

Lowering business utility bills. Smart buildings save on power, water, gas and waste, giving owners and occupants a competitive advantage.

Increasing worker satisfaction. Who doesn't want to work in a state-of-the-art building where the air is fresh, creature comforts are automated and safety and security are wired in? Businesses located in smart buildings are more attractive to potential employees, which allows them to compete for the best and brightest.

Sustainability

The built environment can make a major contribution to lowering emissions and lowering resource use. It is not an exaggeration to say



Providing remote control capabilities.
Many of the smart building technologies discussed in this chapter apply to commercial and industrial buildings. Increasingly, however, the same kind of power is available to residential buildings. Council member Microsoft, for instance, recently teamed with home automation and control company INSTEON on a connected home app for Windows 8.1 and Windows Phone 8 devices. Users can remotely monitor and control their homes via wireless cameras.

Figure 5.4

Reducing water and energy waste:

ENVISION CHARLOTTE: CONNECTING PEOPLE WITH INFORMATION AND INSIGHTS

Building smarter, more sustainable cities requires the support of public, private and civic stakeholders. Envision Charlotte is charting a new course. By taking a holistic and integrated approach to engaging these disparate groups and demonstrating the benefits – both environmental and economic – of lasting change, the initiative has assembled a strong consortium of public and private interests with shared vision and momentum.

The ambitious project will transform the downtown – called Center City – into an incubator for innovative technological solutions. The initiative's aims are not small: energy and water efficiency, waste reduction, green building and site planning, as well as engaged businesses and citizens.

Smart Cities Council member Itron is lending its expertise to the *Smart Water Now* program, which will aggregate information into a single number representing total usage, then drive awareness and behavior change to reduce consumption. The results will lower operational costs, improve sustainability, engage occupants and contribute to the overall value proposition of working and living in Center City.

Awareness and knowledge are key ingredients of sustainability and change. But what's the best way to get information to people who need it? Measurement technology, like Itron's smart meters and communications, provide unprecedented insights with near-real-time data. By rendering the data in intuitive ways – trending, benchmarking against other buildings in the area, or correlating with other data sets like weather – program participants are better able to assess how they can build, operate and live smarter.

> ***Reducing water and energy waste.*** *Kiosks in buildings throughout Center City help participants see a more direct link between their daily business and personal activities, and the impacts to energy and water usage.*
>
> *Figure 5.5*

Sustainability benefits.
Most buildings can reduce energy waste by 10 to 30%.

Figure 5.6

that it is impossible to meet sustainability goals without using smart technology to improve the built environment. Examples include:

Reducing energy waste. Most buildings can save 10% to 30% on energy just by installing an intelligent building management system to manage devices such as occupancy sensors, light dimmers and smart thermostats. There are many other ways a smart building can reduce overall costs too. For instance, buildings with smart meters or smart thermostats can participate in utility demand response programs. By briefly reducing consumption during peak times they allow the utility to make do with fewer expensive standby power plants. (See the Energy chapter for details.)

Reducing water waste. In the same way that ICT helps smart buildings save energy, it helps them save water too. Operational optimization helps smart buildings manage water resources with precise efficiency, eliminating waste and reducing cost for owners and occupants. Sometimes it's just a matter of better scheduling. For instance, scheduling pumping and irrigation at night when power is cheaper.

Reducing carbon emissions. Smart buildings use less energy and less water – important because water requires large amounts of energy to pump and treat. As a result, carbon and other greenhouse gas emissions are lower in smart cities.

Reducing the frequency and cost of repairs. Today's building management systems can monitor key equipment to notice problems as soon as they arrive -- or, in some cases, predict problems before they occur. They can prioritize work orders so the maintenance crew always works on the most important problem first. And since they can keep equipment fine-tuned, it operates at maximum efficiency.

Enabling distributed generation. Not only can ICT reduce energy waste, it can help buildings produce their own energy via on-site solar panels, wind turbines, fuel cells and the like. Distributed generation won't replace power plants outright. But together with energy storage and demand response, it can reduce the number of peaker power plants. (Peaker plants run only when there is high demand for power and sit idle the rest of the time and And since most peaker plants run on fossil fuels, avoiding their use provides carbon reduction benefits.) Distributed generation also helps reduce the environmental costs associated with transmitting energy over long distances, particularly important for more remote villages in developing countries.

Providing ROI for building owners. Smart buildings are a win for building owners. Operational optimization delivers both cost savings and enhanced value per square foot.

‘SMART CODE’ HELPS WEST AFRICAN CITY ENHANCE LIVABILITY

Libreville is the capital of Gabon, a rapidly developing country in west Africa. Recent growth – to almost 1 million people – has outpaced the city’s ability to accommodate change and has taken place largely without the benefit of comprehensive urban planning. As a result, Libreville suffers from unplanned land uses and incompatible development.

The government has introduced the “Smart Code” into Gabon and adopted it as the primary basis for urban land development in Libreville. The Smart Code provides a framework for flexibility that is not possible with traditional zoning, making it possible to incorporate new ideas in land planning as well as smart technologies in transport and water utilities.

Council member Bechtel is working with the Gabonese government to deliver several development projects intended to address pressing issues related to the housing stock and enhancing Libreville’s built environment.

Better quality infrastructure, adapted to the local culture and integrated with new commercial services, will significantly improve the city’s quality of life. A particular focus is on improving less developed neighborhoods, the *quartiers sous integrés,* with the benefits of better housing, transport and water and sanitary systems services.

> ***Enhance livability.*** *Better quality infrastructure will help improve the quality of life in Libreville, where several development projects are expected to help accommodate rapid growth in the west African city.*
>
> *Figure 5.7*

Built environment targets

To this point we've defined the built environment, discussed how cities can influence their buildings and highlighted the benefits of smart buildings. We'll conclude by examining the technologies and best practices that can bring those benefits to your city.

We presume that you've already read the Universal chapter, which explains the targets that apply throughout a city. When it comes to the built environment, those universal goals are sufficient – there are no additional building-specific targets.

For convenience, you will see a checklist at the end of the chapter that lists the universal targets. Below we point out refinements to several of them that demonstrate their relevance to the built environment.

Instrumentation and control

Buildings that use smart devices to monitor conditions like water use and heating and cooling can capture data that building managers can use to make better decisions about managing resources.

Implement optimal instrumentation. You'll want to keep several things in mind as you determine optimal instrumentation for buildings.

For one thing, don't think that building instrumentation simply means a smart meter. You can now remotely monitor almost any building condition – occupancy, light level, air quality, temperature, etc.

For another, you will want to distinguish between existing and new buildings. In existing buildings, you want to take full advantage of any sensors or switches that are already present. Fortunately, companies are starting to make software that can talk to legacy equipment from many different manufacturers. It is usually much less expensive to find a software "overseer" than to rip out old instrumentation and replace it with new.

When it comes to new buildings, you can be more ambitious. It is much less costly to put state-of-the-art instrumentation into a new building than to retrofit it into an existing building. Thus, as you plan the city's building codes and incentives, you can raise the bar for new buildings as compared to old.

This is an area that will require holistic thinking and collaboration between departments and between outside stakeholders. For

> ***Implement optimal instrumentation.*** *Building managers can use data captured from smart devices to make better decisions about resource usage.*
>
> *Figure 5.8*

Implement optimal instrumentation:

PAVING THE SMART GRID FUTURE AT THE NAVY YARD IN PHILADELPHIA

Looking at Philadelphia's Navy Yard today, it's hard to imagine the dynamic 1,200-acre mixed-use campus as the country's first naval shipyard – a place where historic ships were once built and some of the Navy's most significant technological advances achieved.

But when shifting requirements brought closure of nearly all naval activities at the site in the 1990s, Philadelphia leaders saw an opportunity to turn the shipyard property into a redevelopment showpiece to attract business and jobs.

And they've done that. Today The Navy Yard is home to more than 11,000 employees and 145 companies in the office, industrial/manufacturing, and research and development sectors. It is also a testament to energy innovation in keeping with Mayor Michael Nutter's vision of Philadelphia as America's greenest city.

Council member Alstom Grid has played a key role in that vision. The most recent example: In June 2015 Alstom and Penn State launched a Microgrid Center of Excellence. The first-of-its-kind facility will help advance the development of microgrid technologies as part of The Navy Yard's grid modernization project. The campus will be able to operate independently from the main grid in case of an outage due to extreme weather or other extraordinary events.

Harkening back to its roots, The Navy Yard grid will serve as a testing ground for companies to pilot energy controls and other new technologies in a viable commercial environment.

> ***Implement optimal instrumentation.*** *Alstom will combine its energy management and substation automation technology, including advanced systems and controllers, for The Navy Yard's microgrid.*

Figure 5.9

Implement optimal instrumentation:

ONE-STOP METERING SOLUTION FOR MAKKAH CLOCK TOWER APARTMENTS

The Makkah Clock Tower, located in Mecca, Saudi Arabia, is the world's largest clock tower and the second tallest building. It has 76 stories and is 577 meters high. It is a vast complex with hotels, shopping outlets, food courts and luxury apartments.

The owners of the luxury apartments at the Clock Tower wanted the contractor to implement a solution so that each of their 5,000 tenants could be billed individually for their utility usage. That meant finding a vendor that could provide meters that could measure water usage along with cooling and electricity usage. Another challenge was to be able to take the readings from each of these meters remotely.

The contractor chose Council member Spire Metering Technology, which has a product portfolio diverse enough to meet all of the requirements. One Spire meter provides measurements for the water usage in each of the 5,000 units while another was used for cooling and a third to measure electricity usage.

Spire also provided Automated Meter Reading (AMR) software to allow the meter reading to be captured remotely.

The final piece of the Spire solution was billing software that allows each of the 5,000 tenants to be charged for their actual usage.

> ***Implement optimal instrumentation.*** *Owners of the luxury apartments at the Makkah Clock Tower are able to accurately bill each of their 5,000 tenants for the actual amount of water, electricity and cooling they use.*
>
> ***Figure 5.10***

Connect devices with citywide, multi-service communications. *Many forward thinking building owners are choosing a single, "merged" IP network – one that can carry all traffic, whether data, voice or video.*

Figure 5.11

instance, the electric power utility may want smart meters, thermostats and appliances to adhere to communications protocols. Likewise, the fire department may have requirements for fire alarms and smoke detectors. Obviously, the city's codes and recommendations should be compatible.

Connectivity

Once you've deployed smart sensors and systems in a building, the next step is to allow them to communicate the information they gather.

Connect devices with citywide, multi-service communications. In a few cases, a building's sensors and systems may communicate directly with the citywide communications system. For instance, a smart meter or a smart thermostat may tie in directly so it can talk to the electric power utility. In a similar fashion, some utilities talk directly to building load control switches to turn equipment off if the grid is under stress. (The owners get compensation from the utility.)

In most cases, though, the building's sensors will communicate internally to a building management system. That software then monitors and summarizes that internal data and shares it externally as permitted by building owners.

When it comes to new buildings – and sometimes even for old ones -- many forward thinking building owners are choosing a single, "merged" IP network – one that can carry all traffic, whether data, voice or video.

Interoperability

Interoperability targets ensure that your built environment plays nicely with others. Of the three universal interoperability targets, two require additional discussion.

Adhere to open standards. Building technology must adhere to the same communications standards as all other smart city gear – even when the building industry is a barrier to this smart city goal. And it must also contend with standards unique to the built environment.

When it comes to communicating between the building and the rest of the city, you can rely on the standards set forth in the Telecommunications chapter, notably IPv6. But when it comes to the equipment and the communications within the building, you will have to navigate a maze of options.

The buildings sector has been slow to adopt open standards. In areas such as internal communications within a building, the sector has several competing "standards," including BACnet and LonWorks.

Adhere to open standards:

GERMAN CITY CONSOLIDATES BUILDING MANAGEMENT AND CUTS ENERGY USE

The city of Bremen, Germany wanted to unify more than 1,200 municipal properties under a single, open building management system (BMS) to optimize the efficiency of heating systems and reduce energy consumption.

The challenge was that six control stations across the city were running a variety of proprietary building control systems. After analyzing the options, the city's property services company settled on a vendor-agnostic BMS based on the Wonderware® solution from Smart Cities Council member Schneider Electric.

That approach allowed the city to consolidate the various legacy systems into a single operator interface.

Now regional supervisors working from any location can log onto the system and troubleshoot problems in real time at any of the city of Bremen's buildings. Wonderware InTouch® also sends alerts and alarms to individual work-stations, so operators can take swift corrective measures and supervisors have visibility to their actions.

Energy consumption in the buildings is down 15% to 18%.

> ***Adhere to open standards.*** *Choosing a vendor-agnostic building management system, Bremen, Germany was able to consolidate various legacy building management systems into a single operator interface.*

Figure 5.12

In short, you will need a) the help of an expert to make the right choices and b) a firm determination to stay open no matter what inducements are offered to use a proprietary system instead.

We mentioned earlier how a group of cities is collaborating on Open Data applications. Cities could also benefit from participating in ICT standards organizations such as the World Wide Web Consortium (W3C), the Open Geospatial Consortium (OGC) and buildingSMART International. The cost is minimal and ROI can be substantial. Standards for Building Information Models (BIM), indoor location, indoor/outdoor information integration, etc. are being developed with virtually no city input. If cities don't express their interoperability requirements, there's no guarantee they will get what they need. Cities need to be smart about standards development so they know which standards to ask for in procurement documents.

Prioritize the use of legacy investments. It bears repeating – cities and building owners should make every effort to tap into existing devices and equipment before retrofitting buildings with new gear. Older devices can often be integrated with building management systems, thereby avoiding unnecessary replacement. Using existing equipment when possible is a wise way to get maximum value from your investments. For an example, see the *88 Acres case study* linked at the end of this chapter; it explains how Microsoft leveraged legacy investments when it rolled out smart buildings on its campus in Redmond, Washington.

Security and privacy

Of the three universal security and privacy targets, one needs extra discussion.

Publish privacy rules. It's important to remember that information coming from buildings is often extremely sensitive. Consider occupancy sensors, which could reveal when high-value merchandise is unguarded. Or consider energy usage – should that be shared to help the city analyze its energy efficiency targets? Or consider public buildings that use video surveillance to record comings and goings. In what circumstances can the videos be viewed and by whom? In short, be sure to consider your city's built environment when planning your citywide privacy policies.

Data management

Our universal data management target deserves emphasis for the built environment.

Create and adhere to a citywide data management, transparency and sharing policy. The information that can be gleaned from buildings is invaluable for city goals such as energy efficiency, carbon footprint reduction, economic development, transit planning and land use planning. It is crucial that your built environment initiatives adhere to a careful data architecture so that information can flow seamlessly as needed.

Computing resources

Local governments are typically responsible for many buildings – everything from jails to public swimming pools to sewage treatment facilities to bus barns and city hall itself. Of the four universal targets in this section, two deserve emphasis.

Consider a cloud computing framework. A few years ago, only the biggest buildings could cost-justify a top-of-the-line building management system. And until recently, only a few large property owners could afford a system to oversee a whole portfolio of buildings in different neighborhoods or even different cities.

Consider a cloud computing framework:

MICROSOFT BRINGS SMART BUILDINGS TO SEATTLE

Seattle, Washington has a goal to better understand how to create economic opportunity for the city while saving energy and developing a sustainable urban environment.

Council member Microsoft has been working with Seattle's Office of Economic Development to develop an approach to driving energy efficiency at city scale. The result is a smart buildings pilot for the downtown area inspired by the smart buildings pilot implemented on Microsoft's Redmond campus. That pilot used Big Data to provide forecasted energy savings of 10% per year. It's anticipated those savings will be surpassed by the Seattle pilot with energy and maintenance savings between 10 and 25%.

Working with Seattle and its utility Seattle City Light, Microsoft has joined with the Seattle 2030 District, a public-private collaborative of downtown Seattle property owners and managers that has established a 50% energy use reduction goal by 2030. The pilot will increase energy efficiency in large commercial buildings across Seattle's downtown corridor; the initial set of buildings totals approximately 2 million square feet. It's a mix of unique building uses, from the Seattle Municipal Tower and the Sheraton Hotel to Boeing facilities and a University of Washington School of Medicine research building.

A cloud solution based on Microsoft Azure cloud technology will collect data from the myriad systems in those buildings and use data analytics to provide a prescriptive approach to how the building management systems can be tuned to improve energy efficiency.

> ***Consider a cloud computing framework.*** *Thanks to the advent of cloud computing,, building management systems that monitor and control energy usage are more affordable and more widely available than they were just a few years ago.*

Figure 5.13

Today, thanks to cloud computing, these advanced capabilities are affordable and widely available. Cloud computing gives access to:

- High-powered computers
- Sophisticated software
- Expert staff
- 24x7 staffing and monitoring
- Redundant backup
- Advanced security, both cyber and physical

Instead of financing a huge data center and staffing it with specialists, a city can often simply rent all the hardware and software power it needs via the cloud.

Have access to a central GIS. A robust geographic information system (GIS) is invaluable for many city functions related to buildings, including maintenance, public works, parks, building codes, planning and many more. The information you glean about your buildings becomes much more powerful when located on a map.

Analytics

Below we explain how the four universal analytics targets apply to the built environment.

Achieve full situational awareness. Situational awareness has two aspects in the built environment. The first is awareness of individual buildings (or collections of buildings). Today's systems can monitor and display every important parameter. They can even be programmed to alert operators when conditions go out of bounds. Building managers can quickly spot problems and dispatch resources to restore functionality. In some cases, problem identification and resolution can be automated, or even predictive, so that problems are resolved before they cause damage.

Achieve operational optimization. The ultimate goal of a smart building, is to have everything running as smoothly and efficiently as possible. Smart buildings use analytics to ensure that a building's resource usage is efficient. And with the power of analytics, buildings can optimize their conditions to ensure the continued health, productivity and comfort of occupants.

Achieve asset optimization. Sophisticated asset management software can calculate which buildings should be replaced or repaired and when.

Pursue predictive analytics. Unexpected equipment failures can take a toll on maintenance budgets; so can work stoppages caused by equipment failures. Predictive maintenance uses analytics to predict which building equipment is close to failure so it can be repaired or replaced before it fails.

> ***Achieve operational optimization.*** *Smart buildings use analytics to ensure that a building's resource usage is efficient.*

Figure 5.14

Achieve operational optimization:

SMART CONTROL SYSTEMS GIVE ABANDONED BUILDING A NEW LIFE

An "intervention" staged at a long-abandoned building in Molise, Italy was designed to bring it up to current energy efficiency standards and to give it a useful life again.

Toward that end, Council member ABB provided a building automation system based on the international KNX standard with functions including:

- Modifying lighting based on the presence of people in different settings and the level of natural lighting.
- Controlling air conditioning based on the presence of people in different settings, window opening and solar radiation.
- Control and supervision through a PC and a Touch Panel installed in the porter's lodge. The system manages internal and external lighting, occupancy sensors, air conditioning, sunshades and more. Through the PC it is also possible to pre-program on and off times, for example external lighting and corridor lighting.

For the lighting system alone, the estimated electricity saving is about 50-60 MWh, corresponding to a saving of about 10,000 Euros (roughly $13,000).

> ***Achieve operational optimization.*** *A long abandoned building in Molise, Italy served as a proving ground for smart control systems to meet energy efficiency mandates.*
>
> ***Figure 5.15***

ISO 37120: A yardstick for measuring city performance

In 2014, the International Organization for Standards announced an ISO standard that applies strictly to city performance. The document -- known as ISO 37120:2014 -- establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, urban planning, wastewater, water, sanitation and more.

In the table at right, we have indicated how the standards related to Shelter and Urban Planning intersect with the Council's Built Environment targets identified on the next page.

Proper city planning and investment are essential to, at a minimum, keep slums and homeless populations from overwhelming city resources and turning the shining 'cities of the future' envisioned by many into dark, dystopian urban landscapes.

Shelter Indicator

		Create citywide data management policy	Have access to a central GIS	Pursue predictive analytics
Core	15.1 Total residential electrical energy use per capita (kWh/year)	■	■	
Supporting	15.2 Average number of electrical interruptions per customer per year	■	■	
	15.3 Average length of electrical interruptions (in hours)	■	■	

Urban Planning Indicator

Core	19.1 Green area (hectares) per 100,000 population	■	■	
Supporting	19.2 Annual number of trees planted per 100,000 population	■	■	
	19.3 Areal size of informal settlements as a percentage of city area	■	■	
	19.4 Jobs/housing ratio	■	■	■

Figure 5.16

BUILT ENVIRONMENT TARGETS

TECHNOLOGY

Enabler	Built Environment Targets How smart cities deploy and use ICT to enhance their built environment	Implementation Progress None	Partial	Over 50%	Complete
Instrumentation & Control	Implement optimal instrumentation	☐	☐	☐	☐
Connectivity	Connect devices with citywide, multi-service communications	☐	☐	☐	☐
Interoperability	Adhere to open standards	☐	☐	☐	☐
	Use open integration architectures and loosely coupled interfaces	☐	☐	☐	☐
	Prioritize use of legacy investments	☐	☐	☐	☐
Security & Privacy	Publish privacy rules	☐	☐	☐	☐
	Create a security framework	☐	☐	☐	☐
	Implement cybersecurity	☐	☐	☐	☐
Data Management	Create a citywide data management, transparency and sharing policy	☐	☐	☐	☐
Computing Resources	Consider a cloud computing framework	☐	☐	☐	☐
	Use an open innovation platform	☐	☐	☐	☐
	Have access to a central GIS	☐	☐	☐	☐
	Have access to comprehensive device management	☐	☐	☐	☐
Analytics	Achieve full situational awareness	☐	☐	☐	☐
	Achieve operational optimization	☐	☐	☐	☐
	Achieve asset optimization	☐	☐	☐	☐
	Pursue predictive analytics	☐	☐	☐	☐

Figure 5.17

ADDITIONAL RESOURCES

Target: Prioritize the use of legacy investments

88 Acres - how Microsoft quietly built the city of the future

A team of engineers at Microsoft cast aside suggestions that the company spend US$60 million to turn its 500-acre headquarters into a smart campus to achieve energy savings and other efficiency gains. Instead, applying an "Internet of Things meets Big Data" approach, they invented a data-driven software solution that is saving Microsoft millions of dollars. Now Microsoft and its partners are helping building managers around he world deploy the same solution.

Target: Achieve operational optimization

Classroom sensors reduce the number of sick kids – and save money

Analyzing ventilation rates from sensors in more than 150 California classrooms for over two years, researchers at Lawrence Berkeley National Lab found that bringing rates up to the state-mandated standard could reduce student absences by approximately 3.4%. Improving ventilation reduces the amount of carbon dioxide students breathe.

Target: Achieve asset optimization

Building life-cycle cost tool helps compare alternative designs

The National Institute of Standards and Technology (NIST) developed the Building Life-Cycle Cost (BLCC) program to provide computational support for the analysis of capital investments in buildings. The software can evaluate federal, state, and local government projects for both new and existing buildings.

Target: Use an open innovation platform

Powering the Charge for Electric Cars

While developing the Tesla Model S electric car, Tesla launched a program to aggressively deploy high-power, fast-charging stations -- "Superchargers" -- along major travel corridors throughout the United States. Council member Black & Veatch partnered with Tesla to construct the largest contiguous electric vehicle charging system in the world. Learn more about the build out in this video.

Target: Connect devices with citywide, multi-service communications

City Uses JMap Mobile to Fight Emerald Ash Borer Infestation

Scientists estimate that the costs to Canadian municipalities for the treatment, eradication and replacement of trees affected by the emerald ash borer could reach 2 billion dollars over 30 years. Read how a Quebec city is using the JMap Mobile application from K2 Geospatial to inventory infected trees.

CHAPTER 6

ENERGY

Cities can't function without energy. It fuels our cars, subways and trains. It cools, heats and lights our homes and businesses. It pumps our water and processes the food we eat. And it powers the technologies that are the foundation of a smart city. To ensure a smart energy future, cities and utilities must work together – regardless of whether the utility is part of local government or a private investor-owned utility that supplies the city's energy.

So it's easy to see why energy is integral to all city responsibilities and profoundly impacts livability, workability and sustainability. This chapter covers energy's critical role in smart cities, from enabling small-scale power plants that generate energy close to where it's used to advanced technologies that help keep the lights on during power outages. We use the term "energy" broadly throughout to encompass all infrastructures that cities use to produce and deliver energy – electricity, gas, steam, renewables, etc. Whether or not your city directly provides electricity or natural gas as a city service (as in a municipal utility), you'll want to make energy the foundation of your smart city planning.

Energy as a smart cities starting place. Since city leaders are well aware of their own city's pain points, we said in the introduction to this Readiness Guide that we won't recommend which responsibility areas cities should tackle first. But given the critical role energy plays in just about everything that happens in a city, leaders uncertain where to start their smart city journey should consider making smart energy a priority.

That's because the success of a smart city relies on creating and supporting a smart energy system. That's a system that knows in real time where a transformer has blown and automatically reroutes power to keep the lights on in homes and businesses. It's a system that collects and manipulates data from sensors and smart devices to give operators a complete view of the energy infrastructure – for instance, how much power solar installations are generating or when they need to signal a demand response call to help balance the load on the electric and gas grid.

ICT's role in smart energy. Information and communications technologies (ICT) help cities optimize these energy systems, making them more efficient and more resilient. Implementing smart energy systems also helps preserve precious natural resources and gives residents, businesses and cities themselves a whole host of ways to monitor and control their energy consumption to save money.

There are a number of components of a smart energy system. In the pages that follow we'll identify the technologies and technology-supporting practices involved and the array of benefits that cities accrue when they implement them.

> ***ICT's role in more sustainable cities.*** *Amsterdam leveraged public-private partnerships to build a broadband platform for service delivery to achieve social, economic and environmental sustainability.*

Figure 6.1

PIONEERING MUNICIPAL UTILITY – A SMART GRID POSTER CHILD

As the first American utility to receive smart grid stimulus funding and as the first to be "completely operational with smart grid technology," Glendale Water and Power (GWP), located in Southern California, is a bit of a smart grid poster child.

In the GWP system, a single communication system is handling both power and water. Anchored by a suite of technology from Smart Cities Council member Itron, the system includes an Itron advanced wireless communication network that integrates both electric and water meters. It also features leak detection technology for the water system and Itron's meter data management solution to manage the huge volumes of data the system generates and enable other smart grid programs and applications.

GWP completed installation of the system, which included 83,000 Itron smart electric meters and 33,000 smart water meters, in 2011. Components of the overall smart grid system included in-home display units that provide electricity and water usage information, costs and control to consumers as well as thermal storage units, electric vehicle smart charging, demand response and distribution automation.

Speaking at a conference after the installation was complete, then GWP General Manager Glenn Steiger

> ***Energy as a smart city starting place.*** *Anchored by a suite of technology from Itron, the GWP system uses a single communication system is handling both power and water.*
>
> ***Figure 6.2***

talked about the project. "The key thing to remember is that smart grid is really an IT communication system," he explained. "The heart of the system and the ongoing applications are IT-driven. To be successful, you have to shift focus from hardware and infrastructure to IT."

On the water side, the system is providing leak detection capability that is saving precious water in perennially water-challenged Southern California, and also saving money in water they didn't have to purchase. "We're actually optimizing the water system with the data we're collecting through the electric system," Steiger said, referring to the energy costs associated with treating and delivering clean water to Glendale residents.

Smart grid technology ultimately comes down to saving money, Steiger said, for the municipal utility but also cost containment for its customers. GWP's system and the data it delivers have enabled it to streamline operations, improve business processes, and roll fewer trucks, he added. That means keeping costs low for customers, which leads to strong customer support.

Dependencies in energy

Improvements in a city's energy infrastructure – deploying a smart grid, for instance – can't occur without an understanding of dependencies between energy and other city systems and services. Three stand out: communications, transportation and the built environment.

A smart grid is by definition a specialized communications network that moves electricity and data to balance supply and demand and maintain reliable service. The distribution lines and underground cables that are part of the energy grid often follow the layout of city streets (part of the built environment), creating dependencies between utility services and the various transportation systems that also rely on streets.

The built environment is also a major consumer of electricity and natural gas – and potentially a producer of electricity too. As distributed generation evolves and building owners adopt solar, fuel cell and related technologies, utilities and city governments will form even closer alliances.

Benefits of realizing the energy targets

What kind of results can smart cities expect once they've walked down the smart energy path? We've highlighted many of them below, based on their relevance to livability, workability and sustainability.

Livability

Empowering customers with choice and control. Instrumentation, connectivity and analytics combine to give electric and gas customers more information about when and where they are using energy, plus tools to help them control that usage so they can lower their bills.

Improving reliability and resilience. Smart grids can "self-heal" from simple problems, making them more resilient to storms and disasters. With outage management systems, trouble areas can be pinpointed, shaving hours or even days from restoration times. And most smart grids make it easy to combine centralized, "long-distance" generation with local distributed generation, making the system more resistant to supply interruptions.

Lowering costs for citizens. Operational optimization means fewer resources are consumed and paid for. These savings can be passed along to citizens, resulting in lower energy bills.

Workability

Improving competitive advantage. A U.S. Department of Energy lab estimates that economic losses from outages cost $80-130 billion per year in the U.S. alone. Businesses in cities with modern, ultra-reliable energy systems have a competitive advantage.

Creating new jobs. Renewable energy and local energy typically produce more local jobs than "traditional" energy (where energy may be shipped from large centralized plants outside the region).

Generating business investment in cities. A study of the correlation between smart grid – a key component of the smart city – and economic growth discovered that cities with a smart grid have an annual GDP growth rate that is 0.7% higher, office occupancy rates 2.5% higher, and an unemployment rate 1% lower when compared to less advanced cities.

Sustainability

Using less energy. Smart energy means energy that is cleaner, more efficient and produces less impact on the environment. A smart grid makes it easier to use wind, solar and other renewable sources and waste less energy during transmission and delivery. A smart energy strategy gives customers tools to reduce their energy usage and costs. So a key benefit of a smart energy system – e.g., smart grid plus distributed generation plus ways to engage the consumer – is in reduced carbon production from avoided fossil fuel-based generation.

Decreasing reliance on nonrenewable energy sources. Smart grids make it far easier for customers to generate energy on premise (for instance, via rooftop solar) and to trade energy back and forth with the grid. Implementing the right devices and instrumentation, such as improved solar meters, have led many financiers to offer $0 down residential and commercial solar programs, reducing the barriers to solar generation. And smart energy, with the help of reliable two-way communications, makes grids more flexible overall to customer demand.

Lessening energy operating costs. Smart energy reduces operating costs compared to traditional methods. For example, sensors and monitors can report on the actual condition of expensive equipment so it can be serviced based on actual condition and not a guess. This kind of asset management can squeeze many extra years of use from an asset, without compromising safety. For another, smart systems can manage peak times by briefly reducing demand (called demand response) instead of building new standby power plants that will only get used a few times per year, and can even dim LED street lights to enable lower operating costs.

Creating new jobs. *Solar installations and other forms of renewable energy and distributed generation create new, green jobs.*

Figure 6.3

Using less energy:

8 SPANISH CITIES CUT ENERGY CONSUMPTION BY 64% WITH SMART STREET LIGHTING

Eight Spanish cities reduced their electricity consumption by 64% and saved over 4,300 tonnes of C02 in 2014, thanks to efficient street lighting systems and technologies that both cut costs and benefit the environment.

According to Council member Enel, its two companies -- Enel Sole and Endesa —- enabled the towns of Alcázares (Murcia) pictured above Móstoles (Madrid), Batea (Tarragona), Manacor (Balearic Islands) and the Andalusian towns of Vélez Rubio (Almería), Pruna (Seville), Écija (Seville) and Almodóvar del Río (Córdoba) to reduce energy consumption and cut public expenditures.

The technology rolled out by the companies is based on the use of efficient lights with smart controls fitted at every lighting point. This improves lighting quality and leads to significant energy savings. The life span of the lighting module is also extended to over 60,000 hours, while the lighting network gains flexibility as each street light can be programmed independently.

These projects help local councils to drive up energy efficiency, cut CO2 emissions, and increase the availability of street lighting as faults can be detected in real time.

Another benefit of the lighting work has been that the projects involved the hiring of local labor to carry out installation and maintenance work, contributing to regional development.

Enel's public lighting projects have led their companies to install some 183,250 Archilede LED devices in more than 1,600 towns between 2009 and 2014, enabling an overall energy saving of around 111 gigawatt-hours.

> ***Using less energy.*** *In addition to cutting the towns' electricity bills, Enel's street lighting projects also involved hiring local labor to carry out installation and maintenance work, contributing to regional development*
>
> *Figure 6.4*

Instrumentation and control

We start our discussion of this chapter's targets with optimal instrumentation which, when applied to smart energy, refers to smart devices such as sensors and smart meters that gather information about the flow and condition of power and about the condition of equipment within the energy infrastructure.

Implement optimal instrumentation. Thanks to real-time information supplied by smart devices, system operators can predict, diagnose and mitigate issues that might previously have caused an outage or blackout. Examples of energy instrumentation include the deployment of smart meters and distribution system sensors.

Smart meters, which are installed on homes and businesses, are perhaps the most visible instrument in a smart energy network and certainly the most controversial due to concerns about potential health impacts and privacy. All of which points to the importance of developing an effective citizen engagement strategy long before you start deploying them.

Today there are smart meters for electricity, gas and water. They provide two-way communication between the customer premise and the utility. In the old days meters had to be read manually; smart meters transmit energy usage details directly to the utility. When smart meters are combined with smart thermostats, smart appliances and/or energy management devices, consumers can participate in energy-saving demand response programs where they voluntarily allow the utility to send a signal to the smart meter or other device to temporarily make a modest adjustment in energy usage.

> ***Implement optimal instrumentation.*** *Smart meters are part of the smart energy network and also part of a citywide two-way communications system.*
>
> ***Figure 6.5***

Implement optimal instrumentation:

SMART METERS GIVE FP&L CUSTOMERS CONTROL OF THEIR ENERGY USE

In 2013, GE and Florida Power & Light Company (FPL) celebrated completion of Energy Smart Florida (ESF), an initiative implemented to modernize the electric grid and build out a more reliable and efficient electrical infrastructure.

As part of the effort, FPL installed 4.5 million GE smart meters across its 35-county service territory, empowering FPL's customers to take control of their energy use.

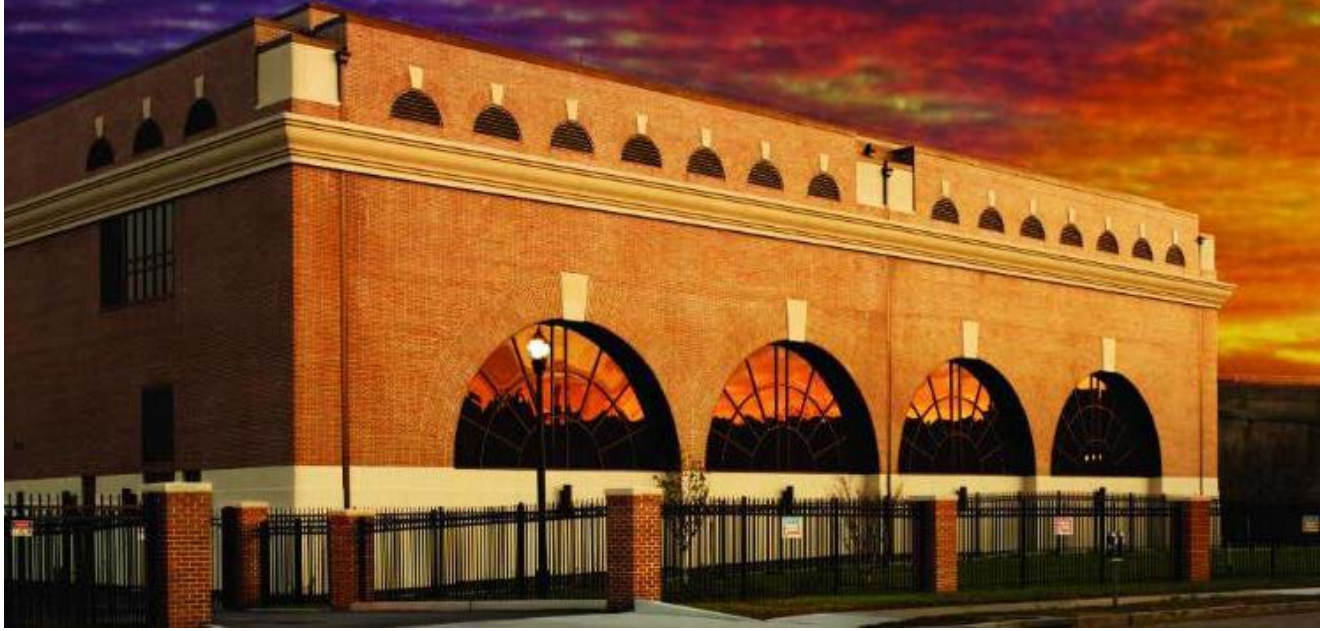
Council member GE's smart grid solutions enable effective two-way communication between FPL and its customers. For example, FPL's advanced metering infrastructure provides its customers with hourly data on their energy usage. Each customer with an activated smart meter can view his or her own "Energy Dashboard" through FPL's website. The dashboard displays information about consumption and costs a day after it has been recorded by the smart meter. Each customer can view his or her own power use by the hour, day and month and can receive bill estimates based on current usage patterns.

Many customers are regular dashboard users and have provided comments to FPL on how much they like it. For example, one FPL customer said, "If people choose to use the customer portal, they will definitely see benefits. Changing our energy habits has saved our family about $100 dollars a month compared to similar homes in our area." Another customer noted, "I think the online portal is the greatest tool FPL has to offer. In today's economy, every dollar is important. Thanks to the smart grid, my family is saving as much as $30 a month."

> ***Implement optimal instrumentation.*** *GE smart meters installed in Floida Power & Light's service territory, along with an online dashboard, are helping utility customers take control of their energy use.*
>
> *Figure 6.6*

Promoting energy assurance:

TECHNOLOGY AND CREATIVE ARCHITECTURE IMPROVE THE QUALITY OF LIFE IN D.C.



Pepco Holdings needed to enhance its electrical system in the Washington, D.C. area. The regulated electric utility turned to Council member Black & Veatch for improvement to a substation and underground transmission system. The goal of the improvement work was to promote energy assurance for the area. It also stimulated the economy in an area that included new federal government facilities and new high-density housing projects.

For Northeast Substation 212, Black & Veatch handled the design, procurement and construction of a new, air-insulated indoor substation. All equipment was enclosed within a masonry building.

Black & Veatch teamed with Maiden & Associates, a D.C.-area architectural firm, to creatively provide a solution to meet the project's design requirements. The exterior of the substation was designed as a masonry building with specific features to help the facility blend in with the surrounding neighborhood.

Black & Veatch installed an array of substation equipment, including power transformers, switchgear, capacitor banks, network feeders, service transformers, redundant batteries and chargers. The substation was also sized to handle a variety of added power equipment to meet future power demands.

The underground work covered a route length of 3.7 miles. That part of the project called for design services for an array of equipment from an existing Pepco generating substation to the new facility. Two 69-kV underground cable circuits were installed in the concrete duct bank system to provide maximum protection. Fiberglass conduits were installed to allow for the addition of more circuits at a later date.

> ***Promoting energy assurance.*** *The enclosed substation was sized to handle a variety of added power equipment to meet future power demands.*
>
> *Figure 6.7*

Connectivity

Not only are the smart meters and sensors part of the smart energy network, they are also part of a citywide two-way communications system – that "system of systems" discussed earlier.

Connect devices with citywide, multi-service communications. Connectivity allows data collected throughout the smart energy network to be transmitted for analysis and action. For example, connectivity might mean that your smart meters, distribution system sensors and utility are connected through two-way communications.

Interoperability

Utilities around the world have started building out smart electric grids and smart gas grids, both of which are part of what this Guide refers to as the all-encompassing smart energy network. But one of the stumbling blocks early on was a lack of standards – and as you can imagine there are numerous pieces of a smart grid that have to work together and talk to each other. Thanks to a number of standards bodies around the world that undertook the task of developing specifications, a lot of the issues that plagued the smart grid pioneers have been resolved. Below is a quick look at interoperability targets, including one that specifically applies to energy.

Adhere to open standards to increase choice and decrease costs. With open standards products can be mixed and matched from different vendors. There are hundreds of standards just for the energy responsibility of a smart city. As we discussed in the Universal chapter, selecting standards is a job for specialists. Your job is first to insist on using them whenever possible and second to hire a supplier with a demonstrated knowledge and commitment to open standards.

But the standards selection process is easier in the energy sector than in others thanks to the free Smart Grid Standards Mapping Tool from the International Electrotechnical Commission, a Council advisor. You can simply point and click to identify any standard in relation to its role within the smart grid. New standards are added regularly. Also see the Sensor Web Enablement standards of the Open Geospatial Consortium.

Enable distributed generation with interconnection standards. Recent decades have seen the proliferation of "distributed generation" – of small, decentralized power plants located at or near the spot energy is used. Think rooftop solar installations on high-rise apartment buildings or wind turbines helping power a shopping mall.

What are required to make distributed generation work effectively are straightforward, easy-to-use interconnection standards that define how the energy sources tie in to the energy grid. It's a relatively new business model for utilities, although many have or are in the process of developing protocols to accommodate distributed generation. Getting it right gives the city and its residents more options for economical and clean power generation without compromising secure and reliable grid operations.

Cities that own their local energy or gas utility can prioritize development of interconnection standards. Those with energy providers that are not municipally owned may need to find ways to encourage them to modernize their interconnection standards to accommodate what is clearly the wave of the future.

Distributed generation has enormous potential, including higher efficiency and greater resilience against natural or man-made disasters. It also reduces dependence on fossil fuels.

SIEMENS

Connect devices:

EV CHARGING TECHNOLOGIES CAN LOWER COSTS, ASSURE GRID RELIABILITY

Siemens teamed with Duke Energy to demonstrate the results of an 18-month effort to reduce the cost and expand electric vehicle charging technologies.

Council member Siemens provided the first Underwriters Laboratories (UL) approved residential electric vehicle supply equipment (EVSE) to demonstrate the ability to monitor status, report energy use and be controlled locally from the local area network and from the cloud.

Siemens' EVSE was shown to be accessible by web-connected computers, smart phones and tablets, allowing the EV owner to better monitor the status of the EV charging, schedule future charge events, as well as determine the total kilowatt hours consumed and the cost of charging.

Meanwhile, utilities can take advantage of the technology to offer programs that help manage the time and level of EV charging across the grid to increase grid reliability and efficiency while minimizing peak demand.

Also demonstrated was the ability to monitor and control the EVSE from an OpenADR server. OpenADR is an open standard for Automated Demand Response, allowing utilities to manage grid load resources remotely and automatically. By using OpenADR or by directly accessing the Siemens Cloud, utilities can offer rate programs to EV owners to allow the consumer to charge at highly attractive rates while simultaneously allowing the utility to manage the loads on the grid. By shifting each EV charging event slightly in time, utilities can potentially reduce the peak demand on the grid, which in turn helps to reduce the total amount of generation needed.

> ***Connect devices.*** *Siemens provided the first Underwriters Laboratories approved residential electric vehicle supply equipment to demonstrate the ability to monitor status, report energy use and be controlled locally from the local area network and from the cloud..*
>
> *Figure 6.8*

Enable distributed generation:

MONITORING AN EXTENSIVE NETWORK OF RENEWABLE ENERGY GENERATION PLANTS

9REN Group designs, develops, builds and operates renewable turnkey power plants using photovoltaics, solar thermal energy and wind. The Spanish company operates some 570 photovoltaic installations, mainly in Spain and Italy. In addition to photovoltaic plants, the company has built 183 solar thermal plants as well as mini-wind installations. 9REN plants generate more than 10,000 megawatt-hours (MWh) of clean energy each month.

To manage and monitor its photovoltaic plant facilities, 9REN created EOSystem, a solution built on the Wonderware® System Platform from Council member Schneider Electric. EOSystem is a real-time monitoring technology that provides instantaneous information from all photovoltaic installations operated by 9REN throughout Europe and the Middle East. System Platform provides a single, scalable software solution for all the supervisory control and data acquisition (SCADA) and supervisory human machine interface (HMI) needs for monitoring 9REN's renewable energy installations.

From a single control center, 9REN can effectively monitor the operations infrastructure at each facility. "The Wonderware System Platform lets us access all our installations in real time," said Antonio Palacios Higueras, services technical manager for 9REN. "Because of this, we only require one person to control the operation of all of the 568 plants, regardless of location. We also have achieved a significant cost reduction in time per designer and project."

> ***Enable distributed generation.*** *From a single control center, 9REN can effectively monitor the operations infrastructure at each of its renewable energy facilities, which includes some 570 photovoltaic installations.*
>
> ***Figure 6.9***

Security and privacy

There are at least three extremely compelling reasons why smart cities take security and privacy seriously in the context of energy as these three targets demonstrate.

Publish privacy rules. Smart meters have raised privacy concerns around the world. People worry that their daily habits are being tracked by their local utility via smart meters, which is why smart cities not only publish and adhere to privacy rules but they let citizens know about it proactively. Making privacy a priority can help ward off consumer backlash that could stall smart energy deployments.

Create a security framework. Security breaches can have a ripple effect. Developing a comprehensive security framework mitigates risk by identifying and addressing threats before they can cause damage. This is critical in the energy infrastructure – even more so given its inherent importance to the operation of other key infrastructures.

Implement cybersecurity. Cyber attacks against energy companies in the U.S. have been well-documented. But what were once thought to be attempts to steal information or trade secrets are now focused on causing serious damage to networks and equipment, according to warnings from the U.S. government. The take-away here for cities is that implementing cybersecurity safeguards early on maximizes protection while avoiding the potentially significant costs associated with an attack.

Data management

There is a tremendous amount of data pouring in from sensors, smart meters and other intelligent devices deployed throughout the energy infrastructure of a smart city.

Create and adhere to a citywide data management, transparency and sharing policy. Energy usage data should be integrated in the policy that was discussed in detail in the Universal chapter. And as noted in the previous section, energy usage data needs to comply with overall security and privacy rules.

That said, access to timely, accurate energy usage data is an essential component of a cleaner, more efficient energy system. So it's imperative that local utilities grant cities access to aggregated, summary usage data which can be invaluable for city planning, for carbon reduction programs, for energy efficiency programs, for low-income assistance programs, for improving city performance and for many other purposes.

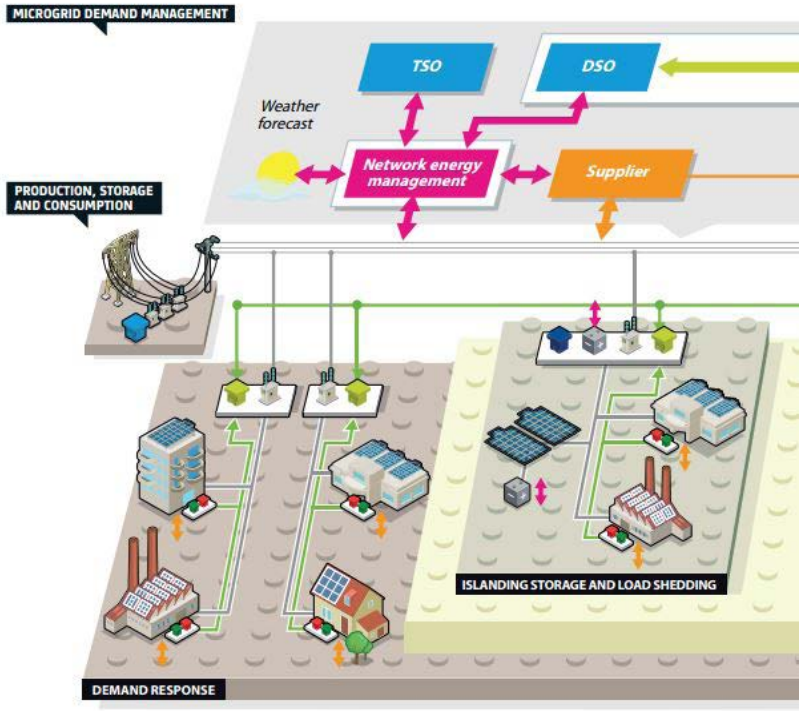
To promote energy efficiency, it's also important for smart cities to encourage utilities to give electric and gas customers access to their own usage data. For example, cities can provide a web portal for viewing and managing energy usage in real time. That way customers can drill down on when and how they use energy to make choices and trade-offs that can reduce their energy usage and utility bills.

> ***Create and adhere to a citywide data management, transparency and sharing policy.***
> *When utility customers have access to data about when and how they use energy they can make choices and tradeoffs that can reduce their energy usage and utility bills.*

Figure 6.10

Enable a secure energy supply:

TESTING THE FUTURE AT NICE GRID



Microgrids have been called "the impatient upstarts of our energy future". They are independent, small-scale electricity systems for communities, towns, campuses and even individuals, delivering integrated distributed renewable energy, improved grid reliability, personal energy use data and customised control.

Although they are a hot topic, few fully commercialised state-of-the-art microgrids with significant generation capacity are actually up and running. Nice Grid, a living laboratory located near Nice in the south of France, is one of the rare demonstrations of microgrids in the world. The project, which is expected to last four years, brings together the French distribution network operator, the electricity supplier, Council member Alstom Grid, battery maker Saft, and other industrial partners and innovative SMEs. The project has been selected as one of the six smart grid demonstrators of the European Union's Grid4EU programme. It will test an innovative architecture for medium and low voltage distribution networks with smart houses capable of managing their electricity needs and new architectures called Virtual Power Plants to run them.

A total of 1,500 residential, commercial and industrial end users are expected to participate in the experiment, which will study and test the economic, technical and social issues related to microgrids of the future.

Nice Grid is one of many smart grid demonstration projects Alstom is actively participating in around the world.

> ***Enabling a secure energy supply.*** *The objectives of Nice Grid are threefold: to test massive photovoltaic integration; enable islanding for secure supply; and provide demand response for flexible consumption.*
>
> ***Figure 6.11***

Consider a cloud computing framework. *With computing resources reliant on energy, monitoring for efficiencies and economies is a smart approach. Cloud computing offers a way to reduce costs and increase reliability and scalability.*

Figure 6.12

Computing resources

Basically all of the computing resources that cities use rely on energy in some way, shape or form, so it makes sense for cities to constantly monitor for efficiencies and economies as they use, deploy and procure computing resources. As discussed in detail in the Universal chapter:

Consider a cloud computing framework to enable scalability of systems, reduce costs and improve reliability.

Use an open innovation platform to empower innovators, increase accountability, generate new revenue streams and stimulate economic growth.

Have access to a central geographic information system (GIS) to improve decision-making capabilities, enable efficiency gains through more intelligent scheduling and routing, provide improved accuracy of essential records and boost resiliency of key assets.

Have access to a comprehensive device management system to improve infrastructure security and resiliency, deliver cost savings and enforce compliance with city data management, security and privacy policies. This target, as we noted, takes on special importance in the energy discussion due to the numerous smart devices and other computing resources deployed throughout smart cities.

Analytics

As we've said previously, analytics are absolutely critical to smart city success and perhaps nowhere is that more evident than in a smart energy network that powers so much of what a city is and does. We'll quickly review three of the analytics targets already discussed in the Universal chapter and then introduce two more that speak volumes about energy's importance in a smart city.

Achieve full situational awareness. This refers to giving operators a complete picture of their energy system at any given moment to increase its reliability and resiliency and quickly respond to trouble. A complete operating picture is incredibly important to city energy systems. One example: It helps operators detect energy theft and thereby conserve resources.

Achieve operational optimization. Building the very best smart energy network possible is what cities want to achieve from the instrumentation and connectivity investments they make in their energy infrastructure.

Consider a cloud computing framework:

RESIDENTS TRIM ENERGY USE BY 20% WHEN GIVEN REAL-TIME DATA

A consortium of companies is taking energy conservation to the next level by creating an entire eco-minded neighborhood just outside of Paris, France.

IssyGrid is France's first smart grid neighborhood, a demonstration project aimed at reducing energy use in the French town of Issy-les-Moulineaux. It is run by a consortium of corporate partners and local utilities that consider energy conservation an opportunity for businesses to solve. About 200 test homes and four commercial buildings in the community have been outfitted with energy consumption monitoring devices, with the goal of ultimately expanding the program to the entire town. IssyGrid collects energy consumption data and processes it in real time using Windows Azure, the cloud services platform from Council member Microsoft.

The consortium analyzes the data by using Microsoft SQL Server 2012 data management software. Then IssyGrid provides the data to citizens so that they can see how they are using electricity. This enables them to take specific actions to conserve – by turning off the television or lowering the temperature by two degrees.

The result: They reduce their consumption – and their energy bills – by 10 to 20%.

> ***Consider a cloud computing framework.*** *IssyGrid collects energy consumption data and processes it in real time using Windows Azure, the Microsoft cloud services platform.*

Figure 6.13

Optimized energy systems help conserve energy, delivering cost savings to cities, residents and businesses and also reducing the drain on energy resources.

Achieve asset optimization. This target plays an important role in the energy sphere, helping cities maximize the value of their assets by 1) calculating which energy assets need to be repaired or replaced and when, and 2) by predictive maintenance, which uses analytics to spot equipment that is close to failure so it can be repaired or replaced before problems arise.

Pursue predictive analytics. Drawing from instrumentation deployed across a city, analytics can enable advanced forecasting and management of a diverse, secure and resilient energy system. ICT helps cities account for demand, weather, effects from distributed resources that may be variable and other operational considerations. Understanding what to expect helps cities save on costs, conserve resources and prepare for extreme events.

Now we'll introduce two new energy-specific targets that are critical to smart city success.

Automate fault and outage management. This is about the "self-healing" grid we referred to earlier. The idea is that the utility that serves your city would enable remote sensors, smart meters and other advanced smart grid technologies deployed throughout the energy network to automatically reduce the number of outages and the duration of those that do occur. For instance, a sensor might detect a fault on the electric grid and be able to locate it and isolate it before it has time to affect other areas. Or smart meters may alert a utility's outage management system of trouble, allowing the utility to immediately dispatch crews and keep customers updated during and after the incident. Before the advent of these advanced technologies, utilities oftentimes didn't know about an outage until customers started calling in.

A quick look at economic losses incurred from power outages explains why this is so important. A study by the Berkeley National Lab back in 2004 estimated that outages cost $80-130 billion per year in economic losses in the U.S. alone. After Superstorm Sandy, which wreaked havoc across the northeastern U.S. in 2012, the U.S. Congress approved more than $60 billion in emergency aid, which is roughly what state governments reported in damages and other losses.

By encouraging automated solutions a city or utility can make the energy supply more reliable, improve response to outages which in turn makes businesses more competitive and residents more comfortable.

Automate fault and outage management. *Automated solutions help make the energy supply more reliable and improve outage response.*

Figure 6.14

Automate fault and outage management:

CHATTANOOGA SMART GRID SAVES COMPANIES $600 MILLION

In 2011 the Electric Power Board (EPB) installed a smart grid in Chattanooga, Tennessee that has achieved a 55% reduction in outage time. The area's businesses will save an estimated $40-$45 million a year, while the overall savings are likely to be $600 million over the first 10 years of deployment.

The project included many smart city functions:

- Ultra high-speed Internet, voice and video access to all residents
- A citywide WiFi network for the city and utility
- Street light controls
- Surveillance cameras
- Enhanced police and fire response

In addition to the smart city features, the project (video) also included smart switch gear from S&C Electric called IntelliRupters® at key points along the power lines. IntelliRupters® automatically pinpoint and isolate the location of a fault, immediately restoring service to all customers, except those directly connected to the faulted line. And even the affected customers will experience drastically reduced outage time, because the utility repair crew finds the exact fault location immediately rather than searching the lines for hours or even days.

When a tornado hit the town in March of 2012, it took out power to only 3,400 residents, half the amount that would have been affected before.

> ***Automate fault and outage management.*** *The smart grid installed in Chattanooga, Tennessee has achieved a 55% reduction in outage time.*
>
> ***Figure 6.15***

Creating a self-healing grid:

HOW CENTERPOINT ENERGY GETS THE LIGHTS BACK ON SOONER

CenterPoint Energy was looking to improve to improve power reliability and restoration in greater Houston. It is using $50 million of its U.S. Department of Energy grant to build a self-healing smart grid that will use smart meters, power line sensors, remote switches and other automated equipment.

CenterPoint Energy is building an "intelligent grid" with power line monitoring equipment, remote switches and other automated equipment that will locate power line outages as they occur. This can speed recovery since repair crews won't have to search for the source of an outage and can begin repairs sooner.

CenterPoint selected Ventyx, a subsidiary of Smart Cities Council member ABB, to implement an Advanced Distribution Management System (ADMS), the computer system which will be the intelligent grid's "brain." The ADMS will allow the intelligent grid to "self-heal" (video) in the event of a major storm to restore power to as much of the system as possible.

"With this technology, we will be able to automatically reroute power around many outage locations to help us get the lights on sooner," said said Kenny Mercado, division senior vice president for CenterPoint Energy's Regulated Operations Technology.

> ***Creating a self-healing grid.*** *Using intelligent grid automation to re-route and restore power, CenterPoint Energy has seen a 21% improvement in outage response.*
>
> ***Figure 6.16***

Segment and personalize programs for customers. This is one of the big pluses of today's smart energy networks. They can consider multiple variables – like a utility customer's preferences, system parameters, weather, cost of energy – to optimize and personalize rates and programs. As part of that personalization, a smart city's utility, whether municipally owned or a private utility that operates in the city, can identify energy use patterns and then make customized recommentions to help customers get the best possible rates or assist with fraud and service connection issues.

Today many electric and gas utilities charge a single rate for every residential customer at every time of the day. In reality, the cost of energy varies widely depending on the time. In particular, electric energy can be very inexpensive at night when demand is low and the output from wind farms is high. But it can be very costly during hot summer days when air conditioners are cranked up, demand is very high and energy is scarce.

Smart meters and smart grids make it possible for utilities to offer a variety of programs to encourage energy efficiency and cost savings. Examples include time-of-use rates, peak-time rebates, efficiency incentives and demand response programs.

CenterPoint Energy in Texas completed installation of more than 2.2 million smart meters from Council member Itron as part of its smart grid initiative, which was designed to give consumers more control over their energy consumption.

Now CenterPoint customers have 15-minute interval access to their energy data from the Smart Meter Texas online web portal and have wireless capabilities to install in-home energy management devices.

"Our smart meter deployment has been extremely successful. Not only have we had compliments from our customers and the Public Utility Commission of Texas, we've also had compliments from the Department of Energy," said Kenny Mercado, division senior vice president of Grid and Market Operations for CenterPoint Energy.

The Smart Grid Consumer Collaborative is a nonprofit organization focused on advancing a consumer-safe, consumer-friendly smart grid and has researched consumers and published reports on smart grid consumer education and segmentation. SGCC's research shows that consumers fall into five broad segments ranging from Concerned Greens, those people who want a cleaner energy portfolio, to Do-It-Yourself and Save, those people who want to save money and are likely to enroll in programs that will help personalize programs that match their values around energy.

Joining with organizations like SGCC to obtain materials, collaborate with others and learn best practices for citizen engagement is one way to increase the likelihood that smart energy projects receive consumer support.

> ***Give consumers more control.*** *CenterPoint Energy customers have 15-minute interval access to their energy data via an online portal.*

Figure 6.17

Segment and personalize programs for customers:

COMPANY'S DEMAND RESPONSE INCENTIVES PAY FOR MORE TECHNOLOGY

When energy demand is high and supply is short, San Francisco, California-based Pacific Gas & Electric (PG&E) offers financial incentives to companies that reduce their load in response to a request.

NetApp, a Sunnyvale, California company that creates storage and data management solutions, signed up for PG&E's Demand Bidding Program, which means the utility pays NetApp $0.50/kWh when the request is made the day before and $0.60/kWh if the request is made the same day.

It started several years ago when NetApp saw an opportunity to significantly reduce energy consumption at its headquarters, which has 1.2 million square feet of space in 10 buildings. The headquarters uses 54 million kilowatt hours annually, with a peak demand of 7.6 megawatts. In 2008, NetApp's annual utility bill was US$7.7 million, 89% of that for electricity.

> ***Segment and personalize programs for customers.*** *California's Pacific Gas & Electric offers financial incentives to companies that reduce their energy load in response to a request. NetApp installed Cisco's Network Building Mediator to enable its participation in the program.*
>
> ***Figure 6.18***

Energy-efficient equipment is only part of the solution. "You also need to make intelligent decisions about equipment settings, and that requires gathering and analyzing information from disparate building systems, including metering systems and PDUs [power distribution units]," says David Shroyer, a NetApp controls engineer.

To aid that effort the company deployed the Network Building Mediator from Council member Cisco, which aggregates information from all of NetApp's building systems, including lighting, heating, ventilation, air conditioning, temperature sensors and PDUs, from multiple vendors.

Building engineers and facilities personnel can control systems in any building using a web-based interface. Demand response payments from PG&E paid for the system and NetApp has since deployed Network Building Mediator for automated demand response at its properties in Europe and India.

"Within 20 minutes of the demand-response signal from the utility, the Cisco Network Building Mediator reduces lighting by 50% and raises the temperature set point by four degrees, shedding 1.1 megawatts."

Facility helps public and private sector researchers scale up clean energy technologies

Located at the National Renewable Energy Laboratory's campus in Golden, Colorado, the new 182,500-square-foot Energy Systems Integration Facility (ESIF) is the first facility in the United States to help both public and private sector researchers scale-up promising clean energy technologies – from solar modules and wind turbines to electric vehicles and efficient, interactive home appliances – and test how they interact with each other and the grid at utility-scale. The U.S. Congress provided $135 million to construct and equip the facility.

Figure 6.19

ESIF, which opened in 2013, houses more than 15 experimental laboratories and several outdoor test beds, including an interactive hardware-in-the-loop system that lets researchers and manufacturers test their products at full power and real grid load levels.

The facility will also feature a petascale supercomputer that can support large-scale modeling and simulation at one quadrillion operations per second.

ISO 37120: A yardstick for measuring city performance

In 2014, the International Organization for Standards announced an ISO standard that applies strictly to city performance. The document – known as ISO 37120:2014 – establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, urban planning, wastewater, water, sanitation and more.

In the table at right we have indicated how the standard related to energy intersect with the Council's Energy targets identified on the next page. While there are many aspects of energy to consider, ISO 37120 focuses on a city's energy efficiency, energy availability and energy mix.

Energy Indicator

		Implement optimal instrumentation	Enable distributed generation	Create energy data management policy	Achieve operational optimization	Achieve asset optimization	Pursue predictive analytics	Automate fault and outage management	Achieve full situational analysis
Core	7.1 Total residential electrical energy use per capita (kWh/year)	■	■	■	■	■	■		
Core	7.2 Percentage of city population with authorized electrical service	■	■						
Core	7.3 Energy consumption of public buildings per year (kWh/m^2)	■	■	■	■	■	■		
Core	7.4 The percentage of total energy derived from renewable sources: as a share of the city's total energy consumption	■	■	■	■	■	■		
Supporting	7.5 Total electrical energy use per capita (kWh/year)	■	■	■	■	■	■		
Supporting	7.6 Average number of electrical interruptions per customer per year						■	■	■
Supporting	7.7 Average length of electrical interruptions (in hours)						■	■	■

Figure 6.20

ENERGY TARGETS

*In the checklist below, targets specifically pertaining to the energy responsibility are in **bold**, universal targets are not.*

Enabler	Energy Targets How smart cities deploy and use ICT to enhance their energy infrastructures	Implementation Progress None	Partial	Over 50%	Complete
Instrumentation & Control	Implement optimal instrumentation	☐	☐	☐	☐
Connectivity	Connect devices with citywide, multi-service communications	☐	☐	☐	☐
Interoperability	Adhere to open standards	☐	☐	☐	☐
	Use open integration architectures and loosely coupled interfaces	☐	☐	☐	☐
	Prioritize use of legacy investments	☐	☐	☐	☐
	Enable distributed generation with interconnection standards	☐	☐	☐	☐
Security & Privacy	Publish privacy rules	☐	☐	☐	☐
	Create a security framework	☐	☐	☐	☐
	Implement cybersecurity	☐	☐	☐	☐
Data Management	Create a citywide data management, transparency and sharing policy **(Supplement: including energy usage data)**	☐	☐	☐	☐
Computing Resources	Consider a cloud computing framework	☐	☐	☐	☐
	Use an open innovation platform	☐	☐	☐	☐
	Have access to a central GIS	☐	☐	☐	☐
	Have access to comprehensive device management	☐	☐	☐	☐
Analytics	Achieve full situational awareness	☐	☐	☐	☐
	Achieve operational optimization	☐	☐	☐	☐
	Achieve asset optimization	☐	☐	☐	☐
	Pursue predictive analytics	☐	☐	☐	☐
	Automate fault and outage management	☐	☐	☐	☐
	Segment and personalize programs for customers	☐	☐	☐	☐

Figure 6.21

ADDITIONAL RESOURCES

Target: Enable distributed generation with interconnection standards

Energy transition in urban environments: battling integration challenges with evolving technologies

As urbanization challenges cities, key technologies and social innovations need further development. This white paper from Council member Alstom Grid puts integration of distributed renewable energy resources with utility grids among them.

Target: Automate fault and outage management

Canada's First Utility-Scale Energy Storage System Islands Remote Town During Outages

The remote town of Field relies on one 25-kV distribution feeder to supply its 300 residents with power. But providing reliable power to Field is challenging. Council member S&C Electric deployed a solution that provided extra benefits.

Target: Achieve operational optimization

Citywide Energy Efficiency and Sustainability in Boston

To meet greenhouse gas reduction goals, the city of Boston leveraged Schneider Electric's StructureWare software for citywide energy, greenhouse gas and sustainability management.

Target: Create a security framework

Big Data and Security in the Smart Grid

In this brief video, Laurent Schmitt of Alstom Grid explains how big data and security are paramount to Alstom's business and future objectives for smart grid systems and how Alstom's collaboration with Council member Intel furthers those objectives.

Target: Consider a cloud computing framework

Donald's Smart City with the PI System and MS Azure

The PI System from Council member OSIsoft shares and combines building and utility data through the cloud. Learn more in this video about what that can mean for building managers, airports, stadiums and others.

Target: Automate fault and outage management

Modernizing the Grid: How a Utility Cured an Ibuprofen Plant's Biggest Headache

The Albemarle Ibuprofen plant is an anchor of the economy in the Orangeburg, S.C. area. But power outages were providing the facility's biggest headache. The local utility worked with Council member Siemens to cure it.

Target: Achieve asset optimization

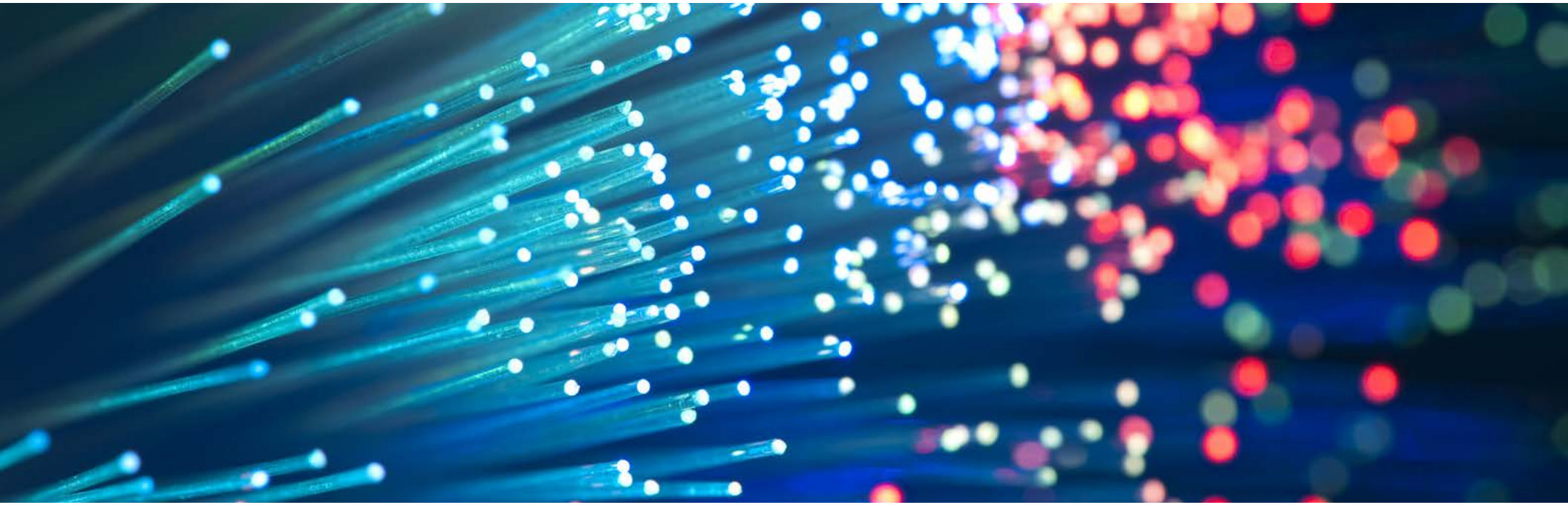
Connect-the-Grid

Get insights in this video from Council member West Monroe Partners about how to better manage all assets connected to the grid. Connect-the-Grid is a scalable, cloud-based resource for utilities.

Target: Achieve full situational awareness

Bringing Software Defined Operations to the Industrial Internet

Learn in this video from Council member Bit Stew Systems how its information processing engine, MIx Core™, enables complex event processing, advanced analytics and sophisticated machine intelligence.



CHAPTER 7

TELECOMMUNICATIONS

Ubiquitous broadband telecommunication is a prerequisite for a smart city. This chapter explains how to achieve a telecommunications architecture that can serve as the foundation of a smart city and the foundation for major improvements in livability, workability and sustainability.

We begin by defining telecommunications, both as it exists today and as it will evolve tomorrow. After we discuss the "what," we'll talk about the "why" – why telecommunications is so vital to smart city success. We'll finish by discussing the targets for telecommunications – the end states at which you should aim your efforts. Along the way, we will pay brief visits to telecommunications success stories from around the world.

First, though, a word about our use of the terms "telecommunications" and "connectivity." Dictionaries define telecommunications as the electronic transmission of signals. When we use the word in this Guide, we are talking about a city responsibility to provide the policy environment and incentives to achieve high-quality telecommunications. However, city responsibilities such as power, public safety and transportation depend on telecommunications. In that sense, telecommunications is also an enabler. When we are talking about the technology in that sense, we use the term "connectivity" to make the distinction. You'll see the word "connectivity" listed in the Smart Cities Council Framework along with other enablers such as instrumentation and computing resources.

In the 21st century, people and businesses consume telecommunications like a resource, just as they consume electricity to light their homes and water to quench their thirst. As a result, it is vital that cities take on the responsibility of ensuring adequate telecommunications so their residents have access to high-quality communications. Cities don't have to build, own and operate the infrastructure – in fact most will not. But they must at least continue to set the conditions and policies that incentivize the private sector to install state-of-the-art telecommunications.

Telecommunications also acts as an enabler by providing connectivity. All the other responsibilities – water, power, transportation, etc. – require connectivity to communicate with the sensors and devices they use to collect data. That's why the Universal chapter already specified a universal target of "Connect devices with citywide, multi-service communications." In other words, you've got two important reasons to pay close attention to telecommunications: 1) for the value it creates on its own and 2) for the value it enables for all the other responsibilities.

> ***Telecommunications is a city responsibility.*** *In the 21st Century, an adequate telecommunications infrastructure is vital for business and industry as well as residents.*

Figure 7.1

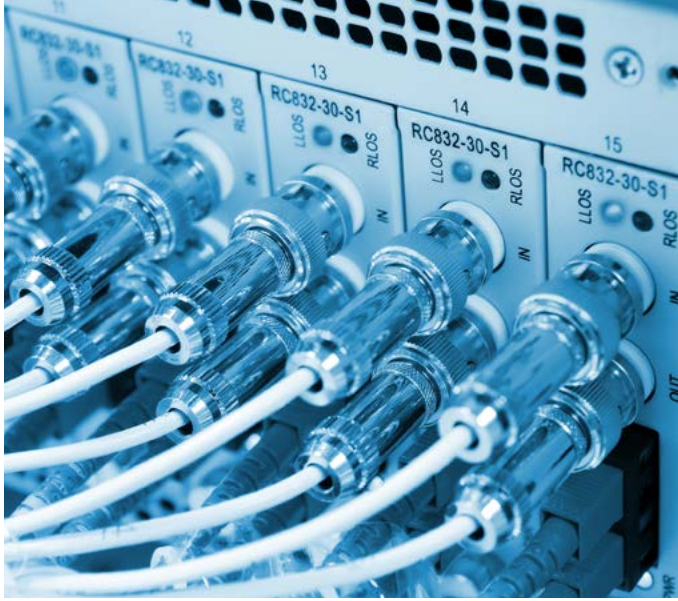
Telecommunications today and tomorrow

Before we define the targets for tomorrow's telecommunications, we should first examine how it works today. Most cities already have many existing communications networks operating side-by-side. A typical city may have multiple cellular/mobile networks plus cable, satellite, RF mesh, microwave, radio, fiber optics, WiFi for homes and offices, ZigBee for smart meters and appliances and more (see list on the next page). Sadly, it can be challenging to bridge between today's networks, making it difficult to achieve the seamless, end-to-end connectivity required for a true smart city.

If that is today's reality, then where do we want to go next? The smart city of the future is likely to have an underlying fiber optic network as both a metro loop around the city (like a ring road for traffic) and then local access that links buildings to this loop. Incredibly, tests have been able to send 100 terabits per second through a single optical fiber – enough to download the entire contents of the Library of Congress in seconds! Although fibers do not run at this speed in normal usage, the extraordinary headroom in terms of performance increases is clear. Wireless access to this underlying network may be provided by WiFi, by RF Mesh, by cellular/mobile technologies or some combination.

Some businesses have taken steps to support this 'high-speed fiber backbone.' These fiber optic networks provide the bandwidth and speed demanded by the Digital Age. The optical network will terminate in network equipment (eg., an optical network unit) that will then break out and deliver IP and other traffic types to their destinations via a local access network. But a city also needs omnipresent wireless to provide access to sensors, controllers, laptops, tablets, smartphones and other mobile devices.

Most importantly, this future city will have a converged architecture embodied in an all-IP, packet-based core network – a unified infrastructure that integrates various wired and wireless technologies, thereby achieving the seamless connectivity required. When we say "converged" or "unified" we do not mean that a city will end up with a single telecommunications system. Rather, we mean that it will end up with a single architecture – a single set of standards – that allow multiple networks to transmit information smoothly. As we move towards the future, interoperability will be key.



> ***The telecommunications foundation.*** *The smart city of the future will have a fiber optic loop that reaches most buildings, combined with citywide wireless communications such as 3G/4G cellular, Ethernet, WiFi, RF mesh or some combination.*
>
> *Figure 7.2*

Those three elements – fiber plus wireless plus a converged, delayered architecture are the essentials to achieve the high speed, high reliability and high availability telecommunications required in a modern city.

TELECOMMUNICATIONS TERMINOLOGY

Most cities already have multiple telecommunications networks in place. Here are 10 of the telecommunications terms and technologies seen most often.

Cable – Coaxial cable, an inner conductor surrounded by insulation and a conductive shield, originally used for cable television but increasingly used as well for voice and data.

Cellular/mobile – A radio network of transceivers called base stations distributed over land areas called cells. Cellular/mobile uses licensed frequencies and services provided by regional and/or nationwide operators. It is typically used for mobile broadband data, voice and text services. It is increasingly being used in machine-to-machine applications. For example, to collect data from smart meters and other sensors. Comes in various flavors including 3G (3rd generation) and 4G-LTE (Long-Term Evolution).

Fiber / FTTH – Fiber optics are thin, flexible strands of glass that transmit signals as light. The bandwidth enables single fiber optic cables to easily deliver 1 Gbps (one thousand million bits per second) services and even faster. Fiber to the Home, or FTTH, describes fiber being deployed to directly connect an operator's central distribution office to individual homes.

Microwave – Line-of-sight devices that must typically be placed in high locations so the sender and receiver can "see" each other. Often relayed from station to station.

POTS – or Plain Old Telephone Service, typically delivered to homes and businesses over twisted pair wires. POTS is a part of the Public Switch Telecom Network (PTSN).

Powerline – Transmitting data over existing electric power lines both inside the home (HomePlug) or outside (Broadband over Powerline). Typically used to collect data from smart meters and other sensors.

RF Mesh -- A system using radio frequency (RF) in a "mesh" configuration such that individual nodes pass a message along until it reaches a "collector" or "gateway" that can forward it to the backhaul network. Typically used to collect data from smart meters and other sensors.

Satellite – Communications satellites can be thought of as microwave relay stations placed very, very high (typically 22,000 miles above the earth). They are often used to relay global positioning signals or to deliver television services to homes and businesses.

Figure 7.3

WiFi – A popular networking technology that uses unlicensed radio waves for short- to medium-range wireless connections.

ZigBee – A communication protocol for "personal area networks" (PANs) created by small, low-power digital radios. Typically used to connect smart meters to thermostats and home appliances that are a short distance apart.

The importance of telecommunications

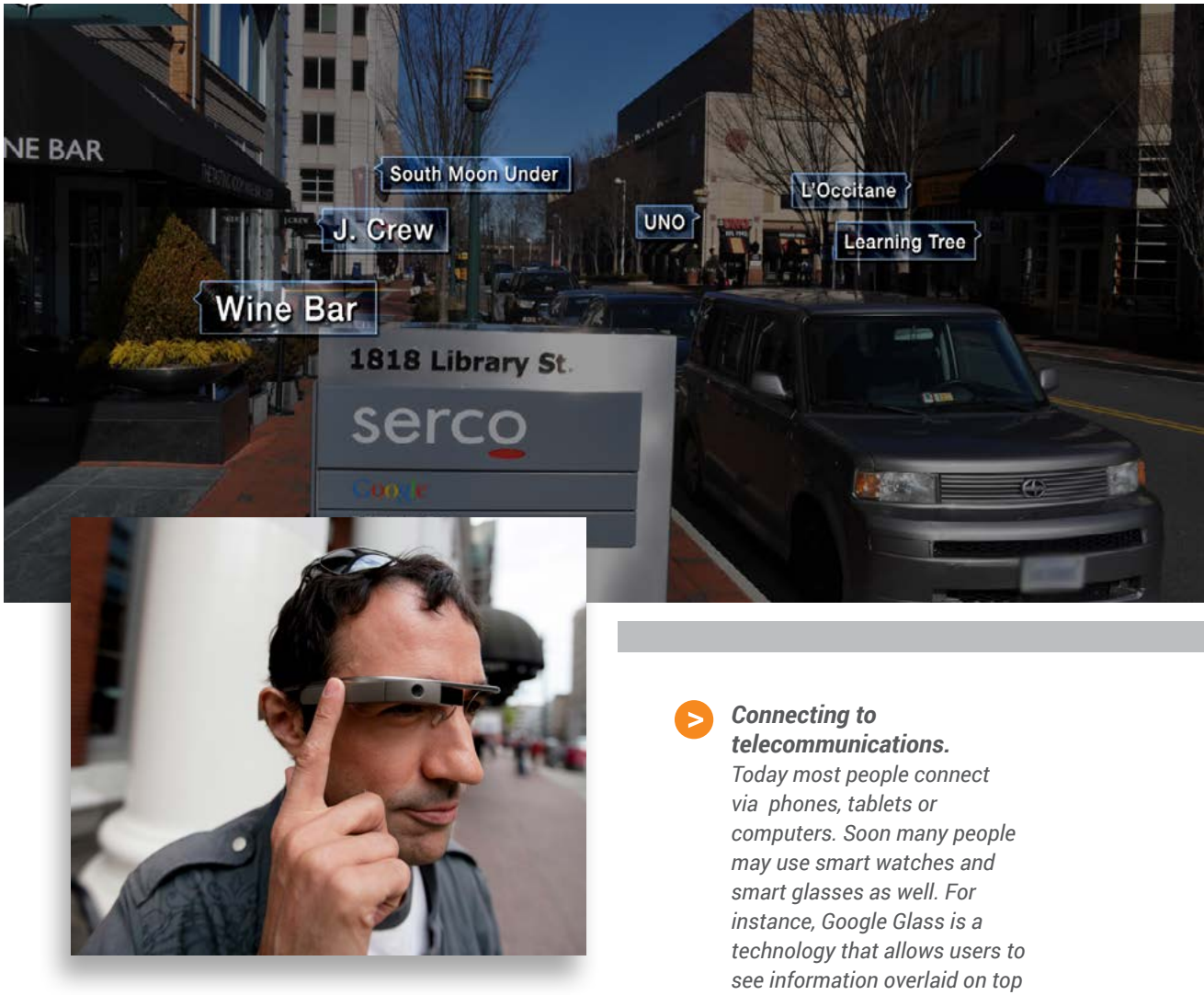
Telecommunications is used in two ways:

1. **To connect to devices people use indirectly** – such as sensors and switches. By 2020 there could be upwards of 50 billion devices and sensors connected in M2M (machine to machine) applications.

2. **To connect to devices people use directly.** Today that means computers, tablets and smartphones. Soon it may also mean smart watches and smart "glasses" (see nearby photos).

In both ways, telecommunications plays a pivotal role in the daily pulse of a city:

- Banks rely on it to process transactions
- Online retailers use it to receive and acknowledge orders
- Cloud computing data centers require it to communicate with thousands or even millions of computers
- Emergency responders need it to receive and act upon life-saving alerts
- Parents rely on it to stay in touch with their children
- Families use it to get access to movies, television and the Internet



Connecting to telecommunications. *Today most people connect via phones, tablets or computers. Soon many people may use smart watches and smart glasses as well. For instance, Google Glass is a technology that allows users to see information overlaid on top of their normal view of the world. It accepts commands via voice recognition. Images: Vancouver Sun and John Angelo*

Figure 7.4

Reducing the digital divide:

NYC REIMAGINES COMMUNICATIONS INFRASTRUCTURE WITH FAST, FREE MUNI WI-FI NETWORK

Despite being one of the most advanced cities in the world, New York City has an antiquated and broken communications infrastructure with approximately 7,500 payphones located throughout its five boroughs. The city recognized an opportunity to utilize this real estate to transform NYC into a smart city platform to provide services and bridge the digital divide by making Wi-Fi more accessible to its citizens. To turn this vision into a reality, the city awarded a contract to CityBridge – a consortium of leading experts in technology, advertising and user experience that includes Council member Qualcomm – to create LinkNYC.

LinkNYC will be the world's largest and fastest free municipal Wi-Fi network, offering up to gigabit speeds and paid for by advertising. These structures, called Links, will not only provide wireless connectivity throughout the boroughs, they will also provide free national calls, rapid charging stations and access to city services. However, this is just the beginning – LinkNYC will also provide an open platform that businesses, academic institutions and municipalities can utilize to produce original content and apps that can spur a new generation of data-centric start-ups, or to tap into information to help steer public policy.

To ensure that it stays at the forefront, the LinkNYC network will support both hardware and software updates over time. Additionally, through advertising screens located on certain Links, the city will generate more than $500 million over the next 12 years. LinkNYC will usher in a new generation of technology and set the standard for connectivity in urban environments globally.

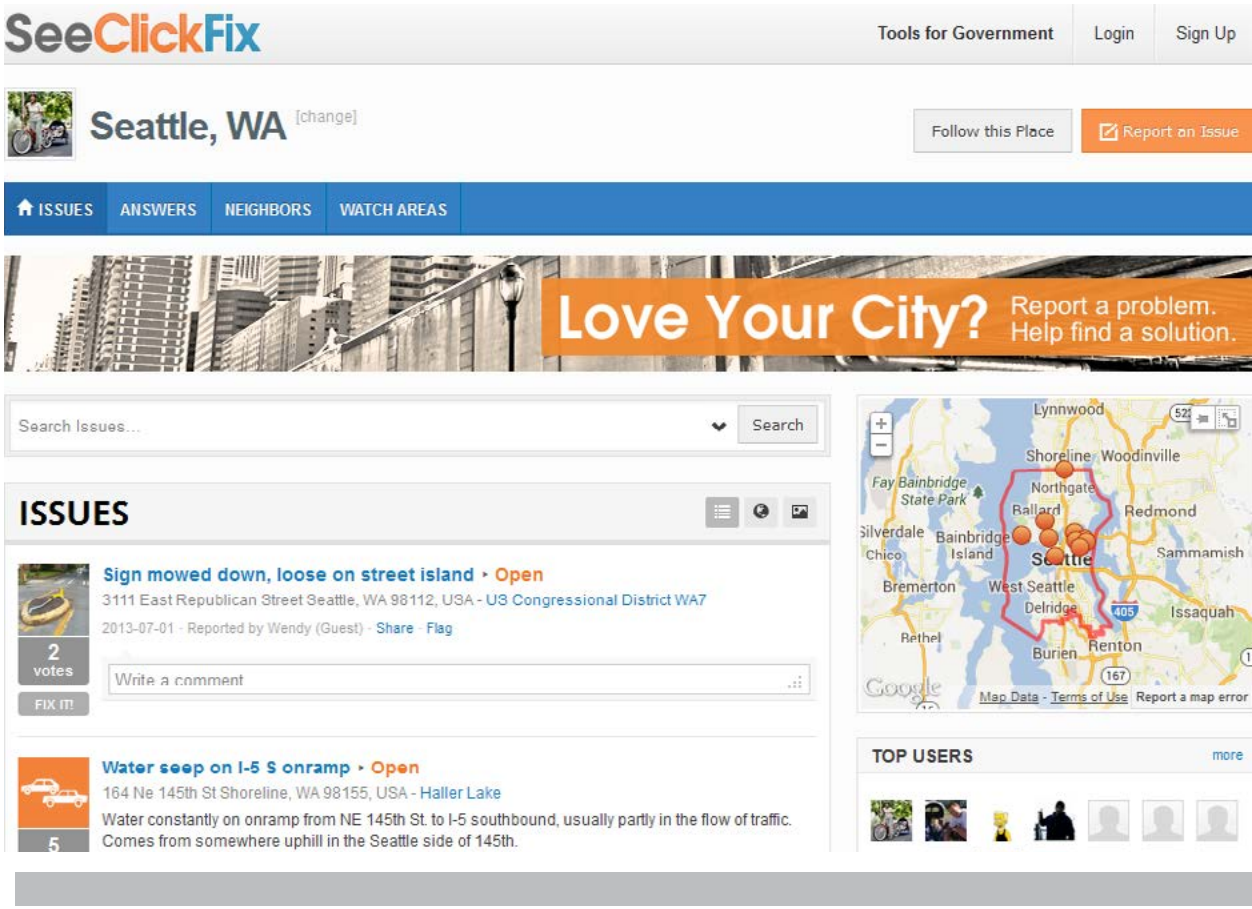
> ***Reducing the digitial divide.***
> *New York City is leveraging advertising revenues to bring new digital infrastructure to citizens.*
>
> *Figure 7.5*

The list of ways telecommunications factors into daily life could go on and on, of course. Telecommunications is a necessity for prosperity in the modern economy. And a necessity for the digital lifestyle increasingly demanded by citizens. (In a 2011 Reuters survey, for instance, 61% of Americans said it would be easier to live without air travel than without the Internet.)

Our reliance on telecommunications will only increase as more people are connected to the Internet each day, and as we invent new uses – from tablets, to video streaming, to video phone calls. Council member Qualcomm – a world leader in 3G, 4G and next-generation wireless technologies – estimates that the world will soon demand 1,000 times more mobile data traffic than consumed in 2012.

Dependencies in telecommunications

As cities contemplate improvements in telecommunications services, they will need to plan them with an understanding of the dependencies on two resources: power and the radiofrequency (RF) spectrum. The power requirement is self-explanatory. The RF spectrum requirement is on the radar now for very few cities, but it will emerge as an important



> ***Better ways to deliver services.***
> *SeeClickFix allows anyone to report and track non-emergency issues anywhere in the world via computer or mobile device, empowering citizens, community groups and governments to improve their neighborhoods. It uses "distributed sensing" to recognize patterns such as those that gradually take place on a street. Citizens can report issues on the go, and set up watch areas to monitor their block. Governments can watch for potholes and cracked sidewalks. Police can monitor crime issues reported within the precinct.*
>
> *Figure 7.6*

issue. RF spectrum is an always-local and limited natural resource that smart cities increasingly depend on and will ultimately need to manage. RF transmissions – from cell phones, WiFi, WiMax, positioning systems, Bluetooth, etc. – interact with the environment. Understanding RF – and an open standard for encoding RF spectrum data – will be important as it becomes necessary for cities to optimize their use of this resource.

Benefits of telecommunications

Telecommunications play a critical role in promoting livability, workability and sustainability in cities.

Livability

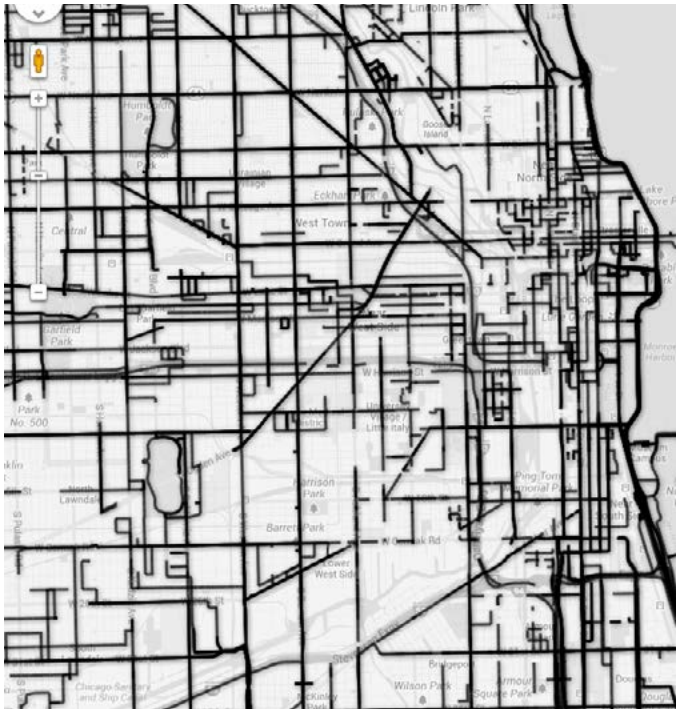
Reducing the "digital divide." Residents without access to the Internet are at an educational and economic disadvantage. By ensuring top-notch telecommunications everywhere, cities can help the disadvantaged level the playing field.

Empowering a connected lifestyle. Access to the Internet and mobile apps delivers an amazing body of human knowledge and connection, ranging from personal interests and hobbies to entertainment options, to job searching, to social media, to online courses and more. In developing countries around the world, mobile devices are now enabling people to have their first experiences with the Internet.

Better ways to deliver services. High-speed broadband creates a whole new way to deliver services. Government can deliver personalized alerts and applications directly to residents' smartphones. M2M solutions can be supported. Schools can make education available 24x7 to anyone with a computer or mobile device. Medical professionals can deliver advice and perform simple examinations remotely.

Enabling safe e-transactions. Many people have come to rely on online shopping and banking. Building a telecommunications infrastructure with solid cybersecurity makes citizen life more convenient and more secure. Enabling safe, easy online and mobile payments reduces the "friction" of the local economy, leading to higher sales and more jobs.

Improving access to health and education. Telecommunications is the bedrock for online education and telemedicine, enabling the delivery of these services above and beyond their traditional boundaries, and allowing health and education professionals to serve a far wider audience than ever before.



> ***Reducing congestion.*** *Chicago suffers through numerous snowstorms each winter. Using an application called Clear Streets, residents can now see which streets have been plowed because the city's snowplows report their position via telecommunications. Residents can enter their address to learn whether a plow has already been by.*

Figure 7.7

Improving healthcare delivery:

BELFAST HEALTH TRUST UNIFIES COMMUNICATIONS, SPEEDS UP CLINICAL DECISION MAKING

Belfast Health and Social Care Trust operates in Northern Ireland through a network of six organizations and more than 100 physical locations with an annual budget of about £1 billion (US$1.5 billion) and a staff of around 20,000. It wanted to replace its previous system with a unified communications system that would make it easier for doctors, nurses, and administrators to access information and communicate effectively regardless of location.

For its new unified communications solution, Belfast Trust selected Microsoft Lync Server 2010. An important factor in its choice was that its staff was already familiar with Council member Microsoft's user interface. Integration was also a key concern. Lync Server 2010 includes a range of communication services that are already integrated, which meant that Belfast Trust would not need to add on those services, at either an extra cost or effort. "We were happy with the built-in integration from the very beginning," says Paul Duffy, Chief Information Officer at Belfast Health and Social Care Trust.

Moving to the new system at Belfast Trust has reduced communication costs and increased the speed of clinical decision making. Clinicians can use the Microsoft Lync 2010 client to send instant messages, initiate on-demand videoconferencing, and share their desktops so that they can view the same clinical information or patient record no matter their location.

> ***Improving healthcare delivery.*** *Moving to the new system at Belfast Trust has reduced communication costs and increased the speed of clinical decision making.*
>
> *Figure 7.8*

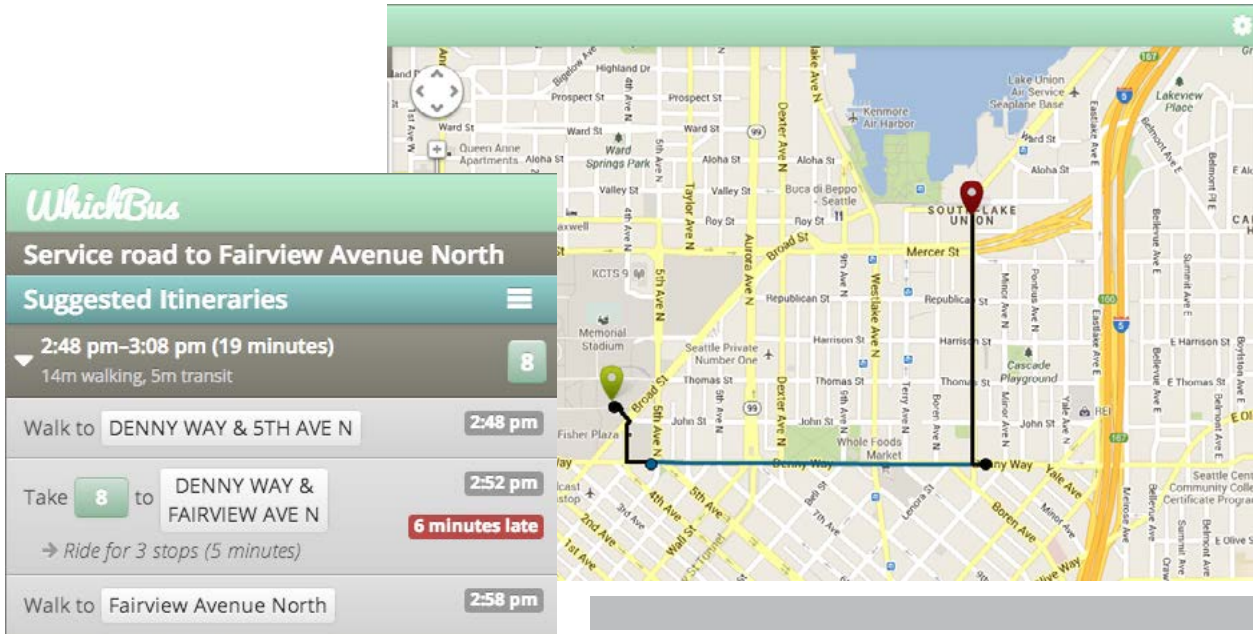
Workability

Enhancing mobility. All over the world, mobile apps are helping people plan their routes, make better use of mass transit, and otherwise travel with greater convenience and speed and less congestion and pollution.

Enabling telecommuting. Fast, reliable Internet access enables telecommuting, creating a more flexible and satisfying lifestyle while improving productivity.

Attracting business and investment. Broadband and high-speed Internet access are no longer a convenience, they are an economic and business requirement. Cities with superior telecommunications have an edge when courting business investment. This advantage was captured in a stunning 2011 study by the World Bank that found that GDP rises 1.3% for every 10% increase in broadband penetration. Similar effects have been found for mobile broadband.

Real estate developers and business owners consider a robust telecommunications infrastructure a requirement. A city's attractiveness is directly related to its ability to offer the services that support growth and create competitive differentiation. What's more, citywide telecommunications help attract investment to areas that would not otherwise see it, such as low-income inner-city neighborhoods.



Enhancing mobility.
It can be challenging to use public transit, especially if riders don't know which bus to take and when their bus is going to arrive. WhichBus is a simple way to navigate public transit in Seattle, Washington, USA. It combines both trip planning and real-time arrival information. It is available on any browser, including phones and tablets.

Figure 7.9

Enhancing mobility

SMART FLEET CUTS CONGESTION IN QATAR BY DIRECTING DRIVERS AROUND IT

Like many developed areas, there are traffic jams in Qatar that not only aggravate commuters but can also be costly for companies with fleet vehicles that move goods and services around the region.

Council member Ooredoo, the telecommunications company based in the Qatar capital of Doha, developed a cloud and sensor-based Smart Fleet solution that deploys GPS and GSM technology to centralize and manage transport-related information. The subscription-based service can be used for any kind of fleet, whether in the services sector, transport and logistics, passenger transportation or construction.

When there is a traffic jam, the system can route a driver around it. That not only saves the driver time, but it can save other drivers time too. By reducing the number of vehicles driving into the congestion, the traffic jam can clear faster.

In addition to reducing the amount of gas wasted in traffic, Smart Fleet can also design fuel-efficient routes for drivers, which can save companies money and help reduce pollution. By keeping track of their assets in real-time, the system also helps the companies that use it reduce loss and theft.

> ***Enhancing mobility.*** *Smart Fleet combines sensors with Ooredoo's wireless network to help businesses better direct their fleet vehicles to avoid traffic congestion and reduce operating costs.*
>
> *Figure 7.10*

Creating jobs. A 2010 Communications Workers of America study found that every $5 billion investment in broadband creates 100,000 direct jobs plus another 150,000 "spinoff" positions.

Helping people boost their professional skills. Expanded access to broadband gives people better access to online professional training programs, online tertiary education and city employment services.

Increasing business access to the global economy. A smart telecommunications network allows local businesses to gain access to national and international markets, and for rural areas to connect to the world economy.

Sustainability

Reducing the need for transportation. Advanced telecommunications enables video-conferencing, telecommuting, telemedicine and online education – all things that lessen the need for lengthy commutes that pollute the air and prolong our dependence on fossil fuels.

Getting more from existing assets. When expensive equipment – transformers, pumps, power plants, power lines – can be remotely monitored, it can be pushed to its maximum capacity without fear of overload. By the same token, its actual condition can be monitored so repairs can be made before the equipment fails, thereby extending its life.

Reducing energy and water use. Smart grids need to connect their embedded devices to technicians and control centers if they are to succeed and reduce resource waste – and they rely on telecommunications for this service. Likewise, telecommunications enables smart buildings to report their conditions and optimize their systems to use as little water and power as possible.

> ***Attracting business and investment.***
> *Council member Saudi Telecom is the largest telecom provider in the Middle East and North Africa. In January 2015, it partnered with the Arab Satellite Communications Organization to build a satellite ground station to meet an increasing demand for telecommunication services. That demand, STC indicated, was coming from several sectors – government and business among them.*
>
> *Figure 7.11*

Reducing energy and water use:

WIRELESS NETWORK HELPS CHARLOTTE, NC DELIVER A MORE SUSTAINABLE FUTURE

Charlotte, NC-based Duke Energy – along with the local organization Charlotte Center City Partners – launched a new partnership called Envision Charlotte in 2010. It's a rare public-private partnership between heads of business, building owners and managers, utilities chiefs, city planning professionals, and more. Their common goal? To achieve up to 20% energy reduction by 2016.

Duke invited Council member Verizon to take on a major role in the project at its outset – an invitation based on a long-standing relationship between the two companies. Efforts began with the Smart Energy Now® program, which focuses on educating office workers about small, simple changes they can make that, collectively, have a huge impact on the city's energy usage.

Envision Charlotte's smart grid captures information using smart meters at 61 buildings within Charlotte. That data is sent across Verizon's wireless network and delivered via the cloud to Verizon-supplied kiosks and displays in the building lobbies.

These live feeds provide both a centralized view of the overall program, and usage data for individual buildings. They also display tools, tips, and facts about energy use in terms that are easy to understand–for example, turning off lights when not in use, setting back the thermostat when buildings are unoccupied, and revising janitorial practices to reduce "lights-on" hours. This delivery model makes information actionable, turning tenants, workers, and visitors into project stakeholders.

> ***Reducing energy and water use.***
> *To date, Envision Charlotte has reduced energy consumption by 8.4% – driving an estimated $10 million in savings. The project is also taking on smart water, waste management and air quality.*
>
> *Figure 7.12*

Have access to comprehensive network and device management:

NAGAHAMA CITY REDUCES ICT COSTS AND SIMPLIES NETWORK MANAGEMENT

Nagahama City is located in the Shiga Prefecture of Japan. In 2006, Nagahama City, Asai Town and Biwa Town were merged into one city. Then in 2010, the city merged with a further six municipalities. All of these now form the current Nagahama City.

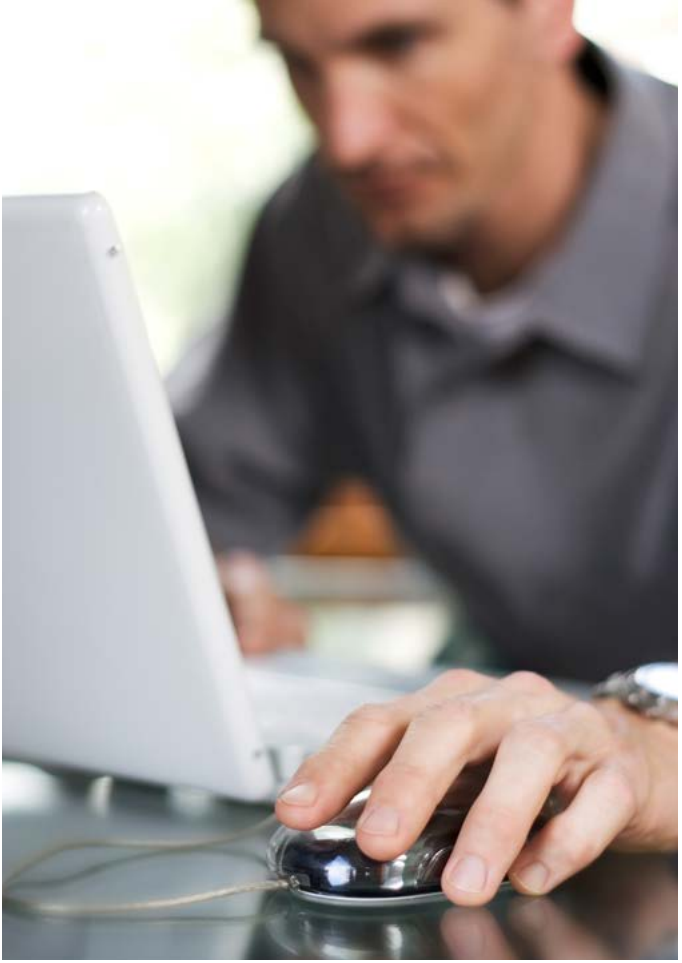
As Nagahama City has expanded the scope of its ICT systems through repeated mergers, their employees have experienced a number of challenges. The city deliberately operated separate backbone, information and VoIP networks, for security reasons. Though this setup was effective for security, it was relatively costly because different sets of network equipment were needed for each of the three networks.

To reduce ICT costs, simplify network operation and management, and build a long-lasting, stable ICT infrastructure, the city leaders wanted to converge their information and IP Telephony (VoIP) systems onto a single network.

The city chose Allied Telesis to provide its new network solution. Their converged network has been constructed from Allied Telesis Management Framework (AMF) capable switches.

Utilizing AMF greatly reduces the city's network operation and management workload, by automating switch configuration and consolidating network management.

> ***Have access to comprehensive network and device management.*** *An added advantage of the high bandwidth LAN is that broadcasts of city council committee meetings, which have been provided for some time via an online video and streaming website, are now running smoothly as live feeds with no interruption.*
>
> *Figure 7.13*



Ensure ubiquitous broadband access. *Smart cities ensure best-of-breed, high-speed broadband access across their geography to all or most buildings.*

Figure 7.14

Telecommunications targets

To this point, we've defined telecommunications and discussed its importance. Now we'll discuss the specific targets that will allow a city to enjoy benefits like those described above.

Instrumentation and control

We use the term "smart cities" but they are also referred to as "digital cities." And for good reason, as you'll see in this section, where we introduce the two telecommunications-specific targets – broadband access and citywide wireless.

Ensure ubiquitous high-speed broadband access. This is the first target exclusive to the telecommunications responsibility. Smart cities ensure best-of-breed, high-speed broadband access across their geography to all or most buildings. Since cities have different legacy investments and circumstances, and because technology will change rapidly in 20 years, we cannot make a definitive technical specification. As noted, however, today this typically means a fiber optic backbone combined with increasingly high bandwidth wireless technologies. Your goal should be to eventually connect virtually every business and home to that fiber loop (or to whatever technology you use in its place).

Important note:

This target does not imply that a city needs to build out high-speed access at its own expense. In most parts of the world, broadband access is provided by the private sector. Elsewhere, public-private partnerships play a role. Even so, a city can provide valuable leadership, helpful incentives, and encouraging policies that go a long way to ensuring that residents and businesses have the access they need.

Ensure ubiquitous high-speed broadband access:

ROBUST TELECOMMUNICATIONS HELP AMSTERDAM COMPETE

Amsterdam, the financial and cultural capital of the Netherlands, strives to be one of Europe's greenest, most sustainable cities while continuing to maintain economic growth. Over the past decade, the city developed a plan for collaborating, envisioning, developing and testing connected solutions that could pave the way to a smarter, greener urban environment.

It teamed in numerous public-private partnerships to create the platforms and services needed to help achieve its goals. SmartCities Amsterdam is the public-private organization that oversees projects with more than 70 partners, including Council member Cisco and many other organizations.

"Broadband is the essential infrastructure for SmartCities projects," says Maaike Osieck, Communications Lead for SmartCities Amsterdam. "From connected buildings, to fiber to the home for residential service delivery, Cisco routing and switching solutions power the core network and aggregation capabilities that underlie projects designed to improve sustainable living and working, public spaces and mobility." Those solutions adhere to IPv7.

Amsterdam's vision evolved into a Cisco Smart+Connected Communities initiative to transform to a connected community. Its vision is wide-ranging, aiming to provide services for connected real estate, government services, utilities, transportation and healthcare. Teaming with a large ecosystem of private and commercial partners, Amsterdam

> ***Ensure high-speed broadband access.*** *Amsterdam has worked with Cisco and other companies to achieve broadband access throughout the city. As a result, says one official, Amsterdam has "a wide-open marketplace for innovative services and economic growth, as well as a fast track for the smarter and cheaper delivery of healthcare, education and other public services."*
>
> *Figure 7.15*

deployed a citywide network that forms a strong foundation for the delivery of smart services and a wide-open marketplace supporting economic growth.

A citywide broadband network creates the foundation. Initiated in 2008, the network originally connected 40,000 households and small businesses through fiber to the home. Three years later, 140,000 homes and businesses had been connected and the city continues to deploy fiber across all areas of the city.

With widespread connectivity in place, the city and Cisco created a foundation to develop Smart Work Centers, which are sustainable work environments designed to deliver information to users, no matter where they choose to work. Located near residential communities, they help reduce or eliminate commuting while enabling workers to access their full corporate resources. Space can be rented by anyone from sole proprietors to multi-national corporations. Workers have access to office space, meeting rooms, broadband connectivity and Cisco TelePresence collaboration systems.

"This robust broadband foundation enables our city to compete with other European cities," says Frans-Anton Vermast, Advisor, Public and International Affairs, Physical Planning Department, City of Amsterdam. "In this way, we help ensure a wide open marketplace for innovative services and economic growth, as well as a fast track for the smarter and cheaper delivery of healthcare, education and other public services."

Ensure a citywide wireless network. This is the second and final target unique to telecommunications. A citywide wireless network ensures that people – whether at work, at play or otherwise on the go – are not tethered to stationary points of Internet access. A cellular or WiFi network empowers a city and everyone in it, creating competitive advantage and convenience.

Local-area wireless networks relying on unlicensed spectrum (ie WiFi) cannot be guaranteed to deliver this service reliably and in 100% of the areas needed. The optimal solution would be 3G/4G operator-managed networks (operating in licensed spectrum), likely augmented by WiFi and in the future, small cells, to handle more data in high-usage areas. Because cities have several technology choices, most will want to work with private providers to identify the solution(s) right for them.

Citywide public wireless has been a luxury until recently. But we are seeing evidence that it is gradually becoming a must-have, at least for those cities that hope to attract high-income technology professionals. For instance, Austin, Texas in the spring of 2013 hammered out an agreement to deploy an ultra-high-speed Google Fiber network and later announced that a significant WiFi network would hook into it. The city of Vancouver, B.C. began deploying a citywide wireless network as outlined in its 2013 Digital Strategy, which calls wireless access "a fundamental aspect of any digital' city" and one that "is expected by citizens." And many cities are using mobile/cellular, including LTE, to ensure citywide coverage. Going forward, citywide wireless access is likely to be heterogeneous – that is, citizens and businesses will access a variety of wireless technologies in both licensed and unlicensed bands to get the best experiences.

Ensure a citywide wireless network:

SILICON VALLEY POWER PROVIDES A FREE PUBLIC WIFI NETWORK

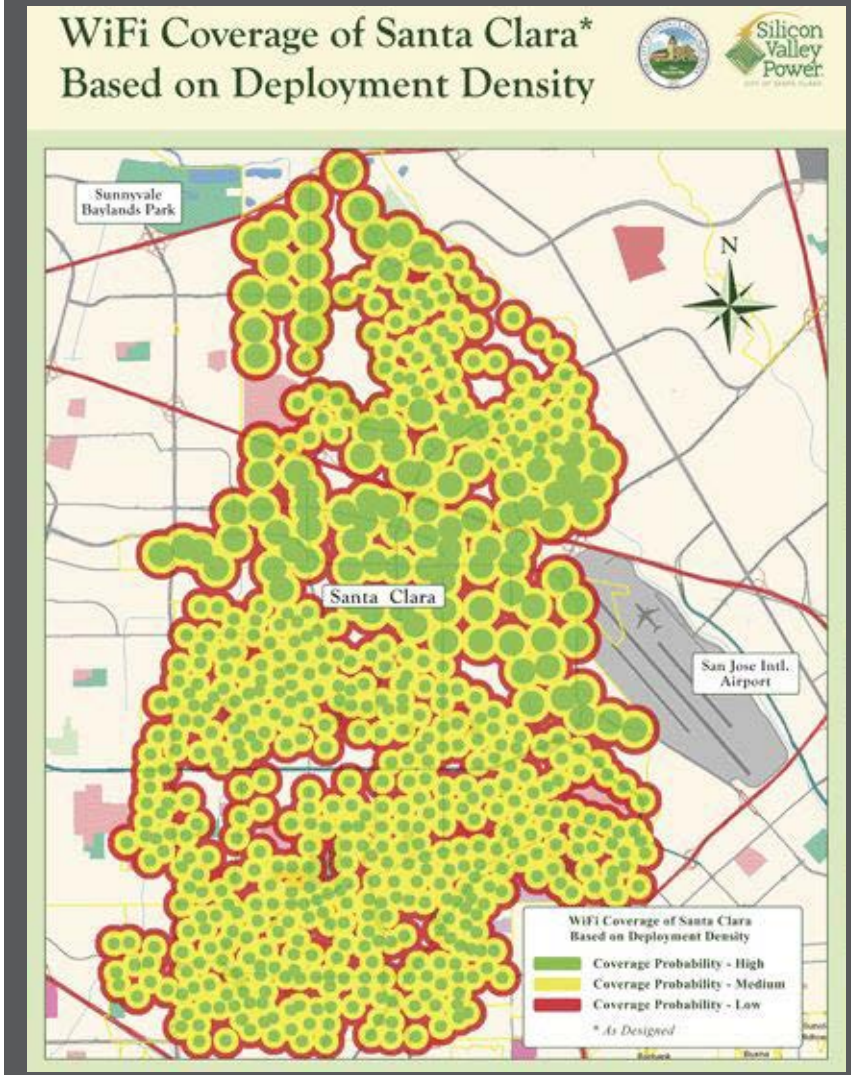
In 2013, Silicon Valley Power (SVP) opened up its existing Tropos wireless communications network provided by Smart Cities Council member ABB to provide free public outdoor WiFi access throughout the city of Santa Clara. Residents and visitors use client laptops, tablets and smartphones with standard WiFi connections to access the Internet throughout the outdoor areas of Santa Clara. The new Santa Clara Free WiFi service replaces an outdated and limited system and provides WiFi access to residents as well as the tens of thousands of workers who commute to the city to work for companies that form the cornerstone of the high-tech industry.

The SVP MeterConnect program includes the Tropos field area communications network, which is based on open-standard IP networking and radios. Previously used to read smart meters, it has now been opened up for use by residents as well.

In the future, the city plans to use the same network to provide mobile access for municipal field workers (public safety, building and fire inspectors, parks and recreation and others) to reduce operational costs and deliver greater bandwidth.

> ***Ensure a citywide wireless network.*** *Silicon Valley Power's MeterConnect program includes a WiFi communications system that connects smart meters to SVP offices while also providing citywide access for other city services. It is also an example of a multi-service communications system.*

Figure 7.16



Connectivity

So far we've talked about the telecommunications responsibility – how telecommunication can ***empower*** a smart city and its residents. In this section, we highlight how connectivity acts as an ***enabler*** of smart cities.

Connect all devices with a citywide, multi-service communications system(s). This universal target deserves additional discussion as it applies to telecommunications.

Earlier we discussed the importance of high-speed access and citywide wireless. For connectivity purposes – for connecting sensors, switches and devices – it is not strictly necessary to have either one. In theory, connectivity can be accomplished with low-speed wireline technology. Many electric power utilities, for instance, use low-speed powerline technology to talk to their smart meters and sensors.

Regardless of the telecommunications technology you choose for device connectivity, strive to make it a "multi-service" network. That is, try to use it for a variety of purposes across different city departments. If each department stands up its own special-purpose network, your city will spend far more than needed. What's more, it will have a harder time managing and maintaining all those disparate networks. And a harder time passing data back and forth between departments. In fact, the services architecture layer should be abstracted from the underlying access network technologies. This enables the network to be continually upgraded with less disruption of the service layer

The clear trend worldwide is to move away from slow, single-purpose communications to fast, multi-service networks. This implies that you may be able to achieve device connectivity by using a high-capacity network that is already in place – be it cellular/mobile 3G or 4G-LTE, WiFi or other solutions like RF mesh, though data rates vary dramatically. You should identify which technology makes the most sense for your city according to your performance and cost requirements, and your circumstances.

If you are approaching device connectivity for the first time, then your technical team must take a hard look at two aspects: bandwidth and latency. Bandwidth is the amount of data that can flow through at one time (just as the width of a pipe determines how much water can flow through). Latency is the time lag to get data back and forth. A network can be high bandwidth (lots of data at the same time) but also high latency (a slow roundtrip). Or vice versa.

Your technical team must carefully determine your bandwidth and latency requirements. For instance, a network for monitoring street lights

Figure 7.17

may be able to get by with high latency (a slow roundtrip). After all, it doesn't really matter if a light turns on or off a few seconds late. But a network for monitoring electric power substations may need very low latency (a fast roundtrip). That network must be able to send and receive signals very rapidly so it can prevent a small outage from cascading to a big blackout.

Whatever your current requirements, try to leave headroom for future growth. At the very least, make sure that the products you choose are "future-friendly" – are capable of expansion when the time comes. In the early days of the smart grid, for instance, some pioneering utilities selected underpowered connectivity solutions in the hopes of saving money. But they spent more money in the long run. Many of them had to go back and upgrade their initial network a few years later. Others had to put in a new system parallel to the old one to get enough capacity. If you build it, they will come, so build in as much extra capacity as your budget allows.

Connect devices with a multi-service communications system:

CITY COUNCIL MAKES SIGNIFICANT SAVINGS WITH UNIFIED COMMUNICATIONS

Leicester City Council provides universal public services to the largest city in the East Midlands, UK, with a population of more than 300,000.

Faced with the challenge of funding cuts, rising customer expectations and having to move premises, the council embarked on a business transformation strategy. It needed to take control of its data, enhance customer experience and modernize its ICT infrastructure to support flexible, collaborative working. As part of this modernization program the council looked to replace its Novell email, diary and file and print solution, along with its existing private branch exchange (PBX) telephone system, supporting more than 8,000 unique numbers.

It deployed a solution using Council member Microsoft's desktop, server, collaboration, unified communications, business intelligence and mapping technologies – replacing the Novell systems with a Microsoft platform.

As a result, efficiencies have been achieved across the council through the adoption of new ways of working and the migration to Microsoft technology. Having documents in electronic format has helped staff access key information quickly and securely, resulting in better service productivity, improved decision making and increased staff sense of worth. The council's carbon footprint has been reduced through green ICT and collaboration with other agencies has been enhanced through better data management.

> ***Connect devices with a multi-service communications system.***
> *The Leicester City Council's business transformation strategy included Microsoft desktop, server, collaboration, unified communications, business intelligence and mapping technologies.*
>
> *Figure 7.18*

Interoperability

Telecommunications networks are major expenditures that cities must get right. These interoperability targets ensure that the systems you use will not strand you with a dead-end system, or tie you to a single vendor.

Adhere to open standards. By insisting on open standards, cities increase choice and decrease cost, as products can be mixed and matched from different vendors. Telecommunications has dozens of relevant standards, but the most important is IPv6 (Internet Protocol version 6), since IPv6 has the huge address space required to accommodate the millions of devices that will ultimately connect to the network. In addition to building the core architecture around IPv6, cities should adhere to published standards from accredited groups such IEEE, WiFi Alliance, IEC, 3GPP and the ITU. Cities can get ahead by leveraging standards that have global scale and interoperability, with strong vendor base and widespread demand. If the standards don't meet cities' requirements, city telecommunications experts can join standards organizations to ensure their particular requirements help shape the standards development.

Prioritize the use of legacy investments. Every city wants to wring maximum value out of its technology investments. If there are ways to use existing assets in the build out of a telecommunications network, it will save money for other purposes and reduce the number of stranded assets. During the dot-com bubble, many different companies built optical fiber networks, each hoping to corner the market. However, the advent of a technique called "wavelength-division multiplexing" increased the capacity of a single fiber by a factor of 100. As a result, the value of those networks collapsed. The misfortune of those companies means that many cities have miles of "dark fiber" under their streets – fiber that can be repurposed at a fraction of its original cost.

Longmont, Colorado, for example, located and repurposed an 18-mile fiber optic loop that was installed in 1997 for $1.1 million by a local power company. It was abandoned after an early partner in the broadband venture went bankrupt. Finding and repurposing fiber can save cities millions in installation costs while re-invigorating the local economy.

Privacy and security

For all of the benefits that broadband and wireless technologies provide, there are important privacy and security considerations that need to be addressed. In particular:

Create a security framework. This universal target is especially important to telecommunications, since the telecommunications

> ***Prioritize the use of legacy investments.*** *Longmont, Colorado has repurposed a fiber optic loop abandoned in 1997. Cities can often find ways to reduce costs by using existing assets to build out their telecommunications networks.*

Figure 7.19

network is one of the "access points" for cyber criminals. There is no point in hardening the rest of the city if the telecommunications system has its door unlocked. Your citywide security framework should explicitly lay out minimum security standards for any telecommunications network it employs.

Implement cybersecurity. The same is true for this universal target. The more telecommunications, the more vulnerability to cyber attack. Insisting on cybersecurity measures early on maximizes protection while minimizing costs.

Computing resources

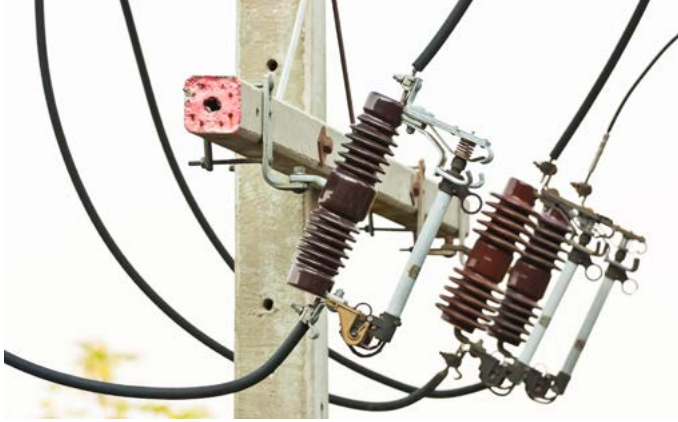
An advanced telecommunications system that includes high-speed broadband and citywide wireless not only makes it easier for city residents and businesses to access the Internet anytime from anywhere. It also enables these important targets.

Have access to a central GIS. The point of citywide wireless is to empower residents as they move about the city. Once they are mobile, they will of course want access to global positioning and geographic information. For instance, city employees will want the ability to see field assets on a map with descriptions – traffic signals, street lights, water mains, park facilities, etc.

Have access to comprehensive network and device management. Once a city has high-speed access and citywide wireless, the number of connected devices will skyrocket. You will need device management software to provision and manage those devices. Departments with maintenance operations will need to manage mobile phones, tablets and laptops connected to the network. Municipal power and water utilities may need to monitor and manage thousands or even millions of smart meters and sensors. Likewise, if the city operates any telecommunications networks of its own, it will need network management software. For instance, some municipal electric power utilities seek "hybrid" management software that can oversee multiple networks from a single console. (Many utilities have multiple networks in place side-by-side.) And don't forget the importance of a comprehensive device management program to enforce compliance with city data management, security and privacy policies. Partnering with suppliers, operators and service providers is the typical path to get access to network and device management.

Analytics

We mentioned in an earlier chapter how smartphones create the equivalent of sensors that collect and broadcast data over telecommunications networks. These add to the data stream that cities can use to analyze patterns and trends and improve city services.



Achieve asset optimization.
In telecommunications, multi-service networks can maximum ROI.

Figure 7.20

One of the universal targets for analytics deserves additional discussion in the context of telecommunications.

Achieve asset optimization. This universal target refers primarily to the use of sophisticated software to a) run equipment to capacity while still staying safe and b) predicting when expensive equipment will need repair and c) calculating which equipment is most critical to prioritize replacements and upgrades. When it comes to telecommunications, it can also refer to a "manual" process – namely, the idea of multi-service networks – using a single telecommunications network for multiple purposes to extract maximum value from your investment.

COORDINATION HELPS DELIVER A NATIONAL BROADBAND-STYLE NETWORK IN MUSCAT, OMAN

The wastewater company in Muscat, the capital of the Sultanate of Oman in the Gulf, has shown great vision as it looked to install a new sewer system across 70% of the Governorate of Muscat.

Recognizing they would be digging up streets with large trenches, the company engaged in a study to consider the benefit of creating a FTTH network at the same time. Trenching and the associated civil works can be as high as 80% of the total network cost for FTTH. But being able to install ducts into an existing open trench, with the backfill and reinstatement already going to be paid for by the main sewer project, was very attractive.

By the end of the project, Muscat will have a FTTH network at a cost far below what would normally need to be spent and with open-access planned in from the start.

The team at Haya Water, their consultants, the Ministry of Communication, Finance Ministry and the telecom's regulator all worked hard to put in place the right conditions and investment for the development, according to Council Advisor Fibre to the Home Council - MENA. In fact, the attractiveness of this network for the 70% of the governorate meant the government and relevant bodies decided to invest in brownfield deployments across the other 30%. This is more expensive as it does not benefit from the 'free ride' of trenches dug for another purpose. However, it shows the determination of all parties to create a world-class network.

> ***Coordination reduces costs and disruption.*** *One thing which annoys residents and businesses is when streets are dug up by one company, repaired and then dug up a month later by another. The project in Muscat is an example of what can be created with vision and coordination.*
>
> *Figure 7.21*

ISO 37120: A yardstick for measuring city performance

In 2014, the International Organization for Standards announced an ISO standard that applies strictly to city performance. The document -- known as ISO 37120:2014 -- establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, urban planning, wastewater, water, sanitation and more.

In the table at right we have indicated how the standard related to Telecommunications correspond to the Council's Telecommunications targets identified on the next page.

This ISO 37120 indicator measures mobile phone, landline and Internet connections per capita, reflecting a city's communications intensity and, by proxy, the city's propensity for innovation.

Telecommunications and Innovation Indicators

			Ensure ubiquitous broadband access	Ensure a citywide wireless network	City-wide, multi-service communication
Core	17.1	Number of internet connections per 100,000 population	■	■	■
Core	17.2	Number of cell phone connections per 100,000 population			■
Supt.	17.3	Number of landline phone connections per 100,000 population			■

Figure 7.22

TELECOMMUNICATIONS TARGETS

*In the checklist below, targets specifically pertaining to the telecommunications responsibility are in **bold,** universal targets are not.*

TECHNOLOGY

Enabler	Telecommunications Targets How smart cities deploy and use ICT to enhance their telecommunications	Implementation Progress None · Partial · Over 50% · Complete
Instrumentation & Control	Implement optimal instrumentation **Ensure ubiquitous high-speed broadband access** **Ensure a citywide wireless network**	☐ ☐ ☐ ☐
Connectivity	Connect devices with citywide, multi-service communications	☐ ☐ ☐ ☐
Interoperability	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments	☐ ☐ ☐ ☐
Security & Privacy	Publish privacy rules Create a security framework Implement cybersecurity	☐ ☐ ☐ ☐
Data Management	Create a citywide data management, transparency and sharing policy	☐ ☐ ☐ ☐
Computing Resources	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	☐ ☐ ☐ ☐
Analytics	Achieve full situational awareness Achieve operational optimization Achieve asset optimization Pursue predictive analytics	☐ ☐ ☐ ☐

Figure 7.23

ADDITIONAL RESOURCES

Target: Ensure ubiquitous high-speed broadband access

ITU Interviews: Sheikh Abdullah Bin Mohammed Bin Saud Al Thani, Chairman, Ooredoo

Why does broadband matter in countries that have so many other pressing issues? Chairman Sheikh Abdullah Bin Mohammed Bin Saud Al Thani of Council member Ooredoo answers that and other questions about connecting people to the Internet in this video interview by the International Telecommunication Union, a Council Advisor.

Delivering seamless broadband

Turning Malta into a smart island with Cisco Wi-Fi

As one of Europe's oldest cable operators, Melita delivers a seamless broadband service with Council member Cisco's Universal Wi-Fi, and together they are helping turn Malta into a smart island. Watch this video to learn more.

Target: Consider a cloud computing platform

Information Where You Need It

This video explains how CivicConnect™ Mobile enables rapid deployment of dynamic mobile websites and applications for smart government on the go. Using the mobile-enabled, cloud platform from Council member Civic Resource Group International, organizations can make public and private data, information and powerful tools available to smartphone and tablet device users, wirelessly, securely, from anywhere.

CHAPTER 8

TRANSPORTATION

In this chapter we refer to transportation as any and every system that moves people around a city. Think of a city's streets, vehicles, railways, subways, buses, bicycles, streetcars, ferries and so on. All play an essential role in the hustle and bustle of today's cities – in commuting to work, running errands, attending classes, enjoying a night out, shipping and receiving products, delivering pizzas. We rely on the vast web of transportation networks in our cities. We trust that they will get us where we need to be in an efficient, safe manner for a reasonable price.

But that's not always the case. Transportation networks in cities around the world struggle with serious problems, like congestion. In 2013, traffic congestion robbed the U.S. economy of $124 billion, according to an Inrix study. Without significant action to alleviate congestion, this cost is expected to increase 50% to $186 billion by 2030. Another study predicts that emissions from vehicles idling in traffic jams will result in 1,600 premature deaths and $13 billion in "total social costs" in the U.S. by 2020.

Of course it's not a problem the U.S. faces alone. A 2014 Congestion Index comparing congestion levels in 2014 versus 2013 in over 200 cities ranked the top 10 most congested cities as:

1. Istanbul
2. Mexico City
3. Rio de Janeiro
4. Moscow
5. Salvadore
6. Recife
8. St. Petersburg
8. Bucharest
9. Warsaw
10. Los Angeles

Fortunately, there are a lot of ways cities can fix traffic congestion by deploying ICT, as you'll read about in the pages that follow.

The promise of smart transportation and the reality of city congestion mean that this market subsector is growing rapidly. According to Navigant Research, the global smart urban mobility infrastructure and services market is expected to grow from $5.1 billion in 2015 to $25.1 billion in 2024.

As you explore this chapter you'll discover there are four targets that cities need to achieve to put smart transportation into high gear. We'll also briefly discuss how the universal targets apply to transportation. But first, a quick look at transportation dependencies and then we'll highlight the incredible benefits in livability, workability and sustainability that smart transportation networks provide.

The promise of smart transportation. *Cities around the world struggle with traffic congestion. Fortunately there are a lot of opportunities to improve traffic flows using ICT.*

Figure 8.1

Achieve operational optimization:

WHAT A DIFFERENCE FAST, ACCURATE TRAFFIC DATA MAKES IN BUCHEON CITY

Located at the crossroads of Seoul and Incheon in the western part of Korea, Bucheon City is an attractive and bustling area that promotes itself as the cultural hub of metropolitan Seoul.

The city lacked the insight it needed to reduce traffic congestion and minimize emergency response times for traffic incidents. Traffic data from its existing solution was highly inaccurate (≤ 50%). For areas where a vehicle detection monitor was not installed, the city was monitoring traffic flow and counting manually from closed-circuit television video, a time-consuming task that often resulted in inaccurate and unreliable traffic data. Without a better traffic monitoring system, the city struggled to reduce congestion, manage urban traffic and meet the needs of its citizens.

To overcome the problem, Bucheon City implemented a solution that provides real-time traffic information and alerts to help drivers avoid congestion.

Utilizing the Smart Vision Suite Traffic Extension and other solutions from Smart Cities Council member IBM, Bucheon City:

- **Increased accuracy of traffic volume data** from 50% (or less) to 90%, ensuring that drivers receive more accurate reports on traffic tie-ups, suggested route changes, etc.
- **Increased speed of collecting traffic data** by over 1,200%, enabling the city to deliver traffic information to drivers, law enforcement and emergency responders in real time
- **Saved on costs** by using existing closed-circuit television video without the need for installing an additional vehicle detection system
- **Reduced labor costs** for manually monitoring traffic volume and counting vehicles

> ***Achieve operational optimization.*** *Bucheon City increased traffic data collection speed by over 1,200%, enabling the city to deliver traffic information to drivers, law enforcement and emergency responders in real time.*
>
> *Figure 8.2*

Dependencies in transportation

Improving transportation infrastructure and services are a high priority for many cities. As they plan improvements they will want to be cognizant of the interdependencies between transportation systems and energy and communications systems as well as the built environment. The connection between transportation and the built environment is straightforward – roads, rails and ports are typically essential components of a smart transportation system – but can also represent massive construction investments.

Beyond cost considerations, the various modes of transport all require power and communications to function properly within a smart transportation environment – especially true as cities move to electrified light rail or buses and set up recharging infrastructure for electric vehicles.

Benefits of smart transportation

In the highlights that follow you'll get a better understanding how smart transportation improves a city's livability, workability and sustainability:

Livability

Reducing traffic and congestion. Advanced analytics and instrumentation can provide cities with the information they need to minimize congestion. Traffic lights can be synchronized and adjusted for optimal traffic flow. In-vehicle collision-avoidance systems can take action to prevent congestion-causing accidents. Incident detention and notification systems can analyze information from cameras and vehicles to detect traffic problems, alert drivers and suggest alternative routes. Parking can be made more efficient through instrumentation and mobile apps.

Reducing trip time. With the help of analytics and ICT, traveler information systems and real-time route planning can plot multi-modal routes for travelers. Smart city transportation networks direct people when and where to switch from a bus to the subway, for example, to arrive at destinations at the lowest cost or fastest time. And traffic and weather alerts can be delivered via smartphone applications to alleviate commute times.

Empowering people with choice and control. Smart transportation gives people the power to make better transportation decisions. In smart cities, multi-modal fare cards are used to pay for all forms of city transportation or parking. And data gathering instrumentation and open data policies empower them with their own transportation information. People create ridesharing apps to optimally pair passengers and drivers, neighborhood-specific parking and traffic maps, apps that publish wait times for parking lots and so on.

Empowering people with choice and control. *Smart transportation gives people the power to make better transportation decisions.*

Figure 8.3

Improving public safety. Smart transportation has a strong link to public safety. First responders require mobility to perform their lifesaving work, and ICT can make their jobs easier by optimizing traffic lights when necessary and empowering them to see potential traffic snarls in real time so they can select the most efficient travel routes.

Reducing trip time:

CROSSRAIL PROJECT CONNECTS LONDON'S MAIN BUSINESS CENTERS

With the goal of improving rail capacity, reducing traffic congestion and reducing public transit travel times in London, Crossrail Ltd and Transport for London (TfL) – the companies responsible for delivery and rail operations in London, respectively – began construction of a new 118 kilometer east-west rail line. The line will, for the first time, produce a direct connection between all of London's main business centers, linking Heathrow, Paddington, the West End, the City and Canary Wharf.

Up to 24 trains per hour will operate in the central section between Paddington and Whitechapel during peak periods, with each train able to carry 1,500 passengers. An estimated 200 million people will travel on Crossrail each year.

When Crossrail opens in 2018, it will increase London's rail-based transport network capacity by 10% and dramatically cut journey times across the city. It has been estimated that Crossrail will generate an economic impact of about £42 billion.

Council member Bechtel is the delivery partner for the central section of the project including the tunneling and underground stations.

Through changes in work processes, Bechtel has triggered dramatic reductions in greenhouse gas emissions on the massive construction project.

> ***Reducing trip time.*** *When Crossrail opens in 2018, it will increase London's rail-based transport network capacity by 10% and dramatically cut journey times across the city. The image above shows the Canary Wharf Station aerial view looking east towards Woolwich.*
>
> *Figure 8.4*

Empowering people with choice and control:

MIAMI PAYMENT CARD SYSTEM MAKES IT EASY ON TRANSIT RIDERS

After Miami-Dade Transit (MDT) replaced its 25-year-old fare collection system with a smart card-based system – named EASY Card – it was so successful that two more agencies in the region joined. Including Hialeah Transit (buses) and South Florida Regional Transportation Authority (commuter rail) added even more convenience through the "one card fits all" interoperability provided by Council member Cubic Transportation Systems.

EASY Card is based on Cubic's open platform Nextfare Central System, a back-end administrative revenue management system. Nextfare gives transit operators the tools they need to better manage the data that allows them to adjust their services to meet their customers' needs and manage their operating costs. For example, the system tracks all the essential aspects of the transit operation, including ridership, financial performance, media distribution and fare breakdown.

"This project has been a partnership from the beginning, and we give credit to both our project team and Cubic for driving this to a successful launch," said Harpal Kapoor, director of Miami-Dade Transit. "Our customers are thrilled with the convenience which the EASY Card offers."

The system makes it just as easy for tourists who use public transit while in Miami. The reusable EASY Ticket is a paper-based smart card that offers the same convenience of the EASY Card.

> ***Empowering people with choice and control.*** *Miami-Dade Transit officials say their customers are thrilled with the convenience the EASY Card system provides.*
>
> *Figure 8.5*

Improving transportation budgets:

HELSINKI BUS FIRM CUTS FUEL USE, OFFERS IMPROVED TRANSPORT

Unlike some other major cities, Helsinki has a transportation system that is operated by multiple vendors rather than a single private company or municipal department. So although bus company Helsingin Bussiliikenne Oy (HelB) is fully owned by the city, it must compete with privately owned bus operators in a public bidding system to serve the city's bus routes. As a result, HelB needs to find ways to lower costs and operate more efficiently to win business.

HelB worked with Council member Microsoft and technology partner CGI to extend its existing data warehouse system to collect and analyze data generated by sensors installed on all buses in the HelB fleet. These sensors generate more than four million lines of data each day, so it was important to have a highly scalable solution.

A careful analysis of the bus sensor data has brought HelB numerous benefits since the solution deployment:

- **Overall fuel consumption** across the bus fleet is down by 5%, helping to reduce the city's carbon footprint
- **Customer satisfaction** among HelB riders has increased by 7%, based on biannual surveys conducted by the city
- **HelB monitors bus driver performance,** including speed and emergency braking, and it shares this information with drivers to improve their driving efficiency and safety
- **Sensor data** about fuel consumption and engine temperature helps HelB identify vehicles developing mechanical problems to proactively address issues

To further improve its performance, HelB began a pilot project using Power Map for Excel to analyze and visualize sensor data in areas of the city where emergency braking is most common. HelB can then physically examine trouble spots and find solutions to help drivers pass through these areas more smoothly.

> ***Improving transportation budgets.***
> *Sensor data about fuel consumption and engine temperature helps HelB identify vehicles developing-mechanical problems to proactively address issues .*

Figure 8.6

Workability

Increasing cities' competitive advantage. The quality of cities' transportation infrastructure is a major factor in business and industry investment decisions. Business and industry often depend on reliable employee travel and/or transport of goods. Transportation networks that offer reliability are sought out.

Becoming more attractive to talent. Professionals, like businesses, consider mobility when deciding where to locate. Cities with efficient transport will see their businesses thrive, thereby increasing the tax and employment base.

Sustainability

Reducing pollution from transportation. Pollution is a problem in both the developed and developing worlds, and transportation is a major contributor. Smart technologies and practices can significantly reduce transportation's environmental impact. Traffic management creates a more efficient road network and reduces travel time, reducing vehicle emissions. And smart public transit is easier and more convenient, attracting more riders and reducing reliance on automobiles. Smart cities also encourage the use of electric vehicles by example, choosing them whenever possible for their own fleets and providing charging stations in public buildings.

Improving transportation budgets. Cities spend billions on their public transportation systems, and yet they are often inefficient, with capacity not in line with demand. Smart technologies unleash the savings and efficiency potential of transportation investments. For example, information from embedded smart devices can be analyzed to determine subway system expansion needs with respect to highest transit priority, future demand needs – and then servicing that demand at the lowest cost.

Additionally, analytics can make the most out of expensive transportation assets. Sensors and monitors can report on the actual condition of infrastructure so that operators can make better decisions, servicing equipment based on actual condition and not on a guess. This kind of asset management can squeeze many extra years of use from an investment, and all without compromising equipment or passenger safety.

> ***Increasing cities' competitive advantage.*** *The quality of a city's transportation infrastructure is a major factor in business and industry investment decisions. Pictured here is a light rail station in Shanghai – one of Asia's leading commercial, financial and transport hubs.*
>
> *Figure 8.7*

Instrumentation and control

As we turn to the transportation targets, this first one highlights the many types of smart devices that help cities monitor and control traffic – roadway sensors, smart streetlights and GPS devices to name just a few.

Implement optimal devices and other instrumentation for all transportation modes. Deploying the right devices in the right places — covering all modes of transport — provides the data smart cities use to analyze traffic in real time. In some cases, optimal instrumentation may mean a smart device for every vehicle, for instance, a GPS tracker for every bus. In other cases it may mean a smart device "every so often." For example, a roadway sensor placed every so often as needed to provide a picture of traffic on city highways and byways. Gathering and analyzing data from all modes of transportation within a city enables multi-modal optimization.

Connectivity

The data collected from a city's smart transportation network often impacts more than just transportation operators. A fire crew racing to an apartment blaze will want to know about a blocking accident so they can take an alternate route. Likewise, long waits at a city ferry terminal may be something the communications office needs to know in real time so they can alert the traveling public.

Connect devices with citywide, multi-service communications. It's not enough to embed smart devices throughout a transportation network. The data the devices gather needs to be channeled through a citywide communications system so it can be analyzed and acted upon.

Interoperability

Cities can rarely afford an out-with-the-old, in-with-the-new overhaul of their transportation systems, much as they might want to. The targets in this section highlight some of the ways cites can make sure they're making decisions today that will bode well into the future.

Adhere to open standards. Insisting on open standards will increase choice and decrease costs, as products can be mixed and matched from different vendors. Cities may also want to work with standards organizations to ensure their particular needs are addressed.

Use open integration architectures and loosely coupled interfaces. Cities that adopt open integration architectures make it much easier and simpler to share data between applications.

Prioritize the use of legacy investments. As you well know, transportation systems can be a huge investment and most cities can ill-afford to scrap equipment that still has lifetime value. So as cities add intelligence to their transportation network, it makes sense to use existing equipment and systems whenever possible to avoid unnecessary spending and stranding assets.

Enable multi-channel access to an integrated customer transportation account. One goal of a smart transportation system is to encourage people to use it – so making it incredibly convenient will be a big factor. A couple ways smart cities can do that is to enable people to 1) pay for all city transportation services with a single account and 2) enable access to this account through multiple channels – integrated fare cards, cell phones, websites, on-vehicle transponders, etc.

A single account covering multiple modes of transportation and offering multiple channels of access lowers barriers to mass use. Increased usage boosts efficiency and revenue and decreases road congestion. Although it is unlikely a city can integrate all modes of transport at once, it's a goal worth working toward.

Empower people with choice and control:

TFL LEADS THE WAY AS CONTACTLESS PAYMENTS PROVE POPULAR ON LONDON TRANSPORT

In the fall of 2014, Transport for London (TfL) introduced contactless payments on Tube, tram, DLR, London Overground and National Rail services that accept Oyster.

What that means is contactless debit, credit or pre-paid cards from Council member MasterCard can be used to make quick, easy and secure payments for everyday transit purchases of £20 and under. There is no need for a PIN or a signature; customers simply have to touch their card on the reader.

TfL projects a savings of 25% in operating expenses. By introducing a MasterCard open loop solution, TfL projects a reduction from £0.14 for every £1 of revenue to run its proprietary Oyster card system—£420 million (US$148 million) a year to under £0.10 per £1 in revenue, resulting in a —£120–130 million a year savings.

"Accepting contactless payments on transport in London is a fantastic achievement for our city," said Shashi Verma, TfL's Director of Customer Experience. "It provides our customers with the most convenient way to pay for their travel and highlights the capital's position as a world leader in transport ticketing."

In March 2015, the BBC reported that "one million contactless taps are made each day on London's transport network which TfL claims makes it the fastest growing contactless merchant in Europe after just six months."

> ***Empower people with choice and control.*** *A leading destination for travelers, London's contactless payments give visitors using the TfL network the ease, speed and security to maneuver around the city.*
>
> *Figure 8.8*

Adhere to open standards:

OFF-THE-SHELF SOLUTION HELPS MANAGE CHINA'S HIGH-SPEED RAIL LINE

To complete the 120-kilometer Beijing-to-Tianjin line in time for the 2008 Olympic Games, the China Ministry of Railways selected solutions from Council member Schneider Electric to help run its passenger information system. The Wonderware® System Platform is off-the-shelf, standardized and scalable software, which contrasted with previous systems China used that were based on proprietary solutions that were expensive, hard to configure and difficult to maintain.

With the first leg complete, the Ministry is now deploying the high-speed line throughout China. When completed in 2020, it will carry both passengers and goods and be able to reach distances of 4,000 kilometers (2,500 miles) in a day.

But it is a massive and complex undertaking involving 12,000 kilometers of rail line, 800 stations and the collaboration of more than 60 different third-party vendors for each station's facilities management system. Interoperability was obviously an issue, but because the Schneider Electric platform is based on open standards, every vendor can communicate seamlessly with each other and new features can be plugged in and expanded to new stations in a very short time.

More than 220 stations across 15 high-speed rail lines are controlled by Schneider Electric today. Once complete, more than 800 stations will be running the solutions throughout the rail network.

> ***Adhere to open standards.***
> *China's railway operators have a single, scalable platform for supervisory functions required to manage overall passenger facility operations in hundreds of stations around the country.*
>
> *Figure 8.9*

Security and privacy

The security and privacy concerns that apply to other city infrastructures are equally important in the realm of public transportation.

Publish privacy rules. As we mentioned in the last section, transit authorities are moving to single account payment systems, which will generate data that can track where an individual has been and when. Some transit systems also use video surveillance for security purposes. Those are just two reasons why publishing privacy rules will help cities get in front of a potential consumer backlash.

Create a security framework. One of the realities of life today is that a driver never knows who's hopping on a bus or what's in the backpack he's carrying. And what about the package left behind on a subway seat? A security framework mitigates risk by taking a proactive approach and using ICT technologies to identify and address threats before they can cause damage.

Implement cybersecurity. Smart transportation systems collect all manner of data that could make them vulnerable to cyber attack – from smart card payment information to ridership details. Having strong cybersecurity measures in place will help ward off trouble.

Data management

With smart sensors, smart payment systems, GPS and all the other intelligent devices that are gathering data as part of a smart transportation system, the city and its residents are all better off when there's a plan for managing it.

Create and adhere to a citywide data management, transparency and sharing policy. Citywide data management plans make it easier to enforce the privacy and security best practices discussed in the last section. But they also can help improve data accuracy and lower costs by eliminating unnecessary duplication.

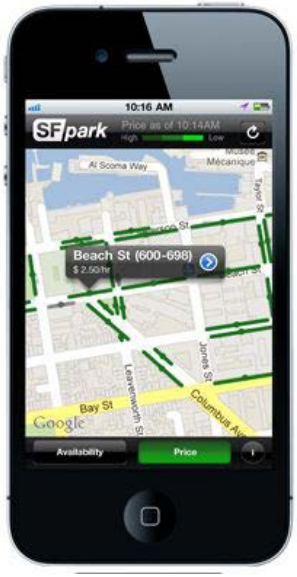
Computing resources

Transportation systems involve a lot of data, a lot of logistics, and a lot of detail that ICT can help cities get under control. The targets below illustrate some of the ways they can do that.

Consider a cloud computing framework. A cloud computing framework enables scalability of systems, reduces costs and improves reliability.

Use an open innovation platform. A lot of cities are seeing amazing results with open innovation platforms that empower developers to create apps that city residents can use. Smart parking apps, for instance, are very popular. Apps that people can use to synch up with bus and train schedules are too.

> ***Use an open innovation platform.***
> *Many cities are having great success with open innovation platforms that encourage developers to create apps. Parking apps like SFpark pictured here are very popular.*
>
> *Figure 8.10*



Have access to a central GIS. City decision-making capabilities are greatly improved with a central GIS. A transit system, for instance, can see efficiency gains through more intelligent scheduling and routing.

Have access to comprehensive network and device management. To manage the large, scattered deployments of smart devices across the transportation infrastructure, smart cities rely on comprehensive device management programs that improve security and resiliency, deliver cost savings and enforce compliance with city data management, security and privacy policies.

Implement optimal devices:

PIONEERING GREEN FLEET MANAGEMENT ON THE UCSD CAMPUS

The University of California at San Diego (UCSD) has a long history of self-reliance when it comes to energy.

The campus has emerged as a pioneer in green fleet management, winning awards for its electric vehicle (EV) program and for its sustainability practices in vehicle service and repair. More than 50% of its fleet consists of hybrid and alternative-fuel vehicles and shuttle buses use cleaner-burning, ultra-low-sulfur diesel fuel.

One part of the campus fleet vision is using Council member OSIsoft's PI System to enable a smart-charging infrastructure in its microgrid.

With the expanding pool of solar on parking structures around campus, zero tailpipe-emission cars are an increasingly interesting possibility. The PI System will also help UCSD go beyond simple vehicle charging. As the fleet grows, the issues around managing vehicle charging will also grow.

As with UCSD's smart solar array, the PI System will integrate with solar data, vehicle battery status information, grid-energy pricing data,and more to support modeling, charging and pricing systems.

> ***Implement optimal devices.***
> *As the UCSD fleet grows, the issues around managing electric vehicle charging will also benefit from the PI System's ability to integrate data.*

Figure 8.11

Consider a cloud computing framework:

MAKING TRAFFIC DATA USABLE VIA CLOUD TECHNOLOGY

As one of the biggest megatrends of the 21st century, urbanization affects both recent and established industrial countries. In the European Union, already more than 70% of the population live in an urban area.

In Germany, the uninterrupted urban growth is likely to pose huge challenges for many municipalities in the future, in areas like traffic, energy, environment and health. In Darmstadt, a city of approximately 150,000 in the German state of Hesse, Council member Urban Integrated [ui!] has tested its UrbanPulse platform, a cloud-based application that brings together the various data sources that cities often already collect, for example traffic light sensor data.

Previously such measurement data has been treated in isolation, but linking the data on the UrbanPulse platform achieves synergies. For instance, street lighting can be reduced at night when sensors register less or little traffic on a particular road. If the traffic volume increases, lighting can be automatically increased again. This way, energy can be saved without jeopardizing traffic safety.

The integration of the isolated measurement data of a city in real time enables municipal authorities to provide novel applications and services for citizens and businesses. UrbanPulse was built on Council member Microsoft's Azure cloud platform with the support of Microsoft Enterprise Services.

> ***Consider a cloud computing framework.*** *By bundling onto one platform, data is made usable for any applications based upon them. That enables value-added services for the administration of a city or to provide services for citizens.*

Figure 8.12

Analytics

No surprise that analytics can have a major impact in a transportation network. This section includes some new targets that reveal how.

Achieve full situational awareness. Using the smart devices deployed across various transportation modes, smart cities use analytics to provide their transportation managers with a complete operating picture. This increases the reliability and resiliency of the infrastructure, and allows for the quickest possible incident response time. Full situational awareness also enables dynamic, multi-modal disaster and recovery plans.

Achieve multi-modal operational optimization for transportation. When it comes to optimizing transportation operations, the goal is to make sure the optimization takes place across all modes, in or near real time depending on circumstances. Cities that optimize transport modes individually limit the returns on their technology investments, since a change or incident in one mode will likely impact another. An example is a problem that shuts down a subway line, sending a big influx of riders to the closest bus.

There are many ways that multi-modal optimization improves transit operations, including:

- **Improved mobility**. Travel is as fast, efficient and safe as possible. Traffic lights are optimized to eliminate structural traffic problems. Or to find the best compromise to allow streetcars to pass with minimum delays for auto traffic. Likewise, data analysis might suggest a new bus route along a particularly crowded transit corridor. Or a smartphone app could alert drivers to the best route, sending them around congestion and accidents. Improved mobility is important to residents, of course, but is also critical for businesses that move people or goods around a city.

- **Cost savings.** In addition to the cost benefits of reduced congestion, multi-modal transport optimization brings cost benefits to cities through more efficient energy usage and improved customer experience. (As noted earlier, the better the experience the more willing people are to use public transportation.) In some scenarios system optimization can reduce costs through shared infrastructure – especially ICT resources – and by getting more out of existing infrastructure. It can also defer or delay the need for new roadways or additional buses by optimizing the use of what the city has in place already.

> ***Achieve multi-modal operational optimization for transportation.***
> *Having more transportation choices available improves the customer experience, which leads to more people using public transportation.*
>
> *Figure 8.13*

Achieve full situational awareness:

ARKANSAS AIRPORT ENHANCES SERVICE RELIABILITY WITH AUTOMATIC RESTORATION SYSTEM

In 1998, Carroll Electric Cooperative Corporation in Bentonville, Ark., installed one of the world's first IntelliTeam® Automatic Restoration Systems at the then-new Northwest Arkansas Regional Airport. The system from Council member S&C Electric Company can provide power to up to three of the Remote Supervisory Pad-Mounted Gear units that feed the airport's electrical loads. Each of the controls is furnished with a UtiliNet® WanGate Radio.

The radios provide inter-team communication but do not report team status to the airport's SCADA system, as is now typically the case for IntelliTeam Automatic Restoration Systems. Team status is instead reported to a pager gateway. Support for the pager system is no longer available, however. It was thus time to update the airport's IntelliTeam system and its communication capability.

Carroll Electric contracted with S&C to update the gear with new 6800 Series Automatic Switch Controls featuring the IntelliTeam® SG Automatic Restoration System, and SpeedNet Radios.

Since IntelliTeam SG can handle as many teams of switches as line loading will allow, each of the Scada-Mate switches can now provide power for all six of the airport's Remote Supervisory Pad-Mounted Gear units, providing enhanced service reliability. And team status serving the airport is now available to cooperatives monitoring the system.

In addition, Carroll Electric can now make any necessary configuration changes to the airport's IntelliTeam SG System remotely from its operations center.

> ***Achieve full situational awareness.***
> *To enhance service reliability at the Northwest Arkansas Regional Airport, Carroll Electric upgraded to third-generation of the IntelliTeam SG power restoration system.*
>
> *Figure 8.14*

Pursue predictive analytics:

CONNECTED BOULEVARD: THE WORLD'S SMARTEST STREET

Council member Cisco has teamed with the city of Nice, France, to pilot a next-generation smart street they are calling "Connected Boulevard."

Boulevard Victor Hugo, located in the center of Nice, is host of the proof-of-concept zone and almost 200 different sensors and detecting devices. In addition to these, it also plays host to "guest" devices such as mobile phones and tablets used in the streets that get connected onto its wireless mesh network.

Data captured through these "things" is being processed and analyzed to offer the city and its residents invaluable context-aware information on parking, traffic, street lighting, waste disposal, as well as environmental quality as experienced in real time. Early projections from pilot tests of smart parking services have shown a potential for up to 30% decrease in traffic congestion, significant air pollution reductions, combined with an increase in parking revenues.

Further benefits are also being realized from estimates in synchronizing street lighting on a need-basis. For example, by calibrating street light intensity with pedestrian and traffic peaks and real-time environmental conditions such as fog and rain, the city could potentially save 20 to 80% in electricity bills. On the environmental aspect, more accurate data of humidity and temperature levels, in addition to air particles are being processed for understanding context-critical patterns.

> ***Pursue predictive analytics.***
> *Boulevard Victor Hugo in Nice, France is host to a Connected Boulevard proof-of-concept zone that includes almost 200 different sensors and detecting devices.*
>
> *Figure 8.15*

This is possible because Connected Boulevard is made up of more than just sensors and devices. The Connected Boulevard equips the city with the capacity to capture data from daily life through the hybrid network infrastructure of the city that includes Cisco WiFi network. The data is processed into real-time information and converted into intelligence with the help of context-aware location analytics, before being disseminated to serve multiple services in city operations and for city dwellers. It is an Internet-centric "always-on" platform designed to be resilient, extensible, highly secure and agile, through four interoperable layers:

Layer 1: Sensors and networked devices with mesh technologies

Layer 2: Data capture, processing, storage and analytics at distributed points across the city

Layer 3: Central data collection, including computing, storage and analytics, combined with integrated and open standard application programming interfaces

Layer 4: New and innovative applications and services

As Nice Mayor Christian Estrosi said, "For Nice to continue welcoming millions more visitors and companies while ensuring a high quality of life, using Internet intelligence is key. Many more things are going to get connected between people, with and between objects, creating valuable interactions and processes including that of public administration. Our ability as a city to harness this data is crucial to understanding what's going on in real time and to enhance a multitude of services for city-dwellers."

- **Flexibility.** Multi-modal transport optimization can be a tool that smart cities use to accomplish specific transportation goals. If pollution is a major problem, then a city can effectively optimize its transport system to promote bus use over private car use, and subway use over bus use. Or if a city suffers from rush-hour bus congestion, it can optimize its transport system to increase subway use during that time.

Achieve asset optimization. The goal is to ensure a city can extract maximum value from its transportation infrastructure and instrumentation investments. This includes calculating precisely which transportation assets should be replaced or repaired and when, to achieve maximum return on investment.

Pursue predictive analytics. The importance of using analytics to predict when elements of a transportation infrastructure are close to failure can't be overstated. Consider the value of predictive maintenance, for example, in relation to the integrity of critical infrastructure such as bridges and highways. Not only can predictive maintenance save money, it can also save lives.

Enable dynamic, demand-based pricing. Smart cities have systems in place to use dynamic, demand-based pricing as a tool to influence customer behavior. As cities better understand people's transportation behavior through instrumentation and analytics, they can influence that behavior by changing prices throughout the day to accomplish their transportation goals.

For example, a city with crippling morning smog can analyze vehicle use at that time and tailor parking prices for vehicles based on distance traveled. Or a city with high road congestion can toll the road with variable pricing and/or alter its bus and subway pricing in targeted areas to reduce traffic. Cities have different transportation circumstances and priorities, and different political operating environments, so the use of dynamic pricing to influence behavior is likely to differ from city to city.

Provide flexible transportation options:

FRENCH CITIES CUT DRIVERS' COSTS BY 90% WITH INTELLIGENT CAR-SHARING

Syndicat Mixte Autolib is an electric car-sharing program established by the city of Paris and 46 surrounding municipalities to relieve traffic congestion, reduce noise and air pollution and provide people with more flexible transit options.

Implemented by logistics company IER, the intelligent system based on Council member Microsoft's Windows Embedded provides connectivity between the in-car system, registration and rental kiosks, charging stations and a central management system.

Available around the clock, the solution has reduced carbon dioxide emissions by 1.5 metric tons annually and replaced 25,000 privately owned gas vehicles. By using Autolib, former car owners have cut their transportation costs by approximately 90% annually. Autolib subscribers also enjoy an enhanced driving experience with GPS navigation, free parking and personalized settings.

The flexible solution also simplifies implementation and minimizes deployment risk, which makes it easier for Autolib to implement new features and services.

> ***Provide flexible transportation options.*** *Microsoft Windows Embedded provides connectivity between the Autolib in-car system, registration and rental kiosks, charging stations and a central management system.*
>
> *Figure 8.16*

ISO 37120: A yardstick for measuring city performance

In 2014, the International Organization for Standards announced an ISO standard that applies strictly to city performance. The document -- known as ISO 37120:2014 -- establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, urban planning, wastewater, water, sanitation and more.

In the table at right we have indicated how the standard related to Transportion correspond to the Council's Transportation targets identified on the next page. The ISO 37120 transportation indicator has cities reporting on the extent of their mass transit and non-car infrastructure, overall transportation safety and direct flight inter-connectedness.

Transportation Indicators

			Implement optimal instrumentation for all modes	Citywide, multi-service communications	Multi-channel access to integrated accounts	Integrate all transport modes for optimization	Enable dynamic, demand-based pricing	Achieve full situational analysis	Achieve operational optimization	Pursue predictive analysis
Core	18.1	Kilometers of high capacity public transport system per 100,000 population	■	■		■	■			
	18.2	Kilometers of light passenger public transport system per 100,000 population	■	■		■	■			
	18.3	Annual number of public transport trips per capita	■	■	■	■	■			
	18.4	Number of personal automobiles per capita	■	■	■	■	■	■	■	■
Supporting	18.5	Percentage of commuters using a travel mode to work other than a personal vehicle	■	■	■	■	■			
	18.6	Number of two-wheel motorized vehicles per capita				■				
	18.7	Kilometers of bicycle paths and lanes per 100,000 population				■				
	18.8	Transportation fatalities per 100,000 population	■	■		■		■	■	■
	18.9	Commercial air connectivity (number of non-stop commercial air destinations)				■				

Figure 8.17

TRANSPORTATION TARGETS

*In the checklist below, targets specifically pertaining to the transportation responsibility are in **bold,** universal targets are not.*

TECHNOLOGY

Enabler	Transportation Targets How smart cities deploy and use ICT to enhance their transportation networks	Implementation Progress None / Partial / Over 50% / Complete
Instrumentation & Control	Implement optimal instrumentation **Supplement: for all transportation modes**	☐ ☐ ☐ ☐
Connectivity	Connect devices with citywide, multi-service communications	☐ ☐ ☐ ☐
Interoperability	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments **Enable multi-channel access to an integrated customer transportation account**	☐ ☐ ☐ ☐
Security & Privacy	Publish privacy rules Create a security framework Implement cybersecurity	☐ ☐ ☐ ☐
Data Management	Create a citywide data management, transparency and sharing policy	☐ ☐ ☐ ☐
Computing Resources	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management	☐ ☐ ☐ ☐
Analytics	Achieve full situational awareness Achieve operational optimization Pursue predictive analytics **Supplement: integrate all transport modes for multi-modal transportation optimization** Achieve asset optimization **Enable dynamic, demand-based pricing**	☐ ☐ ☐ ☐

Figure 8.18

ADDITIONAL RESOURCES

Target: Achieve full situational awareness

Situational awareness keeps Dublin commuters on the move

Collaboration between the city of Dublin and Council member IBM is helping keep 1.2 million residents moving efficiently through Dublin's extensive network of roads, tramways and bus lanes. Integrating data from a citywide network of sensors with geospatial data means the city's road and traffic department is able to better monitor and manage traffic in real time.

Target: Use an open innovation platform

London Transport manages 2.3 million website hits a day with new data feed

Transport for London (TfL) decided to open its real-time data to partners and organizations so they could develop citizen-centric web applications to help relieve congestion and ease commuting for the traveling public. In just six weeks, TfL, Microsoft and the local developer community created an application programming interface that floats real-time data onto the cloud using Microsoft's cloud services, saving TfL millions of pounds.

Target: Achieve operational optimization

Cisco Connected Train

Council member Cisco is helping rail and transit operators converge their aging and disparate networks into a single IP architecture. This video explains how Cisco Connected Train helps enhance the passenger experience, drive operational efficiency, lowers costs and opens up entirely new business models while delivering new services to passengers.

Implement optimal instrumentation for all transportation modes

Mercedes-Benz F 015 Luxury in Motion Research Vehicle

The Mercedes-Benz F 015 Luxury in Motion research vehicle makes the future tangible with the revolutionary concept of autonomous driving. Watch this video from Council member Mercdes-Benz for a preview of how the self-driving car of the future could evolve into a platform for communication and interaction.

Reducing trip time

Building Dulles

This video takes you behind the scenes of the new world-class Silver Line, phase one of the Dulles Corridor Metrorail near Washington, D.C. The new rail line was built by Dulles Transit Partners led by Council member Bechtel. It opened in July 2014, connecting to the region's existing metro system.

CHAPTER 9

WATER AND WASTEWATER

Few people need to be reminded of water's importance. Along with energy, it is essential for everyday life. Water provides sustenance, supports industry and irrigates fields. But city administrations are struggling to meet rising demand from growing populations while contending with issues such as water quality, flooding, drought and aging infrastructure.

This chapter will give cities tools to apply smart technology for an economical and sustainable water supply. It begins by outlining urban water realities. Next it explains the benefits cities can achieve by increasing the intelligence of their water systems. Finally, it talks about the technology targets cities should aim for to gain those benefits.

We need water for human consumption, of course. And to produce food. But not everyone realizes we need large volumes of water to produce energy. Thermoelectric power plants boil water to create steam to drive electricity-producing turbines. In 2005, U.S. power plants withdrew four times as much water as all U.S. residences, accounting for 41% of total water use.

The so-called "energy-water nexus" works in both directions. It takes a lot of water to create electricity. It takes a lot of electricity to pump and treat water. Worldwide, we use an average of 7% of total electricity to pump and treat water and wastewater, but the percentage can be much higher.

But perhaps this next statistic explains the challenge best of all. According to the United Nations, about two-thirds of the world's population – 4.6 billion people – will face water -stressed conditions in the next decade.

> ***The energy-water nexus.*** *In the U.S. in 2005, power plants withdrew four times as much water as all U.S. residences, accounting for 41% of total water use.*

Figure 9.1

Figure 9.2

RISKS TO URBAN WATER SUPPLIES

Think you don't really need to worry about water in your area? Think again. Here is a partial list of the issues confronting urban water supplies.

Sea levels on the rise. For coastal cities, water quality will be further eroded by rising sea levels, which can increase salt concentrations in groundwater and estuarine rivers.

Flooding on the rise. Increased flooding will affect hundreds of millions of people who live close to coastlines, flood plains and deltas. Even inland cities face the problem of flooding as a result of more intense rainfall or snowmelt.

Storms on the rise. Hurricanes, tornadoes and other extreme weather events will become more frequent and rainfall more intense in many areas.

Droughts on the rise. Meanwhile, some regions will receive ***less*** rainfall than usual, leading to droughts more severe than in the past.

Fresh water on the decline. Higher temperatures reduce the amount of water stored in mountain snowfields. They also dry out the soil, which then soaks up more water, reducing the recharge of underground aquifers. The result could be reductions in available water for drinking, household use and industry.

Water quality on the decline. Water quality will become a concern for some cities. Changes in rainfall patterns may change the watershed, affecting quality. Contamination of water wells due to industrial and agricultural pollutants will also have an adverse effect.

Aging infrastructure. Water and wastewater infrastructure in cities around the world is aging and must be replaced to protect its efficiency and the quality of its product.

Competition from agriculture. According to the World Economic Forum, to meet demand from growing populations we will need to grow and process 70% more food by 2050. Yet as early as 2030 we will be confronting a water shortage of approximately 40% due to a toxic combination of rising demand and climate-change-driven shifts.

Competition from recreation. In some parts of the world, boaters, skiers, fishermen, campers and other outdoor enthusiasts have mounted strong protests when cities attempt to get more water from popular lakes and rivers.

Smart water systems. *Every city must use smart technology to preserve and enhance its water supply while keeping the cost of water as low as possible.*

Figure 9.3

Why make water systems smart?

Smart cities use information and communications technology (ICT) to achieve a sustainable, efficient and clean water supply. Most people refer to an ICT-enabled water system as a "smart water system" or a "smart water network." Smart water is driven by four urgent realities:

1. **Water is scarce.** Cities around the world suffer from water shortages. In addition, population growth and extreme weather patterns that create droughts and floods are expected to increase in the coming decades, making water an even more precious resource.

2. **Water is at risk.** Drought, flooding, salinization and other factors can wreak havoc on a water supply. (See list on previous page.)

3. **Water is underpriced.** Water today is often priced far below the level that would accurately reflect its scarcity. This price/value imbalance will rectify as water scarcity becomes more apparent. As a result, the price of water will rise significantly in the future.

4. **Water infrastructure is expensive.** Lack of real-time information about the water network status will lead to costly system break ups and sub-optimal maintenance.

Already we see regions where water periodically becomes scarce. We see regions where water is prohibitively expensive. For these reasons and many other reasons, every city must use smart technology to preserve and enhance its water supply while keeping the cost of water as low as possible. ICT can contribute in at least seven ways:

1. **Map and monitor the physical infrastructure.** Most water utilities do not know with great precision where their pipes and valves are located. In particular, they don't know the actual condition of that infrastructure. ICT gives a highly accurate picture of location and "health."

   "Possessing a clear and comprehensive picture of the entire infrastructure can save a water company tens or hundreds of thousands in repairs each year," explains the Smart Water Network Forum, an industry forum that acts as an advisor to the Smart Cities Council. "Survey-quality GPS, sometimes combined with electromagnetic or ground-penetrating radar, can map pipe

infrastructure, creating three-dimensional maps that show exactly where the pipe is, correcting the widespread errors in existing maps, and ensuring that repair crews will find the pipe when they dig." : Acoustic technology can continuously monitor pipes conditions and pinpoint leaks location.

2. **Accurately measure what is consumed.** Smart water meters can give customers highly accurate records of their consumption while also helping utilities spot "non-revenue water" (NRW) that is being lost to defective equipment, leaks and theft.

3. **Monitor drinking water quality.** A smart water system can have sensors placed strategically throughout the network to detect contaminants. Those sensors can monitor the acidity and alkalinity, watch for biological indicators, measure chlorine and other chemicals and watch for heavy metals, then alert human operators when problems arise so they can intervene quickly to mitigate threats.

4. **Present, perfect and predict conditions.** Using data from the first two examples above, a smart water system can ***present*** current conditions to give operators full situational awareness; ***perfect*** the system by optimizing it; and ***predict*** leaks, floods and equipment failures. "Utilities can achieve better operations through better knowledge and tighter control of the network's extensive and complex assets," explains the Smart Water Network Forum. Modern "dashboards" and tools can "improve the efficiency, longevity and reliability of the underlying physical water network by better measuring, collecting, analyzing and acting upon a wide range of events."

5. **Make better use of diffuse and distributed non-traditional water resources** through recapture, recycling and reuse and through better planning. Water is so much broader than pipes and treatment plants. Rain falls everywhere – on our rooftops. Into our soil, gardens and grass. On our roads. This water can all be captured and put to use with the help of ICT. Instrumentation diffused into these "green water systems" can store water, while advanced analytics are critical to managing this distributed resource. You can have the insight to understand where your green water systems are, how they are performing and how the water they capture can be best deployed.

6. **Better prepare for storms.** Some parts of the world – North America for instance – must confront challenging water quality and storm water regulations. And many parts of the world are faced with flooding that is reaching new extremes. Smart water systems not only monitor flooding, they can predict events in time to prepare for flood control and disaster management.

> ***Present, perfect and predict.***
> *A smart water system can not only monitor flooding, it can predict it in time to prepare.*
>
> *Figure 9.4*

7. **Harness the energy and nutrient resources in water and wastewater.** ICT helps us capture the full potential of water. Beyond its own value as a scare resource, water systems house nutrients and even energy. Technology enables us to reduce and recapture excess kinetic energy in water supply piping utilizing it to power sensors, recover energy and nutrients in wastewater, and avoid the damaging dumping of nutrients into carefully balanced ecosystems.

THE NETHERLANDS IS TAKING BETTER CARE OF STORM AND FLOOD WATER

The Netherlands is working with Council member IBM to transform flood control and the entire Dutch water system. The need is high. Of the total Dutch population, 66% live in flood-prone areas. More than 4,000 square miles (26% of the country) is below sea level.

The financial stakes are high as well. The ongoing cost to manage water, including anticipating flooding, droughts and low water levels is up to €7 billion each year and expected to increase €1- 2 billion by 2020. The project with IBM is expected to reduce costs by up to 15%.

The Rijkswaterstaat (the Dutch Ministry for Water), the local Water Authority Delfland, Deltares Science Institute and the University of Delft are working with IBM on the "Digital Delta" program. They will investigate how to integrate and analyze water data from a wide range of data sources, including precipitation measurements, water level and water quality monitors, levee sensors, radar data, model predictions as well as current and historic maintenance data from sluices, pumping stations, locks and dams. The initiative will provide water experts with a real-time intelligent dashboard. That dashboard will combine, process and visualize data from multiple organizations – data that today is kept in separate "silos."

The new management system will address concerns ranging from the quality of drinking water, to the increasing frequency and impact of extreme weather-related events, to the risk of floods and droughts. By modeling weather events, the Netherlands will be able to determine the best course of action.

Digital Delta is a cloud-based system. "As flooding is an increasing problem in many regions of the world, we hope that the Digital Delta project can serve as a replicable solution for better water management anywhere in the world," said Jan Hendrik Dronkers, director general of the Dutch water ministry.

> ***Take better care of runoff, storm, flood and wastewater.*** *This Dutch storm surge barrier is just one piece of Holland's vast flood control system. The country is working with Council member IBM to use ICT to transform flood control management.*
>
> *Figure 9.5*

Water realities

Before we look at specific targets for the water responsibility, let's quickly consider four realities that affect when, where and how a city should approach the transformation of its water system.

1. **Smart cities "close the loop" around local watersheds.** A watershed is the land area that drains into a particular river, lake or ocean. "Closing the loop" refers to reducing (or even ending) the import of water from other watersheds while taking full advantage of the water available within the loop. Giving preference to locally available water allows a city to be more confident in the sustainability of its water program.

   ICT helps cities close the loop by maximizing the potential of non-traditional sources. The idea is to supplement traditional water sources such as reservoirs and aquifers by capturing storm water runoff, gray water and purple water and by tapping natural systems like wetlands, rivers and lakes. ICT can oversee and optimize the capture of water from these sources. Closed-loop systems also use different grades of water for different needs. For example, treated wastewater isn't suitable for drinking but may be perfectly suitable to water crops.

2. **Smart water requires collaboration.** Perhaps more than any other city responsibility, water is a regional issue. The water source that city residents use to quench their thirst may be the same that a factory uses for its operations or a farmer to water his crops 100 miles away. Water is tied into vast watersheds that link many population centers. Because of that, a smart water vision requires a collaborative approach between cities and a lengthy list of stakeholders. The list includes other cities in the watershed, regional or national government entities that may have regulatory authority, utilities, the private sector, agricultural organizations, citizen and community groups, etc. In some cases, international collaboration may be necessary.

3. **Smart water requires smart policy.** There are many ways that local, regional and national governments can enhance the prospects for smart water. One instance: policy improvements that clear the way for public-private partnerships to help with the financing. Another is mandates for efficiency, conservation, leak reduction or water quality. Yet another is working with suppliers to craft a careful business case that demonstrates the return on investment.

> ***Smart cities "close the loop" around local watersheds.*** *A watershed is an area of land where all of the water that drains off of it goes into the same place. "Closing the loop" means giving preference to water from the local watershed, which allows a city to be more confident in the sustainability of its water program.*
>
> *Figure 9.6*

Whatever steps a city takes, it should NOT mandate a specific technology. Rather, it should mandate the results it wants, and then work with advisors and suppliers to determine the best way to achieve that result.

4. **Smart water may need creative financing and staffing.** Many city budgets are under great pressure. Even if a city can make a strong business case for rapid payback, it may not have the funds to finance the project. Fortunately, several alternative mechanisms have arisen to lighten that load. For instance, some suppliers will sell software-as-a-service (SaaS) on a monthly fee basis. This eliminates the need for the city to make a big capital purchase and install, maintain and update all the hardware and software on its own. Instead, the supplier handles all that in the cloud, and the city simply pays a monthly charge. In many ways, this is similar to leasing a car instead of buying it.

   Another option is a risk-sharing contract. The city pays a reduced fee to the supplier, and then shares a portion of the saved costs or additional revenue back to the supplier.

   It is worth noting that some developing countries have funding available for infrastructure projects, often thanks to grants and programs from development banks. Utilities in those regions have the chance to leapfrog the developed world by jumping straight to a state-of-the-art smart water system.

   Even cities with adequate funding may lack adequate in-house ICT skills and personnel to run a sophisticated smart water system. Here again, SaaS offers a solution, since the supplier provides the bulk of the needed personnel and spreads the cost by making the service available to many cities at once.

Dependencies for water and wastewater

Planning improvements in water and wastewater infrastructure will need to take into account dependencies on other city systems and services. Looking at just a few of these dependencies, it is easy to see how smart water services are heavily influenced by local government policies and how closely they are aligned with communications and energy systems in a smart city context. Contaminant warning systems rely on communications and energy systems. And pumps that move water throughout a city infrastructure require power. Flood control systems (e.g. pumps or gates) require resilient energy systems to operate.

> ***Smart water requires smart policy.***
> *There are many ways that governments can enhance the prospects for smart water. One instance: policy improvements that clear the way for public-private partnerships to help with the financing.*
>
> *Figure 9.7*

WATER AGENCY BUILDS "BORDERLESS" INFRASTRUCTURE TO IMPROVE COLLABORATION

California Natural Resources Agency manages the state's natural resources, including water. One of its largest departments is the Department of Water Resources (DWR), with about 3,500 employees. DWR supplies and manages the water delivery systems, provides flood protection through improvement of levees, inspects 1,200 dams and helps coordinate the state's integrated water management.

To accomplish those tasks, department personnel need to access and manipulate large data sets to model the effects of the environment on the water system. "Many of our missions require close collaboration with other federal, state, and local government organizations, subject matter experts, and the people of California," says CEO Tim Garza.

But DWR had limited ability to share data outside the department, which made it difficult to make timely decisions.

The agency wanted a new data center infrastructure that could adapt easily to support changing business needs. The immediate need was for borderless collaboration with all stakeholders, including local, state and federal government and private sector entities.

The solution the agency chose was a borderless infrastructure based on Council member Cisco's Data Center Business Advantage solutions and Cisco's planning, design and implementation services.

Results enabled secure collaboration by creating 20 distinct security zones, reduced total cost of ownership for the network by 30% and accelerated network performance by 40%.

> ***Smart water requires smart collaboration.*** *California Department of Water Resources required a secure way to share data with other water management agencies. New "borderless infrastructure" from Cisco created 20 distinct security zones, making it easy for multiple departments to collaborate safely.*
>
> *Figure 9.8*

Benefits of a smart water system

In this section we highlight benefits that smart water systems can deliver and their impact on livability, workability and sustainability..

Livability

Promoting water quality and reliability. Smart cities use ICT to protect the safety and reliability of their water supply. Remote sensors can detect impurities, protecting water supply from the intentional or unintentional introduction of contaminants. The affected areas can often be isolated automatically, preventing the spread. Meanwhile, the system alerts human operators so they can deploy repair crews to fix the problem.

Increasing resilience. Smart security measures help protect water infrastructure from external cyber threats. Video cameras and access cards can provide physical security. Automated fault management can ensure problems are found and dealt with before they affect a wide area. In a disaster scenario, analytics can immediately tell cities what equipment needs replacing, and can prioritize tasks for maintenance crews so water delivery is restored as quickly as possible.

Increasing customer choice and control. ICT can empower customers with information about when and where they are using water, plus tools to help them control that use. This allows them to change behavior and make trade-offs to lower their bills.

Reducing damaging floods and overflows. Full situational awareness informed by weather data helps cities see exactly where floods and overflows are occurring. Some systems can even predict floods in advance, so emergency crews can be dispatched in advance. Technology also allows cities to more effectively plan flood prevention efforts.

Saving energy on building cooling. Green roofs and other green water systems not only capture water for use before it enters a crowded sewer, they also serve to cool the buildings and streets and other infrastructure in which they are housed. This can save energy on building cooling while simultaneously reducing the dangerous urban heat island effect.

Workability

Increasing economic development. Smart water can differentiate a city in the competition for business and investment. Smart water is financially attractive to industrial consumers in particular, since they are often the largest users of a city water supply. Water-intensive businesses often decide whether to expand and where to relocate by looking first at a region's water availability.

Lowering operational costs. ICT solutions can dramatically reduce costs for both water providers and customers. Cities can optimize their water infrastructure for efficiency, saving the cost of wasted resources and optimize maintenance. Advanced analytics, using data from smart water meters in homes and businesses can identify ways customers can reduce consumption and save on water bills.

Sustainability

Eliminating wasteful leaks. Smart water meters and sensors reduce water loss. Through situational awareness and automated fault management, water utilities can immediately identify and repair leaks and problems. Most cities that install smart water networks discover they have been losing ***at least*** 10% to leaks and percentages as high as 50% are not unusual.

Getting the maximum value from existing infrastructure. Building entirely new water systems is not an option for most cities. With ICT, cities can make their existing systems far more productive.

Harnessing the kinetic energy of water. Achieving an energy efficient water system to power and use ICT.

Lowering operational costs:

BETHPAGE WATER GAINS MULTIPLE BENEFITS FROM ANALYTICS UPGRADE

When Bethpage Water District (BWD) on New York's Long Island began its quest to improve its water metering system, its primary motivations for upgrading from its touch-read system (circa 1988) to Badger Meter Advanced Metering Analytics (AMA) were to improve efficiency and customer service with more advanced technology and gain more visibility into its operations via Council member Badger Meter's ReadCenter Analytics software.

"The driving force behind our upgrade was to better serve our customers," says Michael Boufis, superintendent, BWD. "We wanted to be able to detect potential leaks quicker, so we can alert customers faster. We also wanted to be able to respond to customer billing questions with more detailed consumption information to avoid disputes." Boufis adds that the new system is providing proactive management tools and economic benefits through more accurate meter data and meter reading efficiency.

Before installing the new system, it took two meter readers 10 working days to read the district's meters. When just 1,500 of the planned 9,300 new meters were installed, the reading time was already shorter, enabling staff to focus on other projects.

Overall, Boufis estimates that with the labor efficiencies and added revenue from more accurate metering, the system will pay for itself within five years.

> ***Lowering operational costs:***
>
> *With labor efficiencies and added revenue from more accurate metering, the Badger systems is expected to pay for itself within five years.*
>
> *Figure 9.9*

Enhancing sustainability:

THE GREENING OF AN INDUSTRIAL CITY IN THE SAUDI DESERT

The Royal Commission for Jubail is a special-purpose government agency empowered to develop and operate industrial cities. Council member Bechtel has provided engineering and construction management services to the Royal Commission since its inception in the 1970s.

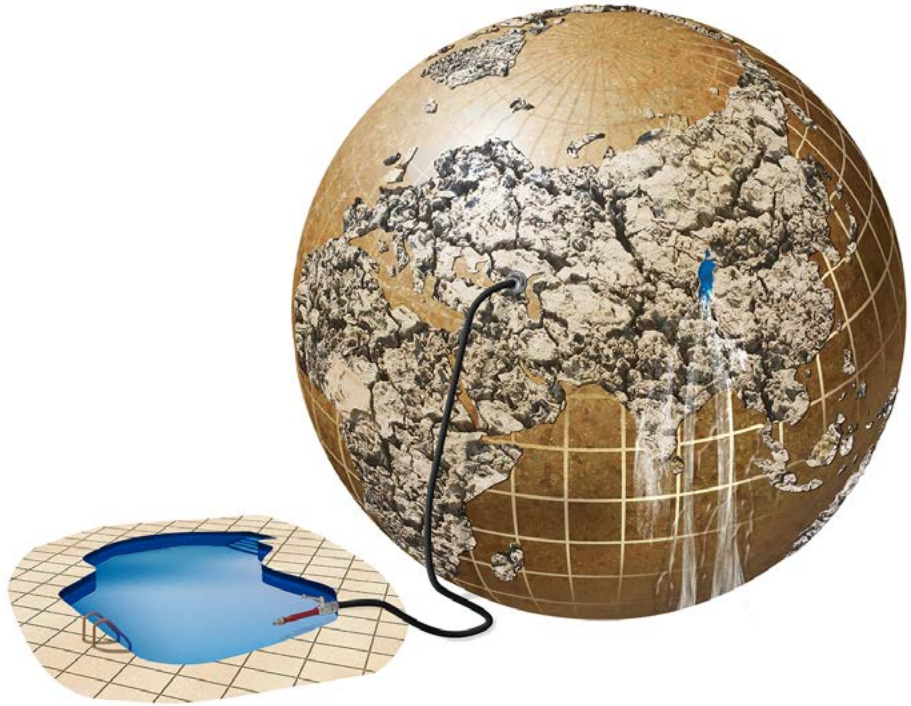
Jubail's mission is to diversify and expand the Saudi economy through major heavy industrial development while simultaneously being a "green" city providing a very high quality of life for the city's inhabitants. Of course, Saudi Arabia is a desert country with limited water resources, making this a difficult objective.

Over the last 30 years, Jubail has grown to become the largest petrochemical industrial complex in the Middle East and now has a resident population of about 150,000 people. Jubail has also become one of the greenest cities in the Kingdom with extensive parks, open spaces and tree plantings. Despite the lack of water, this has been achieved by highly efficient water and wastewater treatment systems using the latest technologies.

The city appears to be an oasis in the desert and provides highly attractive landscapes, parks and waterfront areas for the city's residents. As a result, the city is becoming an ever-more attractive destination for young Saudi families, attracted by the promise of good jobs and a green environment.

> ***Enhancing sustainability.*** *Jubail's mission is to diversify and expand the Saudi economy through major heavy industrial development while simultaneously being a "green" city providing a very high quality of life for the city's inhabitants.*
>
> *Figure 9.10*

THE COMPELLING CASE FOR SMARTER WATER



Non-revenue water (NRW) – water that is produced but lost before it reaches the customer – is a major challenge for water utilities around the world. NRW has a significant financial impact on utilities and their customers. It also represents the loss of a precious resource.

NRW occurs for a variety of reasons:

- Unmetered consumption (where water meters do not exist so usage can't be accurately measured)
- Authorized but unbilled consumption (firefighting, for instance)
- Apparent losses (water theft and metering inaccuracies)
- Real losses (leaks and bursts)

A 2011 study by the Smart Water Networks Forum (SWAN), a Council advisor, compiled NRW losses in urban centers around the world. The findings were staggering. The NRW in Guayaquil, Ecuador topped the list at 73%, but Adana, Turkey wasn't far behind at 69%. NRW ranging from 30% to 50% were not uncommon. Conversely Singapore, which is recognized as a leader and innovator in smart water, reported NRW losses of just 4%.

As Navigant Research analyst Neil Strother states: "Losses from NRW represent $14 billion in missed revenue opportunity each year, according to the World Bank. The economic case for better water metering is compelling."

> ***The compelling case for smarter water.*** *Losses from non-revenue water – which can include everything from water theft to leaks and billing irregularities – represent an estimated $14 billion in missed revenue opportunity each year, according to the World Bank.*
>
> ***Figure 9.11***

Navigant has forecast that the global installed base of smart water meters will reach 29.9 million by 2017, up from just 10.3 million meters in 2011. By the end of the forecast period, Navigant anticipates that 3.3 million smart water meters will be shipped each year, representing an annual market value of $476 million.

And smart water meters are only part of the larger market. In 2011, Lux Research said that the market for technologies to inspect and repair the world's aging water infrastructure was approaching $20 billion worldwide and growing at a healthy 10%. It reported that many municipalities were desperately seeking cost-effective new ways to maintain their pipe networks. Lux claimed that the most successful solutions would be those that can monitor the entire water infrastructure and reveal the sections in most urgent need of repair.

"Outdated water infrastructure and record deficits are both fueling demand for low-cost inspection and repair solutions – namely software and sensor technologies that can provide a snapshot of a utility's entire infrastructure," said Brent Giles, a Lux Research senior analyst. "Without this holistic view, utilities cannot prioritize the most critical repairs – and may end up throwing money down the drain to address the leaks that are visible today rather than the ones that could prove catastrophic tomorrow."

Water targets

Many technologies and best practices can help cities develop a smart water system. Five targets specifically relate to water and wastewater and will be discussed in detail below. We'll also talk about several of the universal targets as they apply to smart water.

Implement optimal instrumentation and control across the watershed. We've added on to this universal target to remind you that most cities will need information that extends beyond their city boundaries. A smart water network uses sensors to capture data on the condition of the water and the equipment. These devices are installed in both traditional and non-traditional segments of the watershed – from the pipes and pumps to green water systems in gardens or rooftops that collect storm runoff or grey water. As noted above (and as illustrated in the case study from the Netherlands), cities will want to collaborate to gather data not just within city limits, but from the larger watershed as well.

Smart water networks also utilize sensors that monitor water quality. This may include tracking different grades of water to ensure they are properly routed for the appropriate end use.

In addition to sensors for the physical infrastructure, some cities will want to consider smart water meters. In regions with conservation mandates, smart meters can give customers the detailed information they need to curb consumption. Smart meters can also reduce the need for additional sensors on pipes, pumps and switches.

Implement optimal instrumentation:

YORKSHIRE WATER IMPROVES SYSTEM RELIABILITY AND SCALABILITY

Water is becoming a critical issue around the world and companies like Yorkshire Water are on the frontlines of managing this precious resource.

Yorkshire Water provides clean water and wastewater treatment services to 4.7 million people and 130,000 businesses in Northern England, delivering its services via 65,600 kilometers of pipelines. The company also manages 650 water storage facilities, 2,250 pumping stations and 86 wastewater treatment facilities.

To ensure its ability to deliver clean, reliable water to households and businesses, Yorkshire Water depends on having access to a large pool of data. When the company's telemetry infrastructure could no longer keep up with its need for data, Yorkshire Water turned to the PI System from Council member OSIsoft for faster, more scalable, data management. In the process, it achieved more than £1 million in annual savings through reduced energy use, improved leak detection and better chemical management.

The PI System helps Yorkshire Water support its planned growth, because it allows the utility to view its assets in an integrated way, supporting continuous improvement of operations as a whole. "As our network grows, we need a lot more detail and instrumentation to support our environmental initiatives, various policy mandates and reporting requirements," said Nick Hook, Telemetry Information Team Manager, Yorkshire Water. "The PI System provides that foundation."

> ***Implement optimal instrumentation.*** *The PI System helps Yorkshire Water support its planned growth, because it allows the utility to view its assets in an integrated way.*
>
> ***Figure 9.12***

Connect devices with citywide, multi-service communications. This universal target applies equally to water. It is worth reminding, however, that most cities should NOT build a communications network just for smart water purposes. Instead, they should seek to piggyback on an existing network. Or share costs with other departments to build a system they all can use. For instance, in Tianjin China, a single communications network carries the signals for smart meters of several different kinds.

Adhere to open standards. Hydrologic data collections and sensor feeds are notoriously non-interoperable. By using open standards such as the new OGC WaterML 2.0 Encoding Standard, diverse data collections can be quickly discovered, assessed, accessed, aggregated, compared, used with other spatial data (weather, geology, elevation etc.), and flowed between computer models.

Create and adhere to a citywide data management, transparency and sharing policy, including water usage data. In the Universal chapter, we discussed the merits of a citywide data management policy. In this chapter, we want to recommend additional rules that apply specifically to water.

Cities may not own their own municipal water utility, but they will want to have access to overall usage data provided by the local utility. It's important to ensure that the data conforms to the citywide data management policy, even if it originated elsewhere. Cities will also want to encourage utilities to grant water customers access to their own consumption data so they can see hour-by-hour how, when and where they use water. Armed with this type of information, they can make choices and tradeoffs that can reduce their water usage and their utility bills.

From a smart city perspective, water usage data is invaluable for long-range planning, for making zoning decisions, for water efficiency programs, for low-income assistance programs – and for setting an example by reducing water consumption in city facilities.

Consider a cloud computing framework. With the cost of cloud services declining, this universal target can make sense for cities large and small. It is particularly germane to the water sector in North America. In that part of the world there are few large water companies. Instead, water is managed by more than 18,000 small- to medium-sized organizations. Few of them have the budget for a large ICT staff and powerful server farms. Yet they can get the same power and benefits as larger organizations by turning to software-as-a-service running in the cloud.

Have access to a central GIS. A central geographic information system (GIS) improves decision-making capabilities citywide, hence its inclusion as a universal target. Two reminders germane to water: 1) In many parts of the world the water system is well over 100 years old and many water utilities don't know exactly where all the pipes and valves are located. 2) A city water department should seek to share costs with other departments if it needs to build a GIS system from scratch. A central GIS enables efficiency gains through more intelligent scheduling and routing, provides improved accuracy of essential records and boosts resiliency of key assets.

Achieve full situational awareness across the watershed, informed by weather data. Situational awareness is a universal target. When it comes to the water responsibility, it means getting a complete view of what's happening across a watershed. Such insight is essential for cities that want to 'close the loop' and promote sustainability by relying on their local watershed rather than importing water from elsewhere. That situational awareness should be further expanded by including local and regional weather data. Weather data can help give an accurate view of current conditions and can help predict future problems.

Achieve operational optimization:

LONG BEACH WATER OPERATORS SEE THE BIG PICTURE IN REAL TIME

The Long Beach, California water department is responsible for keeping the city's 487,000 residents adequately supplied with clean, good-tasting water. It is also responsible for the safe delivery of wastewater to its nearby sewage treatment facilities. It's a complex system consisting of nearly 30,000 different data points.

Operating its remote facilities and treatment plants efficiently requires Long Beach Water to use sophisticated technology to help maintain communications over the entire system in real time.

To enable its control room staff to effectively monitor and manage more than 90 remote telemetry units and its groundwater treatment facility, the water department uses a comprehensive Wonderware® solution from Council member Schneider Electric.

The system is PC-based and uses the Microsoft Windows operating system with Wonderware's InTouch® human machine interface (HMI) software, which provides real-time visualization capabilities to monitor and control different sites.

The department polls the 40 remote sites throughout the water system an average of once every minute to ensure efficient operations. The data is stored in a Wonderware Historian, enabling the water department's main office to have simultaneous access to multiple data inputs from pumps, valves and equipment throughout the city.

Operators have a complete picture of the city's water system processes at any given time, thereby improving overall performance. With this level of visibility, subtle inefficiencies and any water-quality problems can be corrected immediately. And additional data critical to operations, such as where a leak on a pipeline has occurred, can be transferred back to the central site in real time.

> ***Achieve operational optimization.*** *Long Beach Water operators have a complete picture of the city's water system processes at any given time.*
>
> ***Figure 9.13***

Consider a cloud computing framework:

CITY OF SAN DIEGO ADOPTS ONLINE WATER CONSERVATION SYSTEM

San Diego faced a major challenge: It wanted to promote and support water conservation through accurate consumption targeting, tracking and billing, while dealing with the daunting task of working with many local agencies, many different data formats and sources, as well as difficulties getting agency data into a system. There was also the challenge of reaching and educating customers.

Council member Civic Resource Group International developed a web-based system for San Diego as part of a state-funded innovation pilot.

The solution was CivicConnect Water – a comprehensive online water conservation/drought management system- that provides an integrated suite of online tools for San Diego County water agencies to create, track and report water budgets for their customers. Customer reports created by the system are based on a formula that dynamically incorporates such things as customer landscape area measurements, real-time and historic reference crop and effective precipitation data if needed. Water consumption and billing data is transferred on a regular basis from each of the participating agencies..

San Diego has utilized the tool to monitor and manage drought conditions throughout the area. The city has also used it to compare actual usage for hundreds of single family sites to tax assessor parcels to aid in the development of an equitable rate structure for single-family dwellings. Most importantly, the water management system allowed San Diego to strongly encourage and facilitate the conservation of water by making customers aware of their current water usage, historical water usage and recommended/suggested usage.

This project represents a groundbreaking approach to water conservation on a regional basis, and received an Internet Project of the Year award from the California Geographic Information System Association.

> ***Consider a cloud computing framework.***
> *The system includes an online GIS Landscape Area Measurement tool to enable water agencies to expedite measuring the landscape area of each customer site and dynamically calculate the square footage of each designated plant classification type in the area for water budgeting and tracking purposes.*
>
> ***Figure 9.14***

Achieve operational optimization for sustainability, efficiency, cleanliness and safety. Operational optimization is a universal target. We have extended it to emphasize its value in a smart water network. Here are examples.

- **Optimize water capture.** A city might discover it is overdrawing from one source, and underdrawing from another. Correcting the situation creates a more optimized operation and a more sustainable water supply.

- **Optimize water distribution.** Analytics can ensure water goes where it is needed, when it is needed. Demand and supply can be balanced, so that water is distributed, consumed and reported with maximum efficiency. With smart meters providing data on consumption at customer premises, water pricing can move to a variable model to acknowledge that water is more expensive to procure in certain seasons and certain times of the day.

- **Optimize water use.** Smart devices can monitor conditions and assign different water grades. Some grades might be acceptable for your garden, but not for your cooking.

Automate fault and leak management. A smart water network can automate many parts of the leak management process. Leak management systems automate both the prioritization of repair work and the dispatch of crews. They make water systems more resilient to natural disasters and intentional damage.

Pursue predictive analytics. This universal target applies to water in powerful ways. By analyzing the data from a smart water infrastructure and combining it with weather data, cities can predict problems, such as areas prone to flooding. In some cities – including Rio de Janeiro – smart systems can monitor incoming storms and predict where floods will occur later that day, so emergency steps can be taken in advance.

Optimize energy use. Hydro-powered generators can allow real-time sensor operations and significantly cut down on operating expenditures.

Pursue predictive analytics.
By analyzing the data from a smart water infrastructure and combining it with weather data, cities can predict problems, such as areas prone to flooding.

Figure 9.15

Optimize energy use:

HOW GRESHAM USES BIOGAS AND SOLAR ENERGY TO FUEL WASTE-WATER OPERATIONS

Ten years ago, the wastewater treatment plant in Gresham, Oregon was the city's biggest energy-consumer,. But a lot has changed since then.

The plant is now making the same amount of electricity as it consumes in a year, using biosolids from wastewater treatment and fats, oils and grease as well as solar energy to produce power while also reducing energy costs. As a result, the plant now exports excess energy back to the local utility.

The secret to the plant's success is the biogas, which is naturally produced by wastewater in the form of methane. By simultaneously generating energy and heat from that methane – a process known as cogeneration – the Gresham plant can produce its own energy without having to purchase it. In addition to its cogeneration units, the city installed one of the largest land-based solar arrays in the Pacific Northwest, producing approximately 8% of the plant's total power each year.

The city's success in achieving energy-neutral status at its wastewater plant did not occur overnight. It's the direct result of the city's longstanding and ambitious vision. Gresham believed that with the right expertise, its waste-water plant could produce energy instead of being the city's largest energy consumer.

The city looked for a private-sector partner who could help reduce energy usage while ensuring maximum output from the cogeneration program. Veolia North America was chosen based on the company's experience serving more than 500 North American communities, along with access to experts and a company promise to ensure more than 90% "uptime" of the cogeneration unit.

Under the contract with Gresham, Veolia manages all operations and maintenance of the city's secondary acti-vated sludge wastewater treatment plant, a beneficial use biosolids management program, industrial pretreatment program analyses, cogeneration operation, laboratory services and nine lift stations.

> ***Optimize energy use.*** *Gresham Mayor Shane Bemis says what his city did at its wastewater plant is not a secret formula. It is replicable at thousands of treatment plants.*
>
> ***Figure 9.16***

Achieve asset optimization:

SYSTEM HELPS GET METER READERS' FEET OFF THE STREETS OF LAREDO

Established in 1755 as a colonial city of New Spain, Laredo, Texas has a history as colorful as the seven different flags which have flown over it. Today it stands on the north bank of the Rio Grande as the U.S. principal port of entry into Mexico. In keeping with its importance as a center of international trade, Laredo is growing, with a current population of 235,000. Keeping up with the growing number of residents within the city limits and the additional 15,000 in the surrounding county had kept the city of Laredo Utilities Department on its toes. And that was the problem.

The city had been walking to read its 67,543 water meters – 59,138 residential and 8,405 commercial accounts – using a manual method that took up to ten staff on the streets nearly an entire month to read to meet a monthly billing schedule.

With lucrative oil and gas drilling companies attracting away many city workers, Utilities Department Director Tomas Rodriguez was determined to implement an updated, automated meter reading system.

"By automating, we would be getting bills out faster and collecting faster, and, of course, be more accurate too," he said. With the dawn of advanced metering infrastructure (AMI) systems, the city saw a solution.

The city had been using meters from Council member Neptune Technology Group since 2002 and decided that using Neptune's AMI system would shorten the learning curve for employees. Among other benefits, Rodriguez says, "We now have six people doing the work that took 10 people before. Without this system, we would have had to hire extra people to help our billing department."

> ***Achieve asset optimization.***
> *Laredo water customers realize benefits from the new AMI system. Now the department can alert them about a leak before a month goes by and they see it on their bill. It can have a big impact on their pocketbook because leaks happen that they can't see or hear – and don't even know they have.*
>
> ***Figure 9.18***

ISO 37120: A yardstick for measuring city performance

In 2014, the International Organization for Standards announced an ISO standard that applies strictly to city performance. The document -- known as ISO 37120:2014 -- establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, urban planning, wastewater, water, sanitation and more.

In the table at right we have indicated how the standard related to Water and Sanitation and the one on Wasterwater correspond with the Council's Water and Wastewater targets identified on the next page.

The ISO smart city wastewater standard attempts to capture all the risk to the water supply with five core indicators designed to measure the availability of wastewater treatment, the number of people who have access to it and the quality of the treatment.

Water and Sanitation Indicators

		Optimal instrumentation across the watershed	Citywide, multi-service communications	Create water data management policy	Achieve operational optimization	Achieve asset optimization	Automate fault and leak management	Full situational awareness across the watershed	Pursue predictive analysis
Core	21.1 Percentage of city population with potable water supply service	■	■	■					
Core	21.2 Percentage of city population with sustainable access to an improved water source	■	■	■					
Core	21.3 Percentage of population with access to improved sanitation	■	■	■					
Core	21.4 Total domestic water consumption per capita (liters/day)	■	■	■	■	■	■		
Supporting	21.5 Total water consumption per capita (liters/day)	■	■	■	■	■	■		
Supporting	21.6 Average annual hours of water service interruption per household	■	■	■			■	■	■
Supporting	21.7 Percentage of water loss (unaccounted for water)	■	■	■			■	■	■

Wastewater Indicators

Core	20.1 Percentage of city population served by wastewater collection	■	■	■	■	■	■		■
Core	20.2 Percentage of the city's wastewater that has received no treatment	■	■	■	■	■	■		■
Core	20.3 Percentage of the city's wastewater receiving primary treatment	■	■	■	■	■	■		■
Core	20.4 Percentage of the city's wastewater receiving secondary treatment	■	■	■	■	■	■		■
Core	20.5 Percentage of the city's wastewater receiving tertiary treatment	■	■	■	■	■	■		■

Figure 9.19

WATER AND WASTEWATER TARGETS

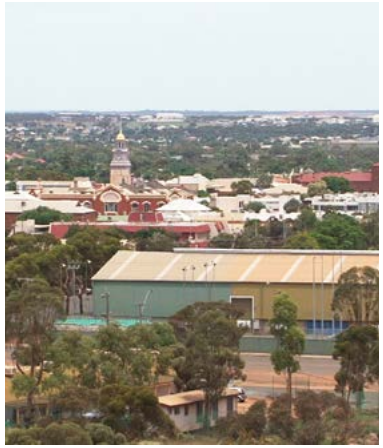
*In the checklist below, targets specifically pertaining to the water and wastewater responsibility are in **bold,** universal targets are not.*

TECHNOLOGY

Enabler	Water and Wastewater Targets: How smart cities deploy and use ICT to enhance their water infrastructures	Implementation Progress: None	Partial	Over 50%	Complete
Instrumentation & Control	Implement optimal instrumentation **(Supplement: across the watershed)**	☐	☐	☐	☐
Connectivity	Connect devices with citywide, multi-service communications	☐	☐	☐	☐
Interoperability	Adhere to open standards	☐	☐	☐	☐
	Use open integration architectures and loosely coupled interfaces	☐	☐	☐	☐
	Prioritize use of legacy investments	☐	☐	☐	☐
Security & Privacy	Publish privacy rules	☐	☐	☐	☐
	Create a security framework	☐	☐	☐	☐
	Implement cybersecurity	☐	☐	☐	☐
Data Management	Create a citywide data management, transparency and sharing policy **(Supplement: including water usage data)**	☐	☐	☐	☐
Computing Resources	Consider a cloud computing framework	☐	☐	☐	☐
	Use an open innovation platform	☐	☐	☐	☐
	Have access to a central GIS	☐	☐	☐	☐
	Have access to comprehensive device management	☐	☐	☐	☐
Analytics	Achieve full situational awareness **(Supplement: across the watershed, and informed by weather data)**	☐	☐	☐	☐
	Achieve operational optimization **(Supplement: for sustainability, efficiency, cleanliness and safety)**	☐	☐	☐	☐
	Achieve asset optimization	☐	☐	☐	☐
	Automate fault and leak management	☐	☐	☐	☐
	Pursue predictive analytics	☐	☐	☐	☐

Figure 9.20

ADDITIONAL RESOURCES



Target: Implement optimal instrumentation across the watershed

Smart water metering solution reduces water usage by 10% in Australian city

Kalgoorlie-Boulder, Australia is an arid area,with low rainfall. Situated east of Perth, it has a population of about 35,000 and no locally available, natural water supply. After installing a smart water metering solution from Council member Itron, the water utility was able to reduce Kalgoorlie's water use by 10%.

Target: Connect devices with citywide, multi-service communications

Using Cellular Technology to Improve Water Management

What if you applied cellular technology -- similar to that used in smartphones -- in water management systems to improve water quantity, quality and cost? Council members Qualcomm and CH2M have teamed up to make it possible, as this video explains.

Target: Consider a cloud computing framework

How the cloud is revolutionizing the future of water utility management

Cloud software services are bringing about rapid and diverse changes to how a water utility operates and how data is used. As new systems often require new technology resources to operate and support, the white paper linked below from Council Associate Partner Badger Meter explains why utilities are finding cloud computing to be a viable alternative to investing in additional hardware.

Target: Achieve operational optimization for sustainability, efficiency, cleanliness and safety

The Murky Future of Global Water Quality

A global study by Council Associate Partner Veolia and the International Food Policy Research Institute found that rapidly deteriorating water quality over the next several decades will increase risks to human health, economic development and thousands of aquatic ecosystems in developed and developing economies alike.

Target: Achieve full situational awareness across the watershed

A layered view of data technologies for the water distribution network

This brief white paper from Council advisor SWAN highlights the entire system of data technologies connected to or serving the water distribution network. For discussion purposes it separates the various components into layers, each of which can be made more intelligent as the water network evolves into a smart water grid.

Target: Achieve asset optimization

Road to R900 RF Technology Leads to More Actual Reads and Proof of Consumption

The utility serving Madison, Tennessee used to read its water meters manually every other month, estimating usage in intervening months. Even so, the process took eight to 10 readers, in four to five cars, more than 20 hours. After switching to RF technology from Council member Neptune Technology Group, it now takes two days, two readers and one truck.

CHAPTER 10

WASTE MANAGEMENT

Surging population growth in cities is not only challenging city leaders to find better ways to deliver transportation, energy, public safety and other municipal services, it's also forcing them to deal with more garbage. The good news is that smart solutions are emerging in the solid waste management arena. Technologies are coming to market that can help cities collect and process waste more efficiently and recover valuable materials from the waste steam.

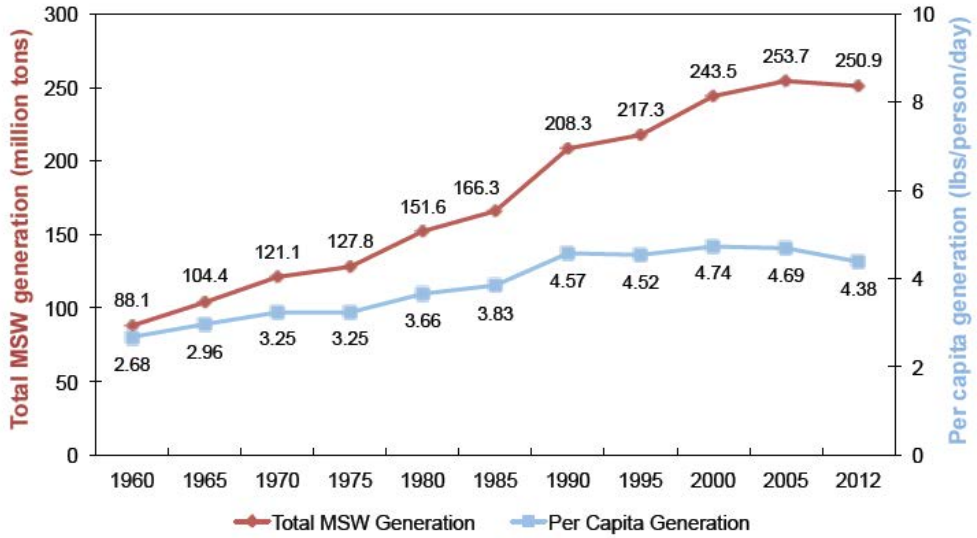
In this chapter we examine how smart technologies are enabling cities to manage municipal solid waste (MSW) in an efficient and sustainable manner. As in other city responsibility areas, information and communications technologies (ICT) are driving many of these new solutions, particularly in the area of garbage collection. But scaled-up applications in the realm of biological and industrial engineering are also involved.

The growth of garbage

Municipal solid waste refers to the garbage that's familiar to most of us. It's your everyday household trash – wrappers, food scraps, junk mail, plastic containers – minus any hazardous, toxic, electronic or medical waste.

In more developed economies, recycling, composting and energy recovery programs are already diverting significant volumes of municipal waste from landfills. Still, the numbers indicate that the overall municipal waste stream continues to grow.

In a landmark report released in 2012, the World Bank estimated that urban residents worldwide generated 1.3 billion tonnes (or metric tons) of municipal waste per year. By 2025, cities are expected to nearly double that amount, producing 2.2 billion tonnes.



Source: EPA

> ***The rising tide of waste.*** *In 2012, Americans generated about 251 million tons of trash and recycled and composted almost 87 million tons of it, equivalent to a 34.5% recycling rate.*
>
> *Figure 10.1*

Moreover, the amount of solid waste being generated is outpacing the rate of urbanization. This phenomenon is, in part, linked to the rapid growth in developing countries, where rising incomes and affluence are accelerating consumption. China, for example, surpassed the United States as the world's largest waste generator almost a decade ago.

Why managing solid waste matters

Cities need to effectively and efficiently deal with solid waste for several reasons. Let's take a quick look at them.

Protecting public health. First and foremost, cities manage waste to mitigate its public health impact. As a breeding ground for bacteria, insects and vermin, accumulated trash has long been linked to the spread of air- and water-borne diseases. The Industrial Revolution and mass movement of workers to

cities spurred the first rigorous efforts to address and improve urban sanitation. These efforts included systematic waste collection with disposal via dedicated incineration plants and landfills.

Protecting the environment. The environmental impacts of traditional waste disposal methods – and their effects on public health – came under closer scrutiny after World War II. In the U.S., federal authorities passed legislation regulating the construction and operation of landfills to prevent, among other things, landfill debris from leaching into and contaminating groundwater.

Today, most landfills are lined and the problem of landfill greenhouse gas (GHG) emissions garners more attention than leaching. Landfill gases are produced by the breakdown of organic materials. They contain carbon dioxide, methane, volatile organic compounds, hazardous air pollutants and odorous compounds that can adversely affect public health and the environment.

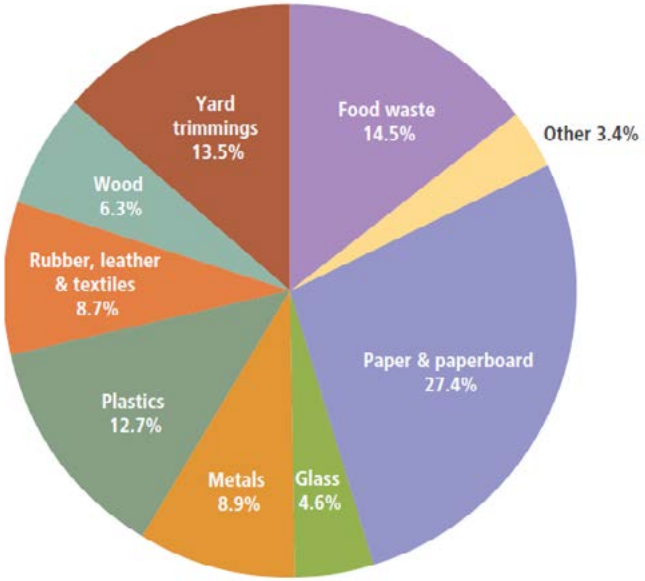
Methane is of particular concern. It is 25 times more effective at trapping heat in the atmosphere than carbon dioxide. Methane from landfills represents about 12% of total global methane emissions.

There are also significant carbon emissions released from the transportation of municipal solid waste.

> ***UK landfilling declines.*** *The UK reports that the amount of municipal waste going to landfills has dropped by 60% in the past decade thanks to recycling and waste-to-energy initiatives.*
>
> *Figure 10.2*

Controlling costs. Managing solid waste can take a huge bite out of a municipal budget. For cities in less affluent countries, trash collection and disposal often represent the largest single budget item. Moreover, the global cost of managing garbage is going up, most severely for those cities in low-income countries. The World Bank predicts the annual global garbage bill will jump from the current $205 billion to $375 billion by 2025.

Stricter government regulations play a role in higher waste management costs. For example, in the 1990s, the U.S. Environmental Protection Agency (EPA) required that authorities in charge of existing municipal waste landfills either install groundwater and gas monitoring programs – plus adhere to other operating standards – or close down their landfills. For many communities the price tag to meet the new require ments was too high. In Texas, the



> ***What's in the waste stream?***
> *This EPA "waste wheel" for 2012 illustrates that paper goods and organics dominate the U.S. waste stream.*
>
> *Figure 10.3*

number of landfills dropped from more than 1,000 to the 100 in operation today.

Similar restrictions are in effect in Europe. In Germany, untreated municipal solid waste has been effectively banned from landfills since June 2005.

Promoting sustainability. Waste management practices have become increasingly linked to the goal of sustainability. Programs that promote waste prevention, recycling and material recovery directly support emerging sustainability goals by reducing demands on resources and energy and the need to create more landfills.

The *zero waste movement* represents an even broader push for sustainability. It not only advocates for eliminating waste through waste prevention and recycling, it works toward restructuring production and distribution systems to make everything reusable – in theory completely eliminating the need for landfills and incineration. This notion of intentionally designing products in a way that their materials can be continually returned to the production process is the basic tenant of what's called the *circular economy*.

A number of cities – San Francisco, Austin, Texas and Ljubljana, Slovenia among them – have officially adopted zero waste as a goal. So has the country of Scotland.

Seeing waste as an asset

The pursuit of sustainability represents one shift in the thinking around modern waste management practices. Another is that waste represents a source of assets from which to recover both materials and energy. This emphasis on recovery departs from the traditional "reduce, reuse, recycle and dispose" mantra chanted by waste management pundits .

"The first message for municipalities considering best practices for waste management is to transition from seeing discarded materials as a waste, a liability, toward recognizing each scrap as a potential asset to be recovered and returned to the marketplace," says Michael Theroux, a resource recovery consultant and Council Advisor who advocates for clean conversion for recovery of energy and raw materials at his Teru Talk website.

This focus on broad recovery of waste stream components strives to shrink the volume of garbage that goes into problematic landfills and incinerators. But it's also introducing the view that waste represents a revenue-generating resource. Cities now have the opportunity to sell their waste streams to companies that sort, divert and process refuse into products that have genuine market value.

Promoting sustainability:

A SECOND LIFE FOR PLASTIC BOTTLES IN ROSTOCK

Germany is among the most advanced countries when it comes to recycling, and in the city of Rostock, Council member Veolia is converting one billion plastic bottles each year into granulate used to make new bottles. Once they are collected and transported to the processing center, the bottles are pre-sorted by color, with their caps and any residual waste removed,.

The bottles are then ground into flakes and subjected to a hot wash. Processing the flakes into food-grade is achieved by a mechanical-chemical recycling step. After being purified in a final step and packed into big bags, these PET flakes can be delivered to manufacturers of plastic bottles and manufactured into "new" PET bottles.

Understanding the character of waste

For cities embarking on new waste management initiatives, experts advise that you first get to know your garbage. Municipalities must understand the nature of waste generation in their particular community, including what's in it, where it's coming from and how much of each type is present. "You cannot manage what you do not measure," says waste consultant Theroux.

He advises that waste characterization studies include city demographic, land use and business data. The use of geographic information system data (GIS) can help plot physical location of waste generators, while useful analytical tools such as "cluster analysis" help city management understand where there are concentrations of large-volume generators of certain waste types.

Getting smart about waste management

Smart solutions are already working their way into the waste management arena. Navigant Research reports that smart waste management technologies now touch 43% of the global solid waste stream. And more convergence is on the way. The research firm estimates that 644 million tons of waste was managed by smart waste technologies in 2014. This volume is expected to increase to 938.4 million tons by 2023.

Smart waste solutions generally fall in these four phases of waste management:

- Smart waste collection
- Smart material recovery
- Smart energy recovery
- Smart waste disposal

Let's look at each of these areas a bit closer.

Smart waste collection

Collecting municipal solid waste is an expensive and sometimes polluting proposition. It requires an army of drivers who operate fleets of trucks that typically get poor gas mileage and spew emissions.

Smart waste collection solutions offer relief in several ways. They can eliminate unnecessary pick-ups on collection routes, along with the associated operating and maintenance costs for collection vehicles. They can also monitor participation rates for waste reduction programs such as recycling.

Trash container sensors

Time and fuel is wasted when garbage trucks include mostly empty trash containers in their collection schedule. To help better determine when trash containers really do need to be emptied, waste companies are installing micro sensors in them that communicate their fill-level status to a central data center. Only when the sensors indicate the container is almost full is the container added a collection route.

Trash can sensors can also be installed in conjunction with an integrated solar-power compactor that pushes down the contents of the container. This adds capacity to the container and further reduces the number of collection trips required.

RFID tags on trash and recycling bins

Some cities have started to embed radio frequency identification (RFID) tags in trash and recycling bins. In the UK, they're sometimes called "bin bugs."

The tags are associated with a specific resident or address and, similar to a barcode, can be read by equipment on collection trucks. Collected RFID information is sent to a city database where it can be analyzed to help cities in several ways. For instance, RFID enables collection trucks to record the weight and filling level of bins. Historical analysis of this data lets waste managers optimize collection routes and schedules. The result is fewer trucks running fewer routes results reduces truck emissions and air pollution. A European Commission technical study on the use of RFID in the recycling industry indicates that use of RFID systems can reduce waste collection costs by up to 40% due to the decrease in fuel consumption and air pollution.

> ***Waste container sensors.***
> *Waste container sensors, like this wire-less device from Enevo, tell waste collectors when, and when not, to schedule a trash pickup*
>
> *Figure 10.4*

In Cleveland, the city's solid waste department used RFID container tagging to link trash and recycling bins to homeowners. After analyzing its trash stream data, the city determined that 42% of the 220,000 tons of trash collected by the city every year is recyclable. Calculating the resale value of the recyclables along with the savings in dump fees by removing these recyclables from the waste stream, the city expects to generate $5.5 million in total savings.

Another use for RFID data is to help track which residents set out their trash and recycling bins. Cities might then target educational programs toward those who don't participate in recycling.

Finally, waste collectors are looking to incorporate RFID technology into pay-as-you-throw (PAYT) programs, where residents are charged for trash collection based on the amount they throw away. The city of Grand Rapids, Michigan has successfully deployed such a system.

GPS truck tracking

The use of global positioning systems (GPS) has proved helpful to optimize waste collection routes, improve driver behaviors and cut operating expenses. These systems help waste managers ensure truck drivers are adhering to routes and schedules and that there's no excessive idling or speeding, which can consume additional fuel.

A study published by the Aberdeen Group noted a 13.2% reduction in fuel costs with adoption of GPS vehicle tracking. There was also a 13.4% reduction in overtime costs.

Optimize waste logistics:

SMART SENSORS PROVIDE COST SAVING SOLUTIONS IN FINLAND

Located 50 kilometers east of Helsinki, the Finnish capital, is Porvoo, an old medieval town situated in the picturesque scenery of the Finnish archipelago.

In the summer of 2011, the scenery at the local recycling stations was less picturesque; overflowing waste containers and angry customers. The local waste management authority, Itä-Uudenmaan Jätehuolto, was having considerable challenges handling the increasing amount of waste that the many guests were generating during the summer season. Overfilling at the local recycling stations was becoming more common, causing increased littering and cleaning costs. Customers were demanding increased collection intervals, while the service was getting too expensive to maintain.

To tackle the problem the authority decided to pursue a smart city solution, installing wireless fill-level sensors at recycling. The sensor system provided by Finland-based logistics solution company Enevo, a Council member, measures and forecasts when waste containers will be full. By combining the forecasts with traffic and vehicle information, Enevo's system can generate millions of different route options and suggest the most cost-efficient to the user.

By utilizing Enevo's smart sensor service ONe, Itä-Uudenmaan Jätehuolto was able to:

- Reduce the amount of collections by 51%
- Reduce unnecessary driving and emissions
- Reduce the overfilling problem at recycling stations
- Achieve a net savings rate of 47%

> ***Reducing resource use through optimization.*** *By installing Enevo smart sensors the local waste management authority was able to cut the amount of collections by 51% and achieve a net savings rate of 47%. The image above shows a typical recycling station in the Porvoo region.*
>
> *Figure 10.5*

GIS-based route planning

A geographic information system (GIS) is used to construct, record, analyze, manipulate and display geographic information. Many cities have had GIS systems in place for a number of years.

GIS technology is now starting to play a significant role in modern solid waste management operations. It can help with planning waste collection routes, as well as prudently siting recycling centers, material recovery facilities, yard waste depots and landfill locations.

Smart material recovery

After collecting refuse and recyclables, the recovery of valuable waste stream material can begin. Let's now look at some of the smart processing solutions that extract waste stream assets.

Advanced material recovery facilities

An advanced material recovery facility is commonly referred to as a MRF (pronounced "murf"). It is typically a large building where collected waste enters on a conveyor belt and, as it moves forward, is separated into various piles for recycling markets.

A variety of mechanical systems are used to sort and separate the good stuff from the waste stream. Magnets pull out ferrous metal. Air jets are used to suspend lighter plastics and paper so that heavier products, such as glass and non-ferrous metals, fall out of the stream. To identify and sort non-ferrous metals, infrared and even x-ray scanning are sometimes used. Plastics are typically sorted by hand, a practice that adds considerably to the expense of operating a MRF.

Material recovery plants generally fall into two categories. Clean MRFs only accept recyclables already separated at the collection point. Dirty MRFs accept comingled trash that includes recyclables, organic waste and everything else that goes into a residential garbage can. A dirty MRF can actually recover more

Smart materials recovery. *Automated systems are used to separate various recyclables at MRFs, but hand sorting is sometimes required, too.*

Figure 10.6

material than a clean MRF because it processes the entire waste stream and targets a greater number of materials for recovery.

Mechanical biological treatment

In addition to clean and dirty MRFs, a third type of recovery system has entered the picture. Mechanical biological treatment (MBT) – also known as a wet MRF – treats solid waste both mechanically and biologically. A mixed waste stream enters these facilities and magnets, shredders and other types of separators mechanically remove metals, plastics, glass and paper. Some MBT facilities will also separate combustible elements from the waste stream, such as plastics and organics, and convert them to refuse-derived fuel (RDF). RDF is typically used as a fuel in power plants.

After mechanically recovering recyclables from the waste, the remaining organic material is processed using biological methods. These include anaerobic digestion, in which microorganisms break down the waste to produce biogas, soil amendments and materials suitable for composting.

Because MRF technologies and systems can vary depending on each community's waste stream profile and management goals, no two MRFs look exactly alike.

However, the main objectives generally overlap:

- Reduce the volume of waste to be landfilled
- Improve resource recovery through recycling and production of a degradable or combustible residue
- Stabilize all waste residuals that end up in landfills

Smart energy recovery

Because municipal solid waste contains plastics, organics and other carbon-rich material, waste managers more and more are viewing their garbage as a potential source of renewable energy. Methods of converting waste to energy – or WTE in waste industry parlance – is the focus of this section .

WTE conversion occurs in two basic ways. One is incineration. This typically implies burning solid waste to heat steam-powered generators that produce electricity. The other way is to process waste in a manner that produces gases and liquid fuels that are used for commercial heat and power.

In some respects, WTE solutions fall outside of our smart cities focus on information and communications technologies. Moreover, some argue that because incineration gener-

Modern incineration plants.
Waste to energy conversion occurs in two basic ways. One is incineration which takes place in plants like the one above in Brescia, Italy.

Figure 10.7

ates emissions and is a relatively low-value use for previously manufactured materials, it falls outside the smart cities sustainability emphasis.

With those caveats in mind, let's briefly take a look at where WTE is headed as a waste management tactic.

Incineration

Incineration has been, and still is, the most common way to recover energy from waste. It also reduces the volume of disposal waste by about 90%.

More than 800 WTE incinerators now operate in 40 countries, with the vast majority in Europe and Asia. The story is far different in the U.S., where public concern over emissions from incinerators remains entrenched, even with ever-tightening air quality regulations imposed by federal and state authorities. But that's starting to change. In Florida, the Solid Waste Authority of Palm Beach County is completing the first WTE plant built in the U.S. since 1995. It will burn 99% of the municipal waste it receives and generate enough electricity for 85,000 homes.

Today's WTE advocates argue that modern incineration facilities work differently from old-fashioned municipal incinerators. Modern WTE facilities combust post-recycled waste in highly controlled and efficient combustion systems that are equipped with proven air emissions control components (such as fabric filters, electrostatic precipitators and scrubbers) that minimize potential emissions. Moreover, the process in modern facilities is closely monitored via control equipment, remote sensors and computers to ensure optimal combustion of the waste.

Other WTE technologies

While incineration dominates the WTE arena, other technologies are emerging that may appeal to cities where resi-dents object to burning garbage.

Anaerobic digestion for biogas. Anaero-bic digestion (AD) technology is gaining traction in Europe, spurred on by European and national legislation aimed at reducing municipal waste going to landfills. The technology relies on anaerobic digesters that, with the help of bacteria, break down organic waste in an oxygen-free environment. Once confined to use on farms to break down manure waste, that's no longer the case today for AD. One natural product of AD is biogas, which typically contains between 60% to 70% methane.

Gasification and pyrolysis. Some cities are using a process called gasification to extract biogas, a fuel that contains hydrogen and methane and can be used in various applications. Gasifica-tion involves heating of mixed waste or derived fuels at high temperatures. Oxygen is introduced to allow partial oxidation, but not enough for full combustion. In Australia, the city of Sydney is pushing forward with gasification, with the goal of producing syngas that can be fed back into a natural gas grid.

> ***Modern incinerations***
> *WTE conversion occurs in two basic ways. One is incineration which takes place in plants like the one above in Brescia, Italy.*
>
> *Figure 10.8*

Another advanced thermal WTE pro-cess is pyrolysis. It involves energy-assisted heating of waste at controlled temperatures but with no oxygen introduced. Byproducts include volatile liquids and syngas – with relative proportions determined by process temperature.

Because gasification and pyrolysis technologies have limited operating history processing solid waste, it is difficult at this time for cities to draw conclusions about their viability.

Trucking waste to landfills. *For many developing countries, which now practice open dumping of trash, trucking waste to managed landfills represents a cost-effective step in advanced waste management.*

Figure 10.9

Smart waste disposal

Waste disposal sits at the bottom of the waste management hierarchy as the least preferred option. Yet for many developing countries, which now practice open dumping of trash, trucking waste to managed landfills represents a cost-effective step in advanced waste management.

In this section, we look at smart waste disposal alternatives.

Sanitary landfills

Today's sanitary landfills are engineered sites where waste is managed to prevent environmental contamination. These landfills isolate waste from the environment while it degrades biologically, chemically and physically.

A primary technology challenge at landfills is managing the release of methane-rich landfill gas caused by the natural breakdown of organic material. These gases can make a significant contribution to GHG emissions.

Smart waste disposal solutions start with removal and conversion of organics from the waste stream before they get to the landfill. In addition, waste managers can implement systems to collect and use the landfill-generated gas for heat or electricity production. Methane captured at San Diego's Miramar Landfill provides 90% of the fuel to power electrical generators at the local Metropolitan Biosolids Center and North City Water Reclamation Plant.

Bioreactor landfills

Unlike a traditional sanitary landfill, a bioreactor landfill accelerates the decomposition of organic waste by intentionally adding liquid and air to enhance microbial processes. Where decomposition in a dry landfill can take 30 to 50 years, the process takes only 5 to 10 years at a bioreactor landfill. By stepping up the rate of decomposition, the volume of material in the landfill rapidly shrinks and creates space for more material. As a result, fewer new landfills are needed.

Managing the biological, chemical and physical processes occurring in a bioreactor landfill requires the use of remote monitoring networks, sensors and other sophisticated technologies.

While not yet widely adopted, bioreactor landfills are gaining attention due to the potential they have to extract landfill gases and convert them to fuels. The bioreactor landfill near Ashville, North Carolina recently added a gas-to-energy operation. It's now producing enough fuel to run a generator that powers 1,110 homes a year.

Solar-capped landfills

When a landfill closes, the site is typically sealed with a polyethylene cap and then covered with several feet of compacted soil on which grass is planted.

One alternative capping system is to cover the buried garbage not with dirt and grass, but with solar panels. This not only eliminates the need to mow grass and replace eroding soil, but brings underutilized acreage into renewable energy production.

Landfill solar farms are already in place in several states, including the Hickory Ridge landfill near Atlanta, Georgia with 7,000 panels installed. The EPA and the U.S.Department of Energy are offering guidance to landfill operators and solar energy developers looking to integrate solar projects with retired landfills.

Solar-capped landfill.
The 48-acre Hickory Ridge Landfill was transformed into the largest solar energy generating facility in Georgia. It is the world's largest solar energy cap and the first use of the technology as a fully permitted landfill final closure system.

Figure 10.10

Dependencies for solid waste management

Improvements to a city's solid waste management system in part depend on other city systems. Transportation systems, computing resources and data analytics capabilities can all play a role in waste management.

Efficient transportation networks, for example, are necessary for collection and transport of debris to material and energy recovery facilities, as well as landfills. Computing resources such as GIS systems are valuable for planning collection routes, siting processing facilities, as well as choosing locations for landfills.

Cities with data analytic tools available can also better support smart waste management initiatives. Data analytics are often required to process and gain insights from data derived from sensors and RFID tags on trash and recycling containers.

Benefits of realizing solid waste targets

Smart solid waste management enhances a city's livability, workability and sustainability in a variety of ways.

Livability

Lowering costs for citizens. Use of technologies that yield more efficient waste management – such sensors, RFID tags and GPS to optimize collection routes – can reduce operational costs and thereby lower or help control garbage bills for residents and businesses. Waste recovery companies that pay municipalities to recover energy and materials from their solid waste stream also help offset waste management costs for cities and citizens.

Protecting public health. Open dumping and garbage burning are still widely practiced in many developing parts of the world. These activities continue to adversely impact urban air and water quality.

Uncollected garbage also takes a toll on public health. Refuse on the streets collects water where insects breed and potentially spread disease. Plastic bottles and packaging left in the open leach chemicals and toxins into the soil and water. Litter clogs and interferes with the function of sewer systems.

> ***Clean streets enhance livability.*** *Smart waste management can visually and aesthetically improve communities by ensuring that garbage is removed and processed in an efficient, timely and responsible manner.*

Figure 10.11

Modern waste management solutions will assure citizens that air and water resources are neither contaminated nor a threat to public health.

Increasing civic pride and property values. Smart waste management can visually and aesthetically improve communities by ensuring that garbage is removed and processed in an efficient, timely and responsible manner. Uncollected waste and litter is not only an eyesore, but encourages people to act less responsibly about how they handle waste. Clean streets and minimized litter, on the other hand, promote civic pride and higher property values.

Workability

Establishing an appealing business environment. Timely and efficient collection and removal of urban waste contributes to an attractive environment for a company's workers and clients. Businesses that want to maintain a strong corporate image utilize advanced waste management practices – such as zero waste initiatives – and look to locate in cities that have strong waste management practices.

Creating new jobs. Cities that promote waste management solutions such as material recovery facilities and waste-to-energy plants open the door to new industries and jobs.

Creating new jobs:

MAKING WASTE SAFER, LESS EXPENSIVE AND MORE USEFUL

When the city of Ballarat in New South Wales, Australia was chosen as one of 16 IBM Smarter Cities Challenge grant recipients in 2014, it had access to five of IBM's top experts, who spent three weeks living there and immersed in the city to analyse and advise on its waste management strategy.

"Waste management is a key priority for the city and we want to lead the way in developing best practice approaches that can be shared with other councils and communities," said Ballarat Mayor John Philips. "We want to empower our community to take action now to ensure our waste management capabilities are both more efficient and more sustainable, as well as explore how we can get more economic value from waste as a resource stream."

What Ballarat heard from the experts sent by Council member IBM was that technology can play a role in making the disposal and recycling of municipal waste more predictable, efficient and safer for the environment. The proper management of waste can even lead to the creation of jobs and new industry.

Among the key recommendations for Ballarat were:

- Utilize modern sorting methods to enhance resource recovery and reduce waste to landfill
- Explore waste-to-energy options that maximize landfill diversion
- Work with the state government to improve the attractiveness of waste-to-energy investments
- Employ a digital waste information system to increase understanding and support waste management process optimization

> ***Creating new jobs.*** *One of the messages Ballarat heard from IBM experts is that the proper management of waste can lead to the creation of jobs and new industry.*
>
> *Figure 10.12*

Enhancing sustainability. *Extracting metals, glass, plastics and paper from the municipal waste stream reduces the resource required to create such materials anew.*

Figure 10.13

Sustainability

Recovering and reusing waste material. Recycling and landfill diversion are basic sustainability practices. Extracting metals, glass, plastics and paper from the municipal waste stream reduces the resources required to create such materials anew.

Reducing greenhouse gas emissions from landfills. Converting organic waste to compost and fuels reduces the amount of organic material going to a landfill. That in turn lowers the production and release of methane and other landfill gases into the atmosphere.

Creating more fuel-efficient waste collection systems. New technologies that involve sensors and RFID tags are enabling waste managers to better analyze and optimize collection routes for garbage trucks.

Enabling alternative energy deployments. Communities are beginning to use dormant acreage covering retired landfills as locations for solar panel installations.

Solid waste targets

The technology targets described in this section can help cities develop a smart solid waste management system that uses intelligence to efficiently and responsibly handle refuse.

Instrumentation and control

Waste collection, processing and disposal practices now include electronic devices and controls to make waste management smarter and more efficient.

Implement optimal instrumentation. New types of instrumentation are gaining traction in the waste management world. RFID tags embedded in recycling bins help identify the types of refuse generated by citizens and help track customer participation in sorting programs. Attaching RFID tags to specific types of items aids waste sorting at municipal recycling facilities.

Evidence from Europe suggests that these improvements can lower collection costs by up to 40%.

Smart wireless sensors embedded in public waste bins inform waste collectors when the container needs emptying, enabling development of efficient pick-up schedules and routes based on the actual fill levels and historic fill level patterns.

Sensors are also becoming key components in waste processing. Scanners and optical sensors at material recovery facilities enable efficient recyclables sorting. Sensors are also used to monitor landfill conditions.

Connectivity

Data collected by waste technology sensors requires transmission to servers or web services for storage, viewing, monitoring and analysis.

Connect devices with citywide, multi-service communications. Communications systems

are an essential component in new waste technologies – RFID, GPS and GIS in particular.

Data transmitted from waste collection sensors and RFID tags typically relies on the presence of wireless and cellular (GPRS) network services. Depending on the vendor implementation, these connectivity resources may be part of a citywide, multi-service communications platform, or they may be included in the vendor's service subscription.

Computing resources

Smart waste management solutions may require that cities expand their in-house computing capabilities. However, solution vendors may also enable waste authorities to connect to their applications via web services or APIs, eliminating the necessity of onsite IT deployments.

Have access to a central GIS. A GIS helps a city know where everything is located. It's useful across a range of city responsibility areas, including waste management. Using GIS software, waste collectors can, for example, plot neighborhood population density and income data against household addresses to estimate volumes of garbage for various city sectors. That, in turn, enables waste managers to develop efficient collection routes that save time and fuel.

GIS systems can also assist with siting waste processing facilities and choosing locations for landfills.

Analytics

With the expanded use of RFID tags, sensors and GPS data in more developed global economies, cities now have the opportunity to apply data analytics for optimizing waste collection, recycling and waste processing.

Achieve full situational awareness. As mentioned earlier, waste characterization studies should serve as the starting point for smart waste management initiatives. Cities and municipalities need to understand the types and volumes of waste being generated from their communities and where it's coming from. Statistical analysis of data from waste collection operations, recovery facilities, city demographics and GIS can help cities see the big picture of their community's waste stream.

Achieve operational optimization. Application of data analytics to GPS information and RFID data lets haulers optimize operations in several respects. The primary benefit is that waste fleet managers can determine in real-time the most efficient routing for collecting trash and recyclables.

> ***Achieve operational optimization.*** *LondonWaste, the company that handles municipal solid waste and recycling and generates landfill rubbish into energy is using Mercedes-Benz Arocs 3240K trucks from Council member Daimler. The new trucks are equipped with FleetBoard telematics that allows LondonWaste to collect vehicle-use data, track fuel consumption and review driver performance. "As we look to reduce waste, reuse it, recycle it, and recover energy, with disposal as the last resort, these low-emission, Euro 6 vehicles are playing a vital role in moving materials to the right places in order to increase their value and usability," said Julian Appleby, LondonWaste's head of operations.*

Figure 10.14

Achieve operational optimization:

HOUSTON LOOKS TO 'ONE BIN' TO DIVERT WASTE

Despite decades of promoting recycling, the city of Houston remains well below the national average. The city's landfill diversion rate is a mere 17%, with just 6% resulting from recycling and the remainder from the recovery of yard waste.

Looking to remedy the situation, Houston Mayor Annise Parker has led a city charge to adopt a "one bin" approach to waste diversion. It would allow residents to mix trash, recyclables, yard clippings and other waste in one container and let a resource recovery facility separate and process the refuse.

Under the plan, the city expects the Houston recycling rate to climb to as high as 75% in two years. It would also reduce pollution from garbage trucks, as there would be fewer trips required to collect waste.

Using the one-bin model in conjunction with advanced material recovery facilities can "completely transform the global solid waste industry," says George Gitschel, chairman and CEO of Organic Energy Corporation, a Council member. Organic Energy, which builds and operates advanced material recovery facilities (MRFs), is one of the companies interested in working with Houston to manage its one-bin waste stream. Gitschel explains that Organic Energy's recovery separates items by density, size, optical characteristics, magnetism and other means into 20 different types of materials, which can be marketed and turned into new manufactured goods.

The city of Montgomery, Alabama recently adopted a one-bin waste collection system in conjunction with the opening of a $35 million materials recovery facility. The city has seen the recycling rate jump from 1% to about 70% in less than a month. When composting and methane production is added to the facility, the material recovery rate is expected to climb to 90%.

> ***Achieve operational optimization.*** *Advocates believe using the one-bin model in conjunction with advanced material recovery facilities can transform the solid waste industry.*
>
> ***Figure 10.15***

ISO 37120: A yardstick for measuring city performance

In 2014, the International Organization for Standards announced an ISO standard that applies strictly to city performance. The document – known as ISO 37120:2014 – establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, urban planning, wastewater, water, sanitation and more.

In the table at right we have indicated how the standard related to Solid Waste correspond to the Council's Waste Management targets identified on the next page.

The solid waste theme is unique within ISO 37120 in that its 10 indicators are the most of any theme, perhaps underscoring the need for more effective management of resources globally. This indicator has cities reporting on the generation and recycling of both hazardous waste and municipal solid waste (MSW) – more commonly known as trash.

Solid Waste Indicators

			Implement optimal instrumentation	Citywide, multi-service communications	Create citywide data management policy	Have access to a central GIS	Achieve full situational awareness	Achieve operational optimization	Achieve asset optimization
Core	16.1	Percentage of city population with regular solid waste collection (residential)	■	■	■	■			
	16.2	Total collected municipal solid waste per capita	■	■	■	■			
	16.3	Percentage of the city's solid waste that is recycled	■	■	■	■	■	■	■
Supporting	16.4	Percentage of the city's solid waste that is disposed of in a sanitary landfill	■	■	■	■	■	■	■
	16.5	Percentage of the city's solid waste that is disposed of in an incinerator	■	■	■	■	■	■	■
	16.6	Percentage of the city's solid waste that is burned openly	■	■	■	■	■	■	■
	16.7	Percentage of the city's solid waste that is disposed of in an open dump	■	■	■	■	■	■	■
	16.8	Percentage of the city's solid waste that is disposed of by other means	■	■	■	■	■	■	■
	16.9	Hazardous waste generation per capita (tons)	■	■	■	■			
	16.10	Percentage of the city's hazardous waste that is recycled	■	■	■	■	■	■	■

Figure 10.16

WASTE MANAGEMENT TARGETS

*In the checklist below, targets specifically pertaining to the waste management responsibility are in **bold,** universal targets are not.*

TECHNOLOGY

Enabler	Waste Management Targets: How smart cities deploy and use ICT to enhance their waste management	Implementation Progress: None	Partial	Over 50%	Complete
Instrumentation & Control	Implement optimal instrumentation	☐	☐	☐	☐
	Embed RFID tags in recycling bins and smart wireless sensors in waste bins	☐	☐	☐	☐
Connectivity	Connect devices with citywide, multi-service communications	☐	☐	☐	☐
	Ensure wireless and cellular network services for waste data transmission	☐	☐	☐	☐
Interoperability	Adhere to open standards	☐	☐	☐	☐
	Use open integration architectures and loosely coupled interfaces	☐	☐	☐	☐
	Prioritize use of legacy investments	☐	☐	☐	☐
Security & Privacy	Publish privacy rules	☐	☐	☐	☐
	Create a security framework	☐	☐	☐	☐
	Implement cybersecurity	☐	☐	☐	☐
Data Management	Create a citywide data management, transparency and sharing policy	☐	☐	☐	☐
Computing Resources	Consider a cloud computing framework	☐	☐	☐	☐
	Use an open innovation platform	☐	☐	☐	☐
	Have access to a central GIS	☐	☐	☐	☐
	Have access to comprehensive device management	☐	☐	☐	☐
Analytics	Achieve full situational awareness	☐	☐	☐	☐
	Achieve operational optimization	☐	☐	☐	☐
	Achieve asset optimization	☐	☐	☐	☐
	Pursue predictive analytics	☐	☐	☐	☐

Figure 10.17

ADDITIONAL RESOURCES

Recovering and reusing waste material

Plastic Recycling Makes Public Spaces

Learn how Loos.fm in the Netherlands utilized plastic recycling to build a pet pavilion that was cost-effective and eco-friendly, and created a public space to benefit the community in this short video from Council member IBM.

Magpie Plastic Sorting Technology as Part of the Recycling Process

Watch this video tour of Council member Veolia's "Magpie" intelligent sorting technology at its Integrated Waste Management Facility in Padworth, West Berkshire. The facility separates mixed plastic into different waste streams.

Target: Embed RFID tags in recycling bins

Smart Trash: Study on RFID Tags and the Recycling Industry

This technical report prepared for the European Commission will help urban waste management professionals weigh the opportunities and challenges of RFID (radio frequency identification) technologies to reduce waste management costs and streamline and automate for efficiencies.

CHAPTER 11

HEALTH AND HUMAN SERVICES

Advances in information and communications technologies (ICT) will transform the delivery of essential health, education and other human services in powerful ways – and smart cities will ride the wave to ensure a better life for their residents.

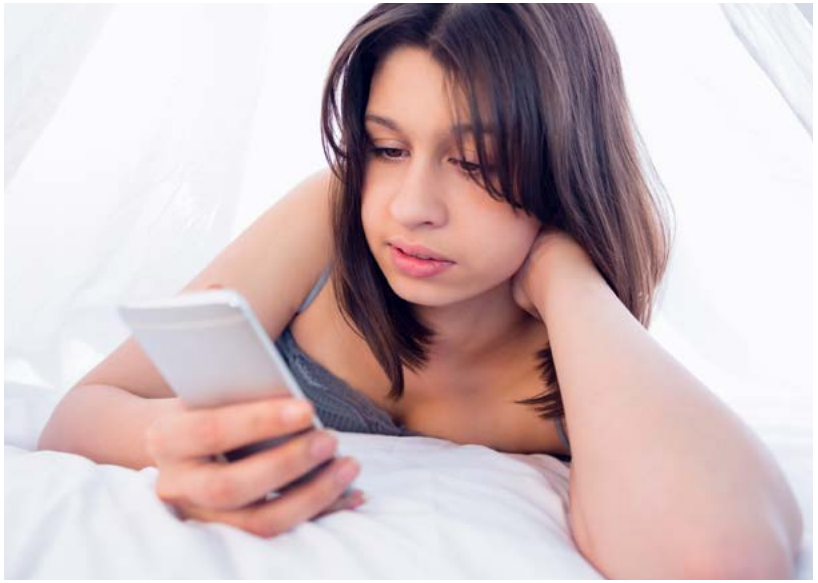
Let's imagine Los Angeles in the year 2030. An ill student is home in bed, following her algebra instructor's lesson over her smartphone. The instructor asks the class to solve for X, and our student raises her hand miles away to solve the equation in real time. Later that night, through an app on the same phone, she downloads her algebra homework assignment and in a virtual classroom she and her fellow students work together to apply the day's lessons.

She finishes her homework and opens up a new app – one that transmits data from her ongoing radiology treatment to her specialist in New York. She uses the mobile medical devices her hospital supplied and sends her health update off in a matter of minutes. Downstairs, her mother is online accessing her daughter's medical records through the same portal that she has used to receive job training and employment referrals.

Welcome to the future of health and human services delivery, enabled by cloud-based apps, wearable devices, telepresence, robotics and other advanced technologies that will help smart cities improve the well-being of their citizens.

But before we dive too far into this chapter, let's deal with some definitions. In the Readiness Guide we consider human services

> ***ICT empowers people to be smarter and healthier.***
> *Cloud-based apps, wearable devices, telepresence, robotics and other advanced technologies help cities improve the well-being of their citizens.*
>
> *Figure 11.1*



those that cities provide to support the well-being of residents – their health and welfare, their education, the clean air they breathe and even the food they eat. Whereas in previous chapters we showed how ICT makes infrastructure smarter, in this chapter we explore how ICT empowers people to be smarter and healthier. The importance of smart human services can't be overstated – after all, an educated and healthy city is a wealthy and successful city.

Making health and human services delivery smarter

There are four inter-related areas in health and human services where ICT can substantially improve services for city residents. Because some elements of those services are not owned by cities, the effort will require participation with public and private organizations.

1. Public health is the macro, citywide view of health. Epidemiology, air quality, UV radiation, health research and development, population health management, food safety, health literacy and other large-scale issues are the concern of city public health agencies. Smart public health uses ICT to improve outcomes for citizens and cities alike. City agencies can use sensors to collect data on air quality, noise pollution, UV radiation, diseases and a host of other factors that impact public well-being. They can also proactively receive health information directly from citizens, by encouraging them to share their health feedback and experiences through mobile apps. This data can then be analyzed to detect trends and potential problems – and to inform city decision-making – which might include anything from zoning laws to emission standards to mobilizing health providers to respond to an outbreak.

2. Health services are how cities support the mental and physical well-being of residents. Traditional approaches to health care are being challenged by several factors that seriously strain tight city budgets:

- Non-communicable diseases such as heart disease, diabetes, obesity, stress and mental health problems have grown significantly in the last decade, and are often concentrated in urban areas.
- Many regions of the world have inadequate health services that are unable to keep up with demand from growing populations, particularly as people age – and live longer.
- Urban populations continue to swell around the globe; over half of all people now live in cities and the trend is expected to continue.

The emerging discipline of smarter healthcare – sometimes referred to as e-health or e-Care – uses technology to overcome these challenges (and greatly improve outcomes) in these ways:

- It broadens and deepens access to health services.
- It addresses health factors holistically, across a broader range of city services and departments, and by focusing on prevention and healthier living.
- It supports better cooperation, collaboration and productivity between multidisciplinary and often geo-dispersed teams of health professionals.

Traditional approaches to healthcare are being challenged. *As urban populations swell and people live longer, demand for health services will increase, requiring new efficiencies in service delivery.*

Figure 11.2

> ***Revolutionizing the connection between student and teacher, school and learning.*** *Children who can't regularly attend school due to serious health problems are using VGo robots powered by Council member Verizon's network to interact with teachers and fellow students -- almost as if they were sitting in the classroom with them.*

Figure 11.3

Remote delivery of health services (as you'll read about in case studies later in this chapter) makes it possible for a patient to receive advice and treatment from a doctor without having to leave home or work. And the doctor can assess and treat conditions in real time and with maximum efficiency. This is one example of how smart cities use ICT to improve health – reaching more people in less time and using fewer resources without compromising the quality of health outcomes.

Here's another: Health care providers are rapidly ditching paper-based patient medical records for electronic health records (EHRs). A doctor enters the exam room, chats with the patient and conducts an exam. The doctor then turns to a keyboard to enter data into fields on a computer screen. The patient's health profile gets electronically updated right then and there.

There's a big upside to having this digital version of a person's medical history. It makes their diagnoses, lab tests, allergies, current prescriptions and other bits of health information easy to share and manage. It allows for coordination of their care between clinicians. It helps control the administrative cost of delivering care. All of these are essentials in smart healthcare and certainly in smart cities that are proactive about enhancing livability for their residents.

Additionally, natural user interfaces and analytics can "learn" about a patient's health history and suggest tailored and specific medical interventions.

There's also the convenience factor. A mother gets a text on her smartphone that it's time for her child's vaccination; she can make the appointment on her phone or on a web portal. In so many ways, information can be a powerful tool in healthcare – and ICT can help get it to the people who need it, when they need it.

3. **Human services refer to a broad spectrum of easily accessed services that help people live better lives.** These include services to help people deal with substance abuse, domestic violence, HIV/AIDS, disabilities, nutrition challenges and physical fitness. It includes helping the homeless find beds to sleep in and dysfunctional families find counseling.

While it is common for cities to treat health and human services separately, smart cities integrate a client's human services history into their health portfolio for better outcomes and greater efficiency.

4. **Education and skill development are a priority in a smart city.** They provide opportunities for all ages and all levels, ranging from toddler story hours at the public library to computer classes at the senior center. K-12 education, workforce training programs and higher education are all essential. But today education is mostly stuck in the physical world. With the right deployment of ICT, cities can revolutionize the connection between student and teacher, school and learning.

Making service delivery smarter:

HOW INNOVATION TRANSFORMED BENEFIT PAYMENTS IN SOUTH AFRICA

The mandate of the South African Social Security Agency (SASSA) is to ensure the provision of comprehensive social security services to South African citizens who are vulnerable or living in poverty. Several years ago the organization recognized its mission was compromised by a variety of resource and logistical limitations that made service delivery prone to widespread waste, fraud and abuse.

To remedy the situation, SASSA and its private sector partners, including Net1 and Council member MasterCard, were able to rapidly and radically reform the distribution of social security benefits nationwide. Together, they designed and built a payments network capable of delivering social security grant payments in a new way that benefits both the government and its citizens.

The scale, speed and impact of the project were enhanced by a combination of product innovation, deep partnerships and a strong focus on providing services. The program went from RFP award to public launch in three months, allowing SASSA to move 10 million people from nearly all cash to electronic social disbursement delivery in a little over one year

For the government, the new nationwide social payment standard combines high efficiency with accuracy and transparency, dramatically lowering the costs of delivering payments by reducing fraud and by improving operational efficiency at a significant scale. The new payments system brought a greater level of security to the world of government payments through the introduction of new biometric technology for cardholder authentication.

For citizens, payments are delivered swiftly, accurately and securely no matter where they live – achieving near universal inclusion in the financial system and new economic potential. The social payments card has already become an iconic brand and the emblem of financial freedom. Even when requesting a non-government card from any bank, customers will often say: "I want a SASSA."

> ***Making health and human services delivery smarter.*** *In South Africa, the SASSA card has become an iconic brand and the emblem of financial freedom for citizens who are vulnerable or living in poverty.*
>
> *Figure 11.4*

Dependencies in health and human services

When planning improvements in the public health arena, it's important for cities to recognize dependencies between healthcare services and other city systems and services.

Clearly, public healthcare services rely heavily on a city's public safety, communications and water systems. One example: The health of a city's population is at risk if municipal water supplies are contaminated.

On the human services front, consider the dependencies between education and communications, energy systems and government administrative services. For instance, enhancing communications technologies and access to them can help conquer the "digital divide" that challenges low-income students. The same communications technologies can improve access to remote education services.

Benefits of health and human services

Before we examine this chapter's targets in detail, consider how smart health and human services enhance livability, workability and sustainability.

Improving patient satisfaction. *With telemedicine, patients can reduce the amount of time they have to take off work to travel to a doctor's office and sit in a waiting room.*

Figure 11.5

Livability

Improving patient satisfaction. One of the primary benefits of remote delivery of heatlhcare services – or telemedicine – is increased patient satisfaction, especially for the elderly and mobility-challenged, but others too. Imagine if instead of taking time off work, making a trip to the doctor's office and then sitting in a waiting room, you could transmit your health data on your own time, and your physician could review it with you via a video feed. Telemedicine eliminates much of the hassle associated with healthcare.

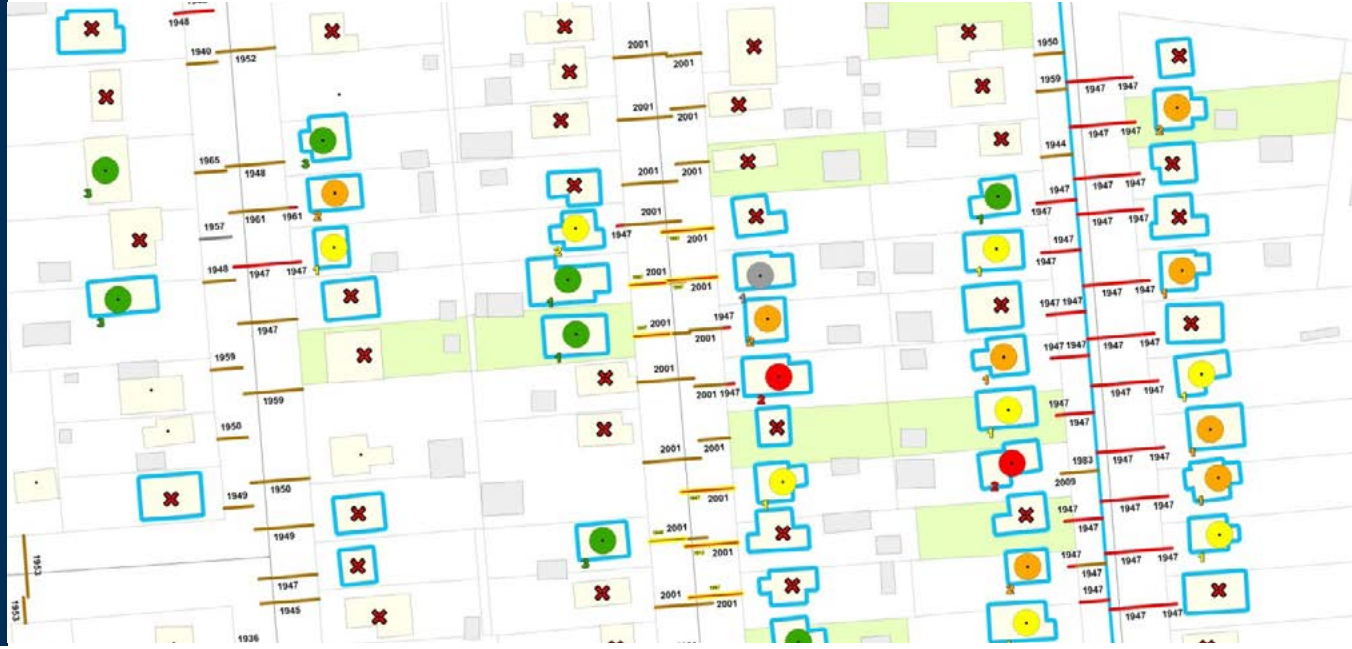
A prime example of how well telemedicine can work is the field of telepsychiatry. A psychiatrist is able, through video technology, to examine a patient in much the same way an office examination would take place. The psychiatrist can interview the patient, examine his or her overall appearance and check for symptoms of problems.

As beneficial as telemedicine can be, it must be noted that there remain barriers to its adoption – regulatory and insurance roadblocks among them.

Improving the delivery of health, education and other human services. City services are often under-utilized because those most in need of them may not know they are available, aren't sure they qualify, or don't know how to access them. An integrated, personalized citizen portal ensures easy, on-demand access to information people need.

Preventing diseases and disorders before they occur:

LEAD AND DRINKING WATER: PROTECTING VULNERABLE CITIZENS



The Community Geomatics Centre (CGC) is a division of the nonprofit Sault Ste. Marie Innovation Centre, a Council Advisor located in Sault Ste. Marie, Ontario. The CGC promotes partnerships and technological means to efficiently share geospatial data, tools and knowledge among community organizations to create a safer, healthier and more prosperous community.

A 2007 study completed in London, Ontario determined that running a water tap in a home did not always flush out unacceptable levels of lead in drinking water. Within a day of the study's release, the CGC utilized data from Algoma Public Health, the local water utility, the municipal social services office and Child Care Algoma to address the issue.

As a first step, the CGC queried the community GIS system and determined that all known lead pipes were installed between 1943 and 1948, a period when copper was in short supply because of the war.

Using postal code level data, the CGC was able to match homes with known or probable lead-based pipes with homes where pregnant residents lived. Exposure to lead has its greatest effect during neurological development. If a postal match was made, exact addresses were provided. Any home with an active pregnancy, and known or probable lead, received a free water filter through the health unit.

The same process was also applied to supply free filters to those residents on social assistance. As well, home daycare locations were checked against known or possible lead. To date, over 150 families on social assistance and over 200 families with active pregnancies received free filters.

> ***Preventing diseases and disorders before they emerge.***
> *The CGC lead pipe initiative demonstrates the benefits of data visualization and breaking down information silos to improve public health. The map above shows lead testing results, ages of homes and pipes and addresses refusing testing for a small neighborhood area in Sault Ste. Marie.*
>
> ***Figure 11.6***

Ensuring better, faster response to public health emergencies. The combination of smart devices, advanced and predictive analytics – even social media – empower public health officials like never before. They can monitor the outbreak of a disease or a hazardous fuel spill in real time, predict how it will spread and alert the public instantly through a wide range of communications channels.

Providing more access to healthcare – and better disease prevention. Cities are growing larger. And as they grow, existing medical resources are not always keeping pace, which means access to them becomes more difficult. How can ICT help cities bridge the gap between growing demand and available resources? By creating targeted prevention campaigns that reach residents and encourage them to act. It can also help the medical community care for more patients with better results.

Workability

Improved public health means fewer work hours missed. A 2012 study estimated that illness cost the United States economy around $576 billion a year. Cities that use ICT to bolster awareness of public health issues and promote remedies optimize their citizens' well-being, which translates into a more productive workforce and a stronger economy as a result.

Smart education makes a city more attractive to business and talent. Cities that make education a priority and use technology to empower current and future workers with a superior education and continuing online education and training – particularly in high-demand fields such as math, science and technology – can capitalize on this demand to draw new businesses and investment that bolsters the local economy.

Smart healthcare and social services make a city more attractive to business and talent too. Cities that offer access to state-of-the-art healthcare and social service programs have a competitive advantage in attracting the creative class of tomorrow. Put simply, if you're a top talent, you're not going to locate your family somewhere they'd have to leave when they needed quality health and human services.

Sustainability

Telemedicine is cost effective. Because of its capabilities, telemedicine can help cities provide quality care with fewer resources.

Long-term healthcare costs drop. Intelligent devices that measure and track health conditions can help public health officials prepare targeted prevention campaigns where they are most needed throughout a city. Successful campaigns can result in lower overall healthcare costs.

Smart learning means less travel. Improved service delivery of educational opportunities utilizing ICT cuts down on travel, which promotes energy conservation.

Smart learning enhances sustainability.
Improved service delivery that utilizes ICT cuts down on travel, which promotes the conservation of energy resources.

Figure 11.7

Mobility enables smarter learning:

WI-FI HELPS FUTURE-PROOF TEXAS COLLEGE CAMPUS

Wi-Fi is as much a part of university life as classes and exams. Originating as a "hotspot" accessory, wireless networking has become a baseline technology that students expect. And once installed campus-wide, WLANs are swamped, with more than 100% usage increases per semester.

That can be a problem for college IT departments. Unlike an office, where wireless users are evenly dispersed in cubicles, students bunch together, jamming access points (APs) and the result is poor performance for all.

Texas State Technical College (TSTC) Waco wanted a wireless system flexible enough for the day-to-day demands of 5,000+ students and that could support any application the college might deploy in the future.

A primary requirement was enabling "mobility, mobility, and more mobility." But most conventional Wi-Fi networks consist of uncoordinated APs, which have difficulty handling many active wireless users converging in the same area. The WLAN also had to provide support for legacy 802.11b/g systems without impacting newer 802.11n clients – a challenge for traditional wireless systems based on micro-cells.

At a tech trade show, TSTC officials found what they were looking for – the Extricom Series from Council member Allied Telesis. The Extricom Series' WLAN is built around Channel Blanket™ architecture, which combines the signal of multiple APs operating on the same channel as contiguous blankets of coverage. Within the Channel Blanket, wireless clients associate with a switch rather than an individual AP, and the switch coordinates AP transmissions to eliminate co-channel interference. There are no handoffs between APs as clients move around. In effect, the entire network appears to the client as a single large AP.

> ***Mobility enables smarter learning.***
> *The future is now at the Waco campus of TSTC. This campus, the largest in the TSTC system, focuses on technical/vocational education, and network requirements— supporting over 5,800 students and faculty members— are just as complex as those of the most sophisticated enterprise.*
>
> *Figure 11.8*

Smart education makes a city more attractive to business:

DEEPER STUDENT INSIGHTS LEAVE A DEEP IMPACT

For the Hamilton County, Tennessee Department of Education, the essence of educational intelligence is insight through granularity. And it's one reason the county's graduation rate has increased and standardized test scores are up too.

The department started down the educational intelligence. path a few years ago, when it began looking into why its students were consistently scoring below state benchmarks on standardized tests. Administrators didn't get far before realizing they lacked the kind of detailed, granular data that would be necessary to understand the factors that contributed to the poor performance, much less act on the problem.

What little performance data Hamilton County had been receiving came from state scoring reports (as part of No Child Left Behind), which provided a lumpy, aggregate measure of whether the county's 40,000 students were on track.

Implementing smart performance tracking technologies from Council member IBM, Hamilton County educators developed a performance modeling tool that extracts individual student data from the county's 78 schools and uses it to create predictive profiles, which help to flag those students in need of proactive intervention by teachers or counselors. Using built-in algorithms, the model determines which factors are the strongest predictors of a student failing or dropping out.

Identifying those students labeled "fragile" or "off-track" is just the beginning of a process whose ultimate aim is the success of the student.

> ***Smart education makes a city more attractive to business.*** *Using analytics and performance modeling tools, educators in Hamilton, County, Tennessee have determined how to identify at-risk students and implement processes to help them succeed.*
>
> *Figure 11.9*

Health and human services targets

As you'll see in the pages that follow, there are two targets specific to this health and human services chapter and they will be discussed in detail. We'll also explain how other universal targets apply to health and human services.

Instrumentation and control

Health and human services use instrumentation and control in two slightly different ways, but the primary mission remains the same as in other city responsibility areas. It's all about data collection.

Implement optimal devices and other instrumentation for each human service. Implementing the right data-capturing devices across all of a city's health and human services responsibility areas is the objective here. Given the new and different types of services involved, different kinds of instrumentation will be required.

For instance in a smart city, instrumentation can include smartphones and apps that allow people to directly participate in city public health and human services monitoring by providing feedback about conditions and experiences. For example, Council Partner IBM has created the Accessible Way app that allows users to report on the accessibility of their cities, and in doing so help construct a crowd-sourced knowledge base about urban mobility challenges.

In the healthcare, social services and education arenas, devices collect data from people for the most part. These include devices that may monitor how patients in a study are responding to a new medication or ones that record academic progress in a new teacher's classroom. The purpose is to provide actionable data that can be analyzed for trends or problems.

Data-capturing devices are critical for the telemedicine systems mentioned earlier. Patients use devices to acquire data on their health status in the comfort of their homes and then transmit it to remote care providers. This greater efficiency can save time, money and resources. Similar savings can occur when health professionals remotely monitor patients with chronic conditions like diabetes or heart disease. And the opportunity to use ICT for real-time, interactive checkups allows physicians to deliver emergency medical help that can save lives where more time-consuming traditional medicine may be too late.

In education, there are many ways to improve outcomes through ICT. Applying data analytics to test results, attendance and graduation rates can help pinpoint problems and trends. Today's smart devices combined with all manner of web apps and social media tools connect students to teachers, to other students and to diverse learning opportunities in ways never imagined a few short years ago. In one example, school-owned smartphones that allowed a 24/7 wireless connection to teachers improved algebra proficiency results by 30%

Privacy and security

While technologies drive the growth of convenient new products and services, those same technologies have raised privacy concerns in many areas. It is critically important that citizens are able to trust that the information they share with programs and services via smartphones, social media and the like – and particularly potentially sensitive personal information – remain private.

To drive that point home, a TRUSTe survey found only 20% of participants believed the benefits of their smart devices were more important to them than their personal privacy. In other words, the great majority thought their privacy was more important than the convenience of their smart devices.

Implement optimal devices and other instrumentation:

KANAIWA HOSPITAL'S NON-STOP NETWORK SUPPORTS ELECTRONIC HEALTH RECORD SYSTEM

When Kanaiwa Hospital in Kanazawa, Japan, decided to introduce a comprehensive electronic health records (EHR) system, it needed a smooth transition from its old paper record-keeping as well as a "non-stop" network to support the new system.

Founded in 1956, hospital departments include psychiatry, psychosomatic medicine and child psychiatry. Mental disorders often require prolonged treatment periods, resulting in vast amounts of medical records and test data, which meant relying on paper records was time consuming and wasteful.

The hospital needed a robust and healthy medical network that would easily connect their departments, services and functions. Key to the success of Kanaiwa's new network was that it provide "non-stop networking"—meaning a high-availability architecture that removes the risk of failure through resilient design.

Constant access to medical records and other online resources was an essential requirement for the hospital, where time can be a critical factor in providing quality patient care.

Working with Council member Allied Telesis, Kanaiwa Hospital now has its EHR system in place. It includes Allied's SwitchBlade x8100 series core switch, and the Allied Telesis Management Framework (AMF). AMF has enabled centralized and automated network management, and the network is now simple to run, saving time and reducing costs. And Allied Telesis Extricom Series wireless technology provides hospital-wide network access with seamless roaming.

> ***Implement optimal devices and other instrumentation:*** *Since a network system failure can lead directly to entire hospital routines and operations coming to a halt, a non-stop network is of vital importance in healthcare environments.*

Figure 11.10

The security recommendations that follow offer a common sense approach to resolving privacy issues.

Publish privacy rules. Smart cities should let residents know what they are doing to protect their privacy.

Create a security framework. A smart risk mitigation strategy designed to identify and deal with threats will give cities the tools to prevent security breaches.

Combat cybersecurity threats. Security professionals have warned of a dramatic rise in the number of cyber attacks against critical infrastructure – ranging from electric grids and the transportation system to hospitals and other providers of key services. Implementing a cybersecurity network as soon as possible will enhance the safety of personal information – and reduce its cost.

Take precautions to protect patient and student data. Remove personally identifying information from data that is to be stored in the cloud to protect their privacy if the data is stolen or compromised.

These steps will not only provide protections for sensitive personal information, they also will go a long way toward minimizing privacy concerns residents may have about using relatively new services such as telemedicine and other advanced ICT-based technologies that may not be new, but are unfamiliar to residents asked to use them.

By taking these steps, cities will do much to assuage potential privacy concerns that could become a barrier to telemedicine or other advances in health and human services technologies designed to help them.

Connectivity

We talked earlier about how public health agencies use smart devices and other instrumentation to collect data about air quality, disease outbreaks and the like. Collecting it is only a starting place.

Connect devices with citywide, multi-service communications. Connecting the smart devices deployed around cities for public health data-capture to a citywide communications system is important for realizing improved public health outcomes in the same way that smart gas or water meters must be connected to optimize those infrastructures. Water quality monitors that detect a chemical leak that could contaminate a popular swimming beach isn't useful unless the information is communicated in real time to all of the city departments that might need to get involved.

Data management

To reinforce the privacy and security strategies highlighted in the previous section, smart cities will want to make sure all departments are following the same rules.

Create and adhere to a citywide data management, transparency and sharing policy. Again, due to the sensitive nature of data involving health and human services, it goes without saying that a policy needs to be very explicit about who owns which data sets, who has access, how it can be shared and when it should not be shared.

When cities adopt an open data policy for non-sensitive information, they unleash enormous possibilities. In conjunction with a strong and clear privacy policy, city health and human services data can be used to create new health, social services and education apps –an easy win for cities and residents.

Architect a single health history for citizens. As we mentioned earlier, smart cities integrate personal health data from their different agencies and departments so that patients can enjoy the benefits of a single health history. This repository can be more than passive storage – it can be an online, security-enhanced storage, sharing and services platform that citizens can access.

Consider a cloud computing framework:

BIG DATA SOLUTION TRANSFORMS HEALTHCARE WITH FASTER ACCESS TO INFORMATION

Based in Bolton, England, Ascribe is a leading provider of business intelligence (BI) and clinically focused IT solutions and services for the healthcare industry. Ascribe estimates that 82% of National Health Service (NHS) trusts in the United Kingdom use its products. With access to large volumes of data maintained by the trusts, the company wanted a BI solution that would help healthcare providers detect, predict and respond more quickly to outbreaks of infectious disease and other health threats.

Healthcare analysts typically work from data collected and coded when patients receive treatment in clinics and hospitals. "By the time they get that information it's usually out-of-date," says Paul Henderson, Business Intelligence Division Head at Ascribe. In addition, huge volumes of potentially useful data existed in text files from sources such as unscheduled visits to emergency rooms, school attendance logs and retail drug sales. The Internet offered another trove of untapped information including clickstream analysis and social media such as Twitter.

Ascribe decided to design a proof-of-concept that would create a standardized approach to working with healthcare data and asked Leeds Teaching Hospitals, one of the biggest NHS trusts in the UK, to participate.

It implemented a hybrid cloud solution based on Microsoft SQL Server 2012 and the Windows Azure platform. Ascribe chose Council member Microsoft's technology both for the capabilities of individual products and because it offered a streamlined, end-to-end solution that it could implement quickly and easily. Leeds is using the solution to improve community healthcare in multiple ways.

> ***Consider a cloud computing framework:***
> *Ascribe designed a proof-of-concept hybrid cloud solution to create a standardized approach to working with disparate types of healthcare data.*
>
> *Figure 11.11*

Computing resources

There's nowhere in a smart city that computing resources aren't a major player. Below is a quick refresher on four targets to consider in a health and human services context.

Consider a cloud computing framework. Cloud computing has become more affordable and more prevalent. Smart cities of all sizes may see advantages in the cloud's scalability, reliability and cost. However, as we mentioned earlier, before uploading personally identifiable health and human services data to the cloud, steps must be taken to "de-identify" it.

Use an open innovation platform. An open innovation platform empowers innovators. And the possibilities in the health and human services arena are limitless. In New York City, for example, residents can download an app that provides all sorts of useful information about local restaurants – including what grade they received in their most recent health inspections.

Adhere to open standards (and help develop them). A number of information technology standards organizations have health working groups and a few standards groups are dedicated to efficient communication in the health industry. Health-related standards are still emerging, and cities have a stake in their outcome. Groups welcome their participation.

> ***Use an open innovation platform.*** *App development possibilities in the health and human services realm are limitless. This app provides details on recent health inspections at New York City restaurants.*
>
> *Figure 11.12*

Have access to a central GIS. With health and human service agencies spread out in many parts of a city, a GIS will prove useful for smart cities. A central GIS enables efficiency gains through more intelligent scheduling and routing, provides improved accuracy of essential records and boosts resiliency of key assets.

Have access to comprehensive device management. It's important to include devices used by health and human services workers in the field – smartphones, laptops, etc. – as part of a city's device management system to ensure they comply with city data management, security and privacy policies.

A SUPERCOMPUTER TAKES ON HEALTHCARE CHALLENGES

While the Watson supercomputer became a household word after its appearances on TV quiz show Jeopardy!, Council member IBM didn't build it to be a novelty or high-tech curiosity. Far from it.

Watson and its cognitive computing technology have been put to work in a variety of industries, from kitchens to hospitals. In a pilot program with the U.S. Department of Veterans Affairs (VA), Watson is sifting through millions of pages of patient records and medical literature to identify better and faster ways to treat the overwhelming number of war veterans who return home with post traumatic stress disorder (PTSD).

Anne Altman, an IBM general manager, said Watson was designed to help find solutions to some of the world's greatest challenges -- and there's no more important challenge than improving healthcare for our veterans. "The VA is poised to join other key healthcare industry leaders who are already pioneering the use of cognitive computing in healthcare," she said.

Consider a cloud computing framework:

SCHOOL DISTRICT USES DATACENTER SERVICES TO REDUCE COSTS, IMPROVE EDUCATION

Tainan City Education Center is responsible for the technology needs of the Taiwan city's 275 public K–9 schools. This includes Internet connection infrastructure; IT education to help students achieve high levels of technology literacy, and value-added services to assist the schools' teachers and administrators, such as electronic administration, educational technology recommendations and self-service application development.

Each school has traditionally hosted its own server infrastructure, and the large number and geographic distribution of the schools has made it challenging and costly to provide a consistently high level of IT support.

The education center has begun migrating to a new centralized IT infrastructure based on a private cloud model developed in consultation with Microsoft Services Consulting. Microsoft is a Smart Cities Council member.

Education center officials anticipate that the new infrastructure will save the city US$344,000 per year in hardware and support costs, and it will reduce the district's carbon emissions by 2,610 tons annually. In addition, teachers can take advantage of cutting-edge technology to improve classroom materials, and students have increased access to educational resources.

> ***Consider a cloud computing framework.*** *Migrating to a new centralized IT infrastructure based on a private cloud model is expected to save Tainan City US$344,000 per year and improve educational resources in classrooms.*
>
> *Figure 11.13*

Use an open innovation platform:

WIRELESS VIDEO SOLUTION HELPS HOSPITAL PATIENTS COMMUNICATE WITH DOCTORS

Bradford Royal Infirmary and St. Luke's Hospital are teaching hospitals in the United Kingdom that serve the healthcare needs of 500,000 citizens, of which 22% are from black or minority ethnic (BME) origins. Many of them do not speak or understand English, a situation that often resulted in patient communication problems at the hospitals.

With over 900 beds and 5,200 staff collectively, these two busy hospitals deal with over 120,000 accident and emergency (A&E) attendances a year, nearly 50% of whom are estimated to be from the BME communities.

Effective communication between doctors, nurses and patients is vital, but interpretation services were inconsistent. For face-to-face consultations, clinicians used in-house interpreters or hired interpreters from their professional register who specialized in a core set of languages. However, these interpreters were not always available at short notice, so clinicians were often forced to communicate via patients' relatives and friends. The alternative was to use a telephone interpreting agency, but this approach was expensive and unpopular with medical staff because it lacked the visual interaction needed in a patient consultation.

In addition to inconsistency and expense, these methods of interpretation had other disadvantages. Using nonprofessionals increased the risk of misinterpretation, which could create potential risks when delivering medical care. Similarly, using a male interpreter could be embarrassing for women, particularly if their condition was of a sensitive nature.

> ***Innovating with ICT.*** *A wireless video solution allows two UK hospitals to provide much-needed interpretive services to patients on a timely basis, providing a better patient experience with less risk of incorrect treatment or cultural offense due to language issues – and also reducing hospital costs.*
>
> *Figure 11.14*

That's when they came up with the idea of video interpreting. They already used wired and wireless networks from Council member Cisco, so they consulted experts from the Cisco Healthcare Team to help design a wireless-based video solution. A proof of-concept was subsequently arranged to thoroughly test the Cisco solution and gather feedback from both clinicians and patients.

The result is a fleet of trolley-based interpreting endpoints, which are powered by battery packs, allowing easy transportation to any hospital location. The trolley offers a simple keyboard and screen with video communication. Using a mouse, clinicians select the language they require and the preferred gender of the interpreter. The system uses one of the hospital's 350 Cisco wireless access points to connect to a dedicated team of interpreters who constitute, in effect, a small contact center. To help ensure quality of services, video interpreting services are segregated from other traffic on the wireless network.

The primary focus is to make hospital services more accessible to non-English speakers, but a hospital official estimates the solution will reduce interpretation costs by 30%.

Analytics

The four targets highlighted here demonstrate how analytics are particularly important as cities monitor trends and developments in public health.

Achieve full situational awareness. Smart cities use monitoring devices to take the pulse of the city and its people. Situational awareness aids that effort by increasing the reliability and resiliency of the public health infrastructure and those monitoring devices, allowing for quick response to incidents that threaten public health and well-being. Situational awareness depends on different systems being able to communicate about "where" and "when." Thus open standards for encoding, discovering, assessing and using spatial and temporal data play a key role in health and human services analytics applications

Achieve operational optimization. Analytics help cities ensure the best possible public health outcomes. For example, they may reveal a sudden shift in air quality in a particular part of a city that requires corrective action. Or analysis of health records may reveal an abnormally high number of lung cancer cases in a community, prompting an investigation by public health officials.

Achieve asset optimization. The objective here is to ensure maximum value is extracted from a city's investments in health and human services infrastructure – which includes everything from computers in offices to field devices that monitor things like water quality at public beaches. Calculating precisely which assets should be replaced or repaired and when helps achieve maximum return on investment.

Pursue predictive analytics. Analyzing health and human services data to spot patterns and trends and take action before situations worsen can make a city more livable. By monitoring the path and characteristics of a virus, for instance, public health officials can predict where it will strike next and alert residents how they can protect themselves.

As we've said, predictive analytics can also help people understand what their own health might look like in the future, offering incentive for behavior changes.

ISO 37120: A yardstick for measuring city performance

In 2014, the International Organization for Standards announced an ISO standard that applies strictly to city performance. The document -- known as ISO 37120:2014 -- establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, emergency response, transportation and more.

In the ISO 37120 tables we have indicated how the standards correspond to Education and Health relate to the Council's Health and Human Services targets identified in the table following these indicators. Environment and Recreation Indicators are that are part of the standard are highlighted on the next page.

It could be argued that the education theme is perhaps the most important of the 17 indicators in that education is essential to human development. Education powers scientific advancement and economic development, enables people to provide for themselves and their families, and allows for individual enrichment and personal growth.

Health Indicators

			Implement optimal instrumentation	Citywide, multi-service communications	De-identify patient data for research in cloud	Architect single health history for citizens	De-identify student data for research in cloud	Create citywide data management policy	Have access to central GIS	Pursue predictive analytics	Achieve full situational analysis
Core	12.1	Average life expectancy	■	■	■	■		■		■	
	12.2	Number of in-patient hospital beds per 100,000 population	■	■	■	■		■		■	
	12.3	Number of physicians per 100,000 population	■	■	■	■		■		■	
	12.4	Under age five mortality per 1,000 live births	■	■	■	■		■		■	
Supporting	12.5	Number of nursing and midwifery personnel per 100,000 population	■	■	■	■		■		■	
	12.6	Number of mental health practitioners per 100,000 population	■	■	■	■		■		■	
	12.7	Suicide rate per 100,000 population	■	■	■	■		■		■	

Education Indicators

Core	6.1	Percentage of female school-aged population enrolled in schools	■	■			■	■		■	■
	6.2	Percentage of students completing primary education: survival rate	■	■			■	■		■	■
	6.3	Percentage of students completing secondary education: survival rate	■	■			■	■		■	■
	6.4	Primary education student/teacher ratio	■	■			■	■		■	■
Supporting	6.5	Percentage of male school-aged population enrolled in schools	■	■			■	■		■	■
	6.6	Percentage of school-aged population enrolled in schools	■	■			■	■		■	■
	6.7	Number of higher education degrees per 100,000 population	■	■			■	■		■	■

Figure 11.15

The health theme measures key health indicators including life expectancy, a city's healthcare delivery system and its citizens' mental health. Businesses and residents generally want to locate in areas with a high quality of life -- and the health indicators included in ISO 37120 reflect key elements of a city's quality of life.

The environment theme's primary focus is air quality. The World Health Organization estimates that outdoor air pollution caused 3.7 million premature deaths worldwide in 2012.

""We change what we measure – and so it's a good thing when cities carefully and persistently measure what's in the air their residents breathe and the water they drink," says Bill McKibben, a noted author, environmentalist and founder of 350.org. "High standards help keep cities in the forefront of the environmental fight."

The recreation theme measures a city's indoor and outdoor recreational space. As technology industry veteran George Karayannis wrote in the series on ISO 37120 he wrote for the Council: "Recreational space is not only key to a city's livability, it is an essential element of public health and, when properly maintained, provides significant economic benefits for both residents and cities. Public green spaces can be especially useful in combating heat island effects in cities, reducing air and water pollution and minimizing storm water runoff issues."

		Implement optimal instrumentation	Citywide, multi-service communications	De-identify patient data for research in cloud	Architect single health history for citizens	Achieve operational optimization	Create citywide data management policy	Have access to central GIS	Pursue predictive analytics	Achieve full situational analysis
Environment Indicators										
Core	8.1 Fine particulate matter (PM2.5) concentration	■	■			■	■	■	■	■
Core	8.2 Particulate matter (PM10) concentration	■	■			■	■	■	■	■
Core	8.3 Greenhouse gas emissions measured in tons per capita	■	■			■	■	■	■	■
Supporting	8.4 NO_2 (nitrogen dioxide) concentration	■	■			■	■	■	■	■
Supporting	8.5 SO_2 (sulphur dioxide) concentration	■	■			■	■	■	■	■
Supporting	8.6 O_3 (Ozone) concentration	■	■			■	■	■	■	■
Supporting	8.7 Noise pollution	■	■			■	■	■	■	■
Recreation Indicators										
Supporting	13.1 Square meters of public indoor recreation space per capita						■	■		
Supporting	13.2 Square meters of public outdoor recreation space per capita						■	■		

Figure 11.16

HEALTH AND HUMAN SERVICES TARGETS

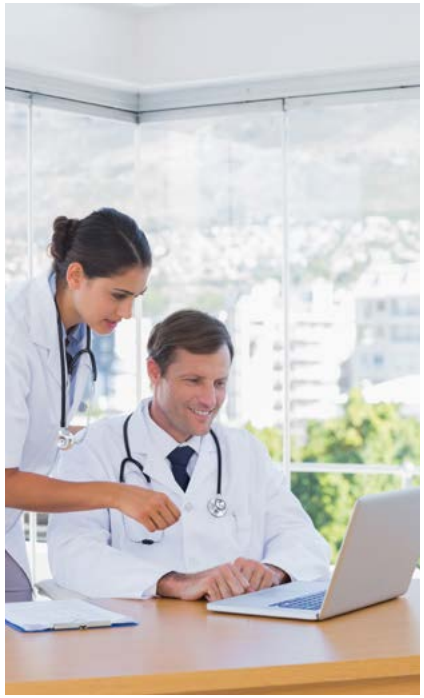
*In the checklist below, targets specifically pertaining to the health and human services responsibility are in **bold,** universal targets are not.*

TECHNOLOGY

Enabler	Health and Human Services Targets: How smart cities deploy and use ICT to enhance health and human services	Implementation Progress: None	Partial	Over 50%	Complete
Instrumentation & Control	Implement optimal instrumentation	☐	☐	☐	☐
Connectivity	Connect devices with citywide, multi-service communications	☐	☐	☐	☐
Interoperability	Adhere to open standards	☐	☐	☐	☐
	Use open integration architectures and loosely coupled interfaces	☐	☐	☐	☐
	Prioritize use of legacy investments	☐	☐	☐	☐
Security & Privacy	Publish privacy rules	☐	☐	☐	☐
	Create a security framework	☐	☐	☐	☐
	Implement cybersecurity	☐	☐	☐	☐
	De-identify patient and student data for storage and research in the cloud	☐	☐	☐	☐
Data Management	Create a citywide data management, transparency and sharing policy	☐	☐	☐	☐
	Architect a single health history for citizens	☐	☐	☐	☐
Computing Resources	Consider a cloud computing framework	☐	☐	☐	☐
	Use an open innovation platform	☐	☐	☐	☐
	Have access to a central GIS	☐	☐	☐	☐
	Have access to comprehensive device management	☐	☐	☐	☐
Analytics	Achieve full situational awareness	☐	☐	☐	☐
	Achieve operational optimization	☐	☐	☐	☐
	Achieve asset optimization	☐	☐	☐	☐
	Pursue predictive analytics	☐	☐	☐	☐

Figure 11.17

ADDITIONAL RESOURCES



Target: Implement optimal instrumentation

Air quality agency automates permitting; higher efficiency leads to better air quality

Bay Area Air Quality Management District regulates air pollution in the San Francisco area. Regulatory oversight for a diverse set of 25,000 businesses requires the district to make its business processes smart, efficient and automated. It worked with Council member Microsoft to implement a foundation for an automated, online permitting and inspection system.

Target: Create a security framework

Nurses on the go: Moving sensitive information securely from remote locations

Visiting Nurse Service of New York (VNSNY) is dedicated to home and community-based healthcare. It has approximately 18,000 employees, including nurses and other healthcare professionals who use tablets to record information from their home health visits. Realizing it needed a way to securely transfer data, including patient health information, to company systems, VNSNY implemented WebSphere MQ software from Council member IBM.

Target: Connect devices with citywide, multi-service communications

8 Essentials for Mobile Learning Success in Education

This white paper suggests best practices and proven solutions to address the most common challenges related to mobile learning, based on experiences from Council member Qualcomm's robust Wireless Reach education portfolio which takes advanced wireless technologies to underserved communities around the world.

Smart Terminals Bring the Whole Hospital to the Point of Care

Hospitals are under pressure to find ways to achieve greater operating efficiency to reduce costs. The "smart" bedside terminal addresses these challenges. This all-in-one device connects and integrates the hospital information network, clinical services and patient entertainment and communication systems, enabling better and more efficient access at the point of care. Read more in this case study from Council member Intel.

Target: Use an open innovation platform

Ooredoo App combats High Infant and Maternal Mortality Rates in Myanmar

Citing infant and maternal mortality rates that are significantly higher in Myanmar than in neighboring countries, Council member Ooredoo launched a free app that gives pregnant women and new mothers instant access to health information.

Stephen Hawking and the Intel Connected Wheelchair Project

In the Connected Wheelchair Project, Intel's Internet of Things group uses the Intel® Galileo board to help Dr. Stephen Hawking and others with disabilities seamlessly interact and analyze their health, wheelchair and accessibility. This video shows the proof of concept being built and includes Dr. Hawking discussing the technology's impact.

CHAPTER 12

PUBLIC SAFETY

From the standpoint of the average citizen, public safety is one of the most visible and perhaps most understood of city responsibilities. We see aid vehicles, lights flashing as they race to the scene of an accident. We watch firefighters on the nightly news risking life and limb to save people from burning buildings. And we pass police officers on bikes and on foot as they patrol city streets. Today's advanced technologies are keeping them – and their communities – safer.

In the Readiness Guide, public safety includes all the infrastructure, agencies and personnel that cities call on to keep their citizens safe — police and fire departments, emergency and disaster prevention personnel, courts, correction facilities, neighborhood watch groups, fire hydrants and squad cars. It's a lengthy list that may include infrastructure and resources from other city departments and non-city agencies and even private citizens.

Smart cities empower these agencies and personnel with information and communications technologies (ICT) to create "smart public safety" and greatly improve safety outcomes. The brief scenario at right illustrates the smart public safety concept.

Enabling smart public safety. *Smart cities empower their public safety agencies and personnel with ICT to improve safety outcomes.*

Figure 12.1

Figure 12.2

In 10 minutes, a tornado will touch down in a suburb of Eindhoven in the Netherlands. Wind and audio sensors deployed across the city have been tracking the super cell as it moves towards a densely populated area.

Eindhoven's command center mobilizes fire and emergency management personnel and resources with a single command, and these personnel move into position. The tornado touches down, damaging several homes. As the tornado dissipates, the two public safety agencies begin their combined search and rescue and triage operations seamlessly – each knowing which resources the other has brought to bear thanks to a citywide communications network. That means they aren't wasting time duplicating effort.

Through their mobile devices, the fire and medical first responders stay current on conditions across the neighborhood as it is explored by their colleagues. At the end of the operation, quick response time and efficient division of labor between agencies are credited with saving lives and resources.

It's about the data

At its core, smart public safety is all about the use of "intelligence" – information that helps people make better decisions. For example, intelligence might hint at the identity of a criminal. Or it might suggest to emergency personnel that a wildfire is likely to occur on the outskirts of town. This kind of public safety intelligence creates immeasurable value not only to first responders, but to city residents and businesses too. As cities become safer, people are happier and healthier, businesses take note and tax revenue increases.

Let's look at four specific ways ICT-enabled smart cities improve public safety outcomes:

- Generating their own public safety data
- Accessing the universe of relevant data
- Correlating data sources to create intelligence
- Delivering intelligence to decision makers

Generating public safety data is a first step in realizing intelligence. Many cities will have much of this data as well as mechanisms for generating it in place already. It's what we call legacy information, or legacy investments. Think of your own criminal database and records that include fingerprints, mug shots, video evidence and so on. Smart cities augment existing sensors with others to obtain all relevant information in their environment. Sensors might include CCTV, other video sensors or audio sensors.

But this data alone isn't enough to create actionable intelligence. Cities must augment it with many other data sources, traditional and non-traditional. In fact, accessing the universe of relevant public safety data is absolutely critical for improving safety outcomes. Public safety requires close cooperation and data sharing across city departments. Police might need access to drivers' license records from a licensing department. Or fire personnel might need to understand weather data from a meteorological agency housed in an energy department.

> ***Using ICT to create intelligence.*** *After being held at gunpoint on a city street, Shayan Pahlevani co-founded a company that makes the free CrimePush app that lets smartphone users push a button to report a crime in progress.*
>
> ***Figure 12.3***

Bridging the information gap:

NEW TECHNOLOGY MAKES CHARLESTON SMARTER AND SAFER

Like many cities, Charleston, South Carolina, faced a need to improve its public safety-related IT and communications infrastructure to help deliver more efficient public safety services for its fast-growing population. Above all, Charleston wanted to find better ways to coordinate the efforts of its police, who are charged with protecting more than 125,000 residents scattered across 127 square miles, along with parks, waterways,and coastal areas.

In addition, Charleston anchors a metropolitan area of about 700,000 people, with several municipalities in a small geographic area, all served by their own separate law enforcement agencies. Sharing information among jurisdictions sometimes proved cumbersome, complicating efforts to respond to developing situations in a timely manner.

Keeping officers safe in the line of duty remained a top priority, and the city wanted to ensure that new technology met internal mandates for cost-effectiveness and sustainability.

The city selected Council member Verizon to help build a solution which ultimately gave their police officers the data, applications, and support they need in an efficient and cost-effective way. They collaborated with makers of in-car video recorders and ruggedized laptops to equip 72 Charleston police cars with a system that allows officers to stay in contact with dispatchers, supervisors, and other patrol units wherever they are in the field. The system immediately helped increase productivity for both officers in the field and personnel back at headquarters.

> ***Bridging the information gap.*** *Charleston police say their patrol officers have reduced the length of traffic stops by almost two-thirds– from about 15 minutes to five. And even though citizens may not like receiving a citation, they appreciate the officers' efficiency and accuracy.*
>
> *Figure 12.4*

Accessing the universe of relevant data aids decision making. States, provinces and regions keep records. National governments and their agencies keep records. Even international organizations like Interpol keep records. And helpful, relevant information can come from non-traditional sources as well – consider the wealth of data that exists in social media. Indeed, by 2030 every city asset, across much of the world, might be sending data in an Internet of Things. Smart public safety agencies seek access to all of it, for every new piece of data that a city has access to makes their intelligence that much stronger and that much more precise.

Accessing all of this information is both a big task and a critical one. Fortunately, ICT and good interoperability and data management policy can help. Already, standards exist that can ensure that the data cities collect and use is interoperable.

Smart cities employ ICT to correlate data and create intelligence. Computing power and analytics transform otherwise useless piles of data into decisions, insight and foresight. For example, armed with this intelligence smart cities predict crime, so that their law enforcement agencies can better protect citizens and make more efficient use of resources.

Additionally, thanks to the open government movement discussed in the Universal chapter, we're seeing more and more crime data making its way into applications that everyday citizens can use. Buying a house and want to make sure you're in a safe neighborhood? On vacation in a new city and want to steer clear of crime-infested areas? Chances are there's an app that can help.

Finally, smart cities deliver this intelligence to decision makers. Public safety intelligence is about saving lives and property, so it must be accessible "no matter where, no matter what." With ICT, smart public safety agencies can disseminate intelligence to multiple departments and thousands of employees so there is a common operating picture.

On the law enforcement side of public safety, intelligence will often lead to arrests, and the involvement of city courts and corrections systems. ICT plays a role in these systems as well. Proper data management systems can help courts make effective use of the enormity of information that they hold. Public defenders can level the playing field with private lawyers and their large staffs with the help of ICT.

Figure 12.5

Dependencies in public safety

Cities contemplating Improvements in public safety will want to take into account public safety's dependencies on other city systems and services. For example, police, fire and emergency services all rely on communications, transportation systems and energy. In normal daily operations, police and fire departments rely on communications and energy systems to maintain real-time situational awareness of activities taking place across a city. And in the urgent case of a natural disaster, first responders will rely on the resilience and reliability of communications, electrical power and transportation systems to help them establish command and control, gain situational awareness, coordinate inbound aid resources and potentially outbound evacuations.

More to smart public safety than meets the eye

As we mentioned earlier, public safety may be one of the more visible and best understood of city responsibilities. But many may not realize how the benefits stack up when cities make it smarter. Here are some highlights that align with our livability, workability and sustainability goals.

Livability

Reducing response times. Citywide public safety situational awareness provides emergency managers and other public safety personnel with an immediate and real-time understanding of incidents, allowing them to respond more quickly.

Making more arrests. Police and investigator outcomes in criminal cases are improved through access to data. Analysis of the universe of relevant public safety data can unearth links between suspects, crimes and other incidents that result in higher case closure rates – meaning fewer criminals on the street.

Lowering crime rates with more resolution and more prevention. Smart public safety lowers crime rates in two ways. First, it empowers police to realize better outcomes, with more cases solved and more arrests made. Second, through analytics it allows for the identification and prevention of threats before they cause harm.

Making people 'feel' safer and mitigating pain and suffering. There is an intangible but very real value to the feeling of safety in a community – when people feel safer, their lives seem more livable. Through improved outcomes, smart public safety also delivers a freedom from the pain and suffering that crime and other incidents cause to citizens.

Workability

Attracting business and talent. Lower crime rates and resiliency to natural disasters like fires and floods aid cities in the competition for businesses and jobs, and they help ensure that once businesses do locate in a city, they can operate safely.

Mitigating reduced earnings and lost productivity. Crime and disaster can result in injuries to employees and damage to business infrastructure. Improved public safety means that not only do smart cities become more attractive to business, but businesses that operate in smart cities are able to do so more securely and with fewer safety-associated costs and risks.

Ensuring fewer business resources go to crime prevention. Crime forces businesses to spend more money than they otherwise would to pay for security and insurance. When crime rates are lowered through smart public safety, businesses win.

Sustainability

Creating operational savings and enabling better resource deployment. To put it simply, smart public safety agencies cost less. In one estimate, a hypothetical public safety agency with $350 million in operating costs can save up to $60 million annually through smart technologies and best practices. Savings rise to $200 million when society, other agencies and victim costs are considered.

Avoiding criminal justice and correction costs through crime prevention. Unleashing analytics on an integrated public safety information database increases cities' crime prevention capabilities. When prevention efforts are empowered, cities spend less on prosecuting and jailing criminals.

Creating higher property values and increasing tax revenue. As neighborhoods across cities become safer, property values rise and increase the prosperity of their residents. This in turn expands the tax base for smart cities' governments.

Ensure better responses to emergencies:

PREPAID CARDS GIVE DISASTER VICTIMS A SENSE OF SECURITY

Every year, the Red Cross responds to nearly 70,000 disasters around the world from home fires to major hurricanes. Since 2005, Council member MasterCard has enabled the American Red Cross to provide emergency relief through prepaid cards. Along with feeding and sheltering, this service allows many disaster affected families and individuals to quickly and reliably get the immediate help they need to get back on their feet.

John Ravitz of the Red Cross provides an example of how important the client assistance cards (CACs) are. A major apartment fire affected 66 people, 30 of them children under age 10. It struck at 3 a.m. on a Sunday morning and people lost most everything. By the next morning they would need medications and food and other daily essentials.

Red Cross was able to get those people client assistance cards within two hours of the fire. Having the MasterCard logo on them means the fire victims could use them at stores in their neighborhood and anywhere MasterCard is accepted. The prepaid cards can also be used to obtain cash at ATMs.

The Red Cross says it prefers to use CACs for a wide range of assistance types because they provide clients with flexibility as to where they shop as well as greater privacy and dignity while making purchases.

"It gives them a sense of security moments after they lose everything," Ravitz said, and helps them to start their recovery process.

> ***Ensure better responses to emergencies.*** *Red Cross was able to get fire victims prepaid client assistance cards within two hours of a major apartment fire, providing the means to immediately start their recovery.*
>
> *Figure 12.6*

Public safety targets

The technology targets described in this chapter can help cities develop a smart public safety infrastructure that uses intelligence to protect lives and property and save resources. There is one new target specific to public safety we'll introduce in this chapter, and we'll also highlight how public safety intersects with the universal targets discussed earlier.

Instrumentation and control

In a smart city, first responders use and obtain data in the field, and therefore they must have a two-way relationship with command centers. That is, police, investigators, firefighters and EMS technicians must not only input data to a command center, they also need to interact with the command center and others in the field. This two-way relationship requires devices that can display information in useful ways, and devices such as video feeds that can transmit data to storage. This target addresses that need.

Implement optimal devices and other instrumentation. In public safety, these devices include those that help agencies and personnel capture data and those that enable first responders to use that data in the field.

For many cities, a large part of capturing data will be surveillance devices, for instance those deployed in neighborhoods or precincts designated as high-risk areas. Some cities may even prefer to adopt a citywide surveillance system to enable more detailed awareness. Importantly, these surveillance networks should produce evidence-quality video. Data-capturing instrumentation is also likely to include audio and pressure sensors in critical areas, or devices purposed for disaster prevention and awareness – weather instrumentation, water sensors and so on. It is likely that some of this instrumentation is the province of other city responsibilities; one of this Guide's universal targets recommends smart cities share infrastructure when possible.

Connectivity

Communications are a critical part of a smart city's public safety strategy, as this target explains.

Connect devices with citywide, multi-service communications. To be effective – and that's absolutely what a smart city wants in its public safety system – two-way communication is essential. So is a citywide communications system that loops in all the personnel, smart devices, databases and ICT systems that have a role in public safety outcomes. As we mentioned earlier, a city might require multiple networks and share them when appropriate, but the key is to ensure all devices are able to communicate effectively on a citywide network.

> ***Connect devices.*** *A citywide communications system that loops in all the personnel, smart devices, databases and ICT systems that have a role in public safety outcomes is essential in a smart city.*

Figure 12.7

Implement optimal devices:

CONNECTING CAMBRIDGESHIRE CONSTABULARY

Cambridgeshire Constabulary is an English force of around 1,400 officers and 200 police community support officers responsible for an area of approximately 3,500 kilometers and a population of 0.7 million.

Cambridgeshire officers depended on paper-based notes that created an inefficient administrative burden and siloed important information. Facing budget constraints, Cambridgeshire Constabulary wanted to make better use of officers' time to reassure the public and protect their safety. It also wanted a way to ensure and demonstrate the integrity of all notes officers take at the scene of a crime which could later be used as evidence.

Cambridgeshire worked with independent software developer Black Marble to develop a mobile application that enables officers to access all relevant data systems from a single point. It deployed the application on Lenovo tablet devices powered by Council member Intel's Core i5 and Atom processors to create a cryptographically secure electronic notebook for each officer. Officers can print wirelessly; share data via USB ports, Wi-Fi or 4G; and connect to existing peripherals such as keyboards and cameras.

The Constabulary estimates that simply mobilizing the desktop for police officers in the field or on patrol has already saved, on average, an hour a day per officer . Internal assessments also show that officers spend significantly less time on administrative tasks.

> ***Implement optimal devices.***
> *The tablets run on Microsoft Windows* 8.1, in line with Cambridgeshire's strategy to standardize its IT, and are compatible with existing x86 applications and peripherals deployed across the force.*
>
> ***Figure 12.8***

Connect devices with citywide, multi-service communications:

WIRELESS MESH COMMUNICATIONS GIVE ROCK HILL POLICE, FIRE ACCESS TO CRITICAL DATA IN THE FIELD

Wireless mesh communications technology from Smart Cities Council member ABB deployed in Rock Hill, South Carolina allows city police officers to spend two more hours per day in the field.

That's because their cars are like mini-offices. With routers mounted in police vehicles, officers have high-speed access to criminal records, including mug shots, right in their vehicles. Within seconds they can perform a background search from a laptop computer or pull up mug shots and fingerprint profiles to help identify a suspect quickly. With the ability to create and file reports from their laptops, each officer spends an average of two additional hours each day in the field protecting the community.

Rock Hill fire department vehicles are equipped with mobile routers enabling firefighters to download documentation such as building blueprints and hazmat data on their way to an emergency call so they are better prepared upon arrival.

"We're really pleased with the fact that Rock Hill is not just staying abreast, but is actually on the cutting edge of the latest technology, and that the implementation of this technology provides a direct benefit to our citizens," said Rock Hill Mayor Doug Echols.

> ***Connect devices with citywide, multi-service communications.*** *Rock Hill fire department vehicles are equipped with mobile routers enabling firefighters to download documentation such as building blueprints and hazmat data on their way to an emergency call so they are better prepared upon arrival.*

Figure 12.9

Interoperability

Interoperability is key in smart public safety because it opens up the world of data and helps generate integrated intelligence, as you'll read in the targets highlighted below.

Adhere to open standards. Open standards for data are a major step in creating actionable, life-saving intelligence for public safety decision makers. Smart cities adhere to data standards that ensure all of the data they collect – not just by public safety instrumentation and personnel, but across their responsibilities and departments – is handled the same way. Standards exist already for the recording, storing, transmission and use of data. Smart cities use the best and most widely adopted standards possible so they have easier access to data from other agencies. They also help promote the use of standards nationally and internationally so that more and more data from across the world can be efficiently shared.

Additionally, by requiring open standards in the procurement of public safety systems and equipment, cities increase the choices available to them and decrease costs because open standards mean products can be mixed and matched from different vendors.

Use open integration architectures and loosely coupled interfaces. There are a number of reasons for sharing public safety data within city departments. And in some cases public safety applications used by one department can be adapted for use by another. Both scenarios are made much simpler when open integration architectures are used.

Prioritize the use of legacy investments, including physically stored data. Earlier we mentioned how cities can avoid redundant and unnecessary investments in data-capturing devices. Police, courts and other agencies involved in public safety gather massive amounts of data, but often critical pieces – mug shots, arrest records, court files, fingerprints and the like – are stored physically. Similarly, some CCTV systems produce physical tape. Smart cities digitize these data sources, connecting them to the rest of the universe of relevant public safety data to create more robust intelligence.

Privacy and security

Even those responsible for safeguarding the public's privacy and security will want to deliver on ICT-related privacy and security targets as they move toward a smarter public safety infrastructure.

Publish privacy rules. By its nature, there is the potential for privacy red flags in much of the day-to-day work that public safety is responsible for. That's why it is so important to address the legal, privacy and ownership issues with a comprehensive privacy policy. Different cities will have different strategies for dealing with access to video, phone records, social network traffic and the like. But all will want to develop rules and governance protocols that are not only transparent but have been vetted with citizens and other stakeholders.

Data management

We mentioned in the last section the importance of privacy rules in the public safety realm; the targets here are an important follow on given the amount of often-sensitive data involved.

Create and adhere to a citywide data management, transparency and sharing policy. Data management policies make it clear what city departments can and can't do with the data they collect. This alleviates confusion, improves data accuracy, eliminates unnecessary duplication and reduces the likelihood of privacy or security breaches.

SUNGARD

Create data management sharing policies:

HOW DATA SHARING HELPS POLICE AGENCIES WORK TOGETHER AND GET THE BAD GUYS

In most parts of the world, this would be a completely useless description of a bank robber: white male, 30-45 years old, bandage on the left side of his neck. Thanks to advanced database technology, however, that's all detectives needed to find the Striped Hoodie Bandit.

The big break in the case came as a result of database technology developed by Council member SunGard Public Sector, technology that helps different police agencies work together. Thanks to the ability to share information with other agencies and the dedication of police to enter even small clues into it, that seemingly vague description pointed to one man.

Before the police caught up with their robbery suspect, he had already robbed three banks and a convenience store.

Since he robbed places that are under video surveillance, police had pictures of him, but even when detectives went door-to-door they couldn't find anyone who recognized him. The answer ultimately came from Police-to-Police (P2P) Data Sharing, a component of SunGard Public Sector's ONESolution Records Management System. That service links all of the police agencies that use it through one search form. All the agencies that use it can search all of the other members' records for distinctive features about individuals, cases or trends.

A Crimestoppers coordinator entered what appeared to be an ambiguous description into that database and came up with a name. Police got a warrant for his arrest after they compared previous pictures of him with the video..

> ***Create data management sharing policies.*** *The success in solving the case of the Striped Hoodie Bandit showed the various police agencies who worked on it the value of working together and using the available tools.*
>
> ***Figure 12.10***

Computing resources

Advanced computing capabilities have dramatically changed the public safety playing field as these targets reveal.

Use an open innovation platform. Here's a prime example of why this target is so important. Like so many other cities today, Glasgow, Scotland holds regular "future hacks" or "hackathons" to encourage software developers to focus their brainpower on apps that can help solve city problems.

According to The Guardian, an event in early 2014 challenged the coders to do something that improved public safety. The winning team presented the idea of helping emergency services find people quicker when they are calling from a mobile phone.

"At the moment, if someone calls 999 their location can be determined using the nearest mobile phone masts," said Joshua McGhee, a computing science student who worked on the winning design. "But that doesn't give very detailed information. Instead we're providing geotagged data which lets services see exactly where someone is, even if the user isn't sure where they are themselves."

Have access to a central GIS. Public safety's focus on location and on being able to act decisively in time-sensitive situations makes GIS critically important. It improves decision-making capabilities, enables efficiency gains through more intelligent scheduling and routing, provides improved accuracy of essential records and boosts resiliency of key assets.

Keep in mind, however, that in public safety and disaster management, users of many different geospatial systems need to communicate, often in an ad hoc fashion. Thus a central GIS and countless other GISs and miscellaneous devices and resources need to implement open standards that make it possible for them to communicate complex geospatial information.

Have access to comprehensive device management. This target is also extremely relevant in public safety, given the number of devices dispatched in the field and the serious problems that could occur if they end up in the wrong hands. A comprehensive device management system helps enforce compliance with city data management, security and privacy policies.

> ***Have access to comprehensive device management.*** *Public safety data in the wrong hands could lead to massive problems. Protecting data with device management software reduces the risk.*

Figure 12.11

WHY HAYWARD STREAMLINED NETWORK TRAFFIC ONTO A SINGLE, FLEXIBLE PLATFORM

Like many cities, Hayward, California's IT department faces growing demand for services while budgetary resources recede.

Located in California's Bay Area, Hayward has a population approaching 150,000 and is the third largest city in Alameda County. The city's network provides vital technology support to its onsite and remote staff, as well as a number of important community services for city residents.

The network is the hub of all activities that keep it moving forward, including mission-critical public safety systems. As demand has grown and with technology continually evolving, the city administration realized its infrastructure was at risk of becoming outdated and complex, which was making it too costly to scale, let alone maintain.

Hayward began looking for an answer that would result in a network capable of scaling the services and applications to more effectively support staff and the public. At the same time, the city needed a streamlined solution to reduce complexity and cost..

Council member Cisco's Nexus 5500 and 2200 Series Switches provided a platform to accomplish exactly what the city needed: new technology that would update and simplify its infrastructure and result in overall sustainability.

Using the Cisco solution to converge the data and storage networks improved how the network is managed and created a robust, more compact architecture that is very efficient. Streamlining the network traffic onto a single, flexible platform has improved the network's overall performance and enabled the city to handle its existing load and boost capacity. The change transformed the total network footprint into a smaller configuration that required less space, power and cooling.

> ***Computing resources.*** *Converging its data and storage networks improved how the city of Hayward's network is managed and created a robust, more compact and more efficient solution.*
>
> ***Figure 12.12***

Analytics

There's a big story to tell about the impact analytics can have in the public safety sector, as the targets below explain.

Achieve full situational awareness. In smart public safety, full situational awareness (also referred to as a "complete operating picture") is created and maintained through the use of city command centers. Command centers are so important because they assimilate a single version of "the truth" so everyone involved in a situation is working off the same information. When time is a factor and lives are at risk, you want to be sure that the left hand knows what the right hand is doing. You want thousands of employees, and a handful of different agencies and city departments, to have the exact same information.

Command centers deploy analytics capabilities across the universe of relevant public safety data – the discipline often referred to as Big Data. They correlate, in an automated way, these hundreds or thousands of data sources, criminal profiles or social media streams, for instance, to create intelligence. And they use this intelligence to render a complete operating picture for public safety personnel – actionable intelligence that helps keep people safe (themselves included). This correlation of data is an ongoing and automated process, so new data is always informing the constantly evolving public safety picture across the city.

Command centers also provide unified threat assessment functionality and are responsible for the coordination and control of incident response and management. With this real-time understanding, emergency managers can assess safety needs and prioritize actions and resources. Because it is a central command, there is authority to deploy resources across agencies, departments and service boundaries to achieve desired outcomes without jurisdictional issues. This is critical because often in emergency situations, other city departments must be part of the response – for example, transportation or public health.

A complete operating picture. *When time is a factor and lives are at risk, cities want to ensure that everyone working on an incident response has the same information.*
Figure 12.13

Achieve full situational awareness:

MADRID REDUCES PUBLIC SAFETY RESPONSE TIMES BY 25%

On March 11, 2004, Madrid suffered a major terror attack when several commuter trains were bombed. As with the 9/11 attacks in the United States, this tragic incident highlighted the need for greater coordination among first responders.

"The different emergency entities — the police, the fire department, the ambulance service and the mobile police — intervened independently, and all of them had disparate communication systems and technologies," says Fernando Garcia Ruiz, head of innovation and development, Department of Security for the City of Madrid. There was no way to organize a unified response to incidents, and there was a lack of centralized command and control.

A key lesson was that more than one major incident can happen simultaneously, and emergency assets may be needed in more than one place. Different incidents may be related, or have nothing to do with one another – without a clear overall picture, it may be impossible to tell if there is an important pattern emerging. This potential for complexity poses a significant challenge for emergency managers. They not only need to coordinate activity, but also require a thorough understanding of everything happening in the metropolitan area so as to properly allocate limited resources to provide the best response to each incident. In addition, proactive measures such as limiting access to impacted areas, or crowd and traffic control for public events, has to be included in the mix.

> ***Achieve full situational awareness.*** *The combination of forward-looking system design and end-to-end integration gives emergency managers in Madrid the tools needed to not only deal with today's threats, but also handle rapidly evolving situations and technologies as they emerge.*

Figure 12.14

The need, therefore, was not only for top-down coordination, but also for the ability to capture and integrate information to give managers the understanding and insight required to quickly make the right decisions.

In the aftermath of the bombings, the Madrid City Council took action to better protect the public by commissioning an advanced emergency command center for the city—the Centro Integrado de Seguridad y Emergencias de Madrid, or CISEM.

The mission was ambitious: reduce emergency response time, integrate information, standardize procedures and protocols, provide seamless coordination and planning, enable shared use of resources, optimize information management and promote prevention through better planning.

Indra, a regional systems integrator specializing in the public sector, teamed with Council member IBM to provide the integrated, service-oriented IT infrastructure that would make CISEM a reality, along with needed business process transformation to enable coordination among all of the stakeholders.

Now the combination of forward-looking system design and end-to-end integration gives emergency managers in Madrid the tools needed to not only deal with today's threats, but also handle rapidly evolving situations and technologies as they emerge. Any sensor input — video, data or voice — from any source can be readily incorporated into the data stream and accessed by anyone who needs it.

Situational awareness is now at an unprecedented level. The single, unified view of status and events reduces confusion and enables far faster and more effective decision making. Managers are now better able to deploy the right assets the first time, reducing response time by 25%.

> ***Achieve full situational awareness.*** *Indra, a regional systems integrator, teamed with Council member IBM to provide the integrated, service-oriented IT infrastructure that made CISEM a reality.*

Figure 12.15

Achieve operational optimization.
ICT helps level the playing field for public defenders who often don't have the funds for research that private attorneys do. With analytics and operational optimization, city courts can transform the way they access information.

Figure 12.16

Achieve operational optimization. This target offers savings potential for cities' public safety agencies. Along with full situational awareness, analytics can unearth new insights into how cities deploy their public safety resources, thereby generating savings.

Operational optimization also holds great promise for city court systems. Courts have access to an enormous quantity of data, often so much so that the data can be difficult to make use of. Public defenders often have much smaller staffs than the lawyers they are up against, and these larger staffs can devote much more time and energy to research that wins cases. ICT levels the playing field. With analytics and operational optimization, city courts can transform the way they access information, improving outcomes for not just the courts, but the cities and the people that they represent and protect.

Pursue predictive analytics. The insights analytics provide can lead to better public safety planning and decision-making by projecting trends and predicting outcomes to the point that they can even prevent some crimes from occurring. Full situational awareness allows cities to allocate their resources more efficiently for incident response and management. And they can simulate, for example, a potential natural disaster and take steps to mitigate some of the likely devastation before the disaster occurs.

All of the applications of analytics discussed in this section deliver tangible operational savings. Better planning, decision-making, predicting and resource allocation all lead to money saved for public safety agency operations budgets.

Achieve operational optimization:

THAI LAW ENFORCEMENT AGENCY OPTIMIZES INVESTIGATIONS WITH BIG DATA SOLUTION

Established under Thailand's Ministry of Justice, the Department of Special Investigation (DSI) is a national law enforcement agency dedicated to stopping serious criminal activity. DSI needed better tools for mining large sets of structured and unstructured data to improve investigation processes and reduce manual procedures.

The agency's large data sets included more than 1 million records gathered from multiple sources in both structured and unstructured formats, such as images, videos and documents.

"It was very difficult to mine through the data, and the results were too broad with unclear targets," says Police Colonel Yannaphon Youngyuen, Deputy Director of the DSI. "This often forced us to send personnel to the actual crime scenes, which cost us a lot of time and money."

DSI implemented a big data solution based on Council member Microsoft's platform and Apache Hadoop software to give investigating officers self-service business intelligence tools and data-management capabilities. With them, DSI has improved accuracy and shortened criminal case investigation time from two years to 15 days. DSI plans to implement its own private cloud to manage the security of confidential data.

> ***Achieve operational optimization.*** *DSI needed better tools for mining large sets of structured and unstructured data to improve investigation processes. The Microsoft Big Data solution it implemented has dramatically shortened time spent on criminal investigations.*

Figure 12.17

Improving public safety:

PRIORITIZING THE IMPLEMENTATION OF AUDIBLE PEDESTRIAN CROSSWALKS

The Community Geomatics Centre (CGC) is a division of the nonprofit Sault Ste. Marie Innovation Centre, a Council Advisor located in Sault Ste. Marie, Ontario. The CGC is unique in Canada and promotes and establishes partnerships and technological means to efficiently share geospatial data, tools and knowledge amongst community organizations to create a safer, healthier and more prosperous community.

The City of Sault Ste. Marie's population is aging rapidly, as is the population of visually impaired individuals. With the commitment to implement audible pedestrian crosswalks in the city, the CGC was approached to prioritize intersections for audible pedestrian crosswalk infrastructure implementation over time.

The CGC acquired postal codes of all visually impaired citizens through the Canadian Institute for the Blind (CNIB) and had these citizens complete a survey about the businesses and locations they visited when outside of their homes.

This data was combined with pedestrian collision data, transit routes and stops, speed limit and intersection characteristic data. Data elements were weighted and processed to rank intersections from high to low priority for implementation.

During the past few years, several high priority intersections have had the audible crosswalk technology implemented as determined by the suitability analysis.

> ***Improving public safety.*** *Several data variables, including transit routes and stops, are weighted and processed to create a suitability index for the implementation of audible pedestrian crosswalks in Sault Ste. Marie, Ontario.*
>
> *Figure 12.18*

ISO 37120: A yardstick for measuring city performance

In 2014, the International Organization for Standards announced an ISO standard that applies strictly to city performance. The document -- known as ISO 37120:2014 -- establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, urban planning, wastewater, water, sanitation and more.

In the table at right we have indicated how the standards related to Safety correspond to the Council's Public Safety targets identified on the next page.

A visible and engaged police presence is a critical element in deterring crime, as reflected by the ISO 37120 indicators measuring police officers per 100,000 population and response times. However, many cities are finding that it takes more than law enforcement and criminal justice to combat crime. Community involvement, economic opportunities, substance abuse treatment and socially inclusive programs for at-risk individuals have also been shown to reduce crime in targeted areas.

Safety Indicators

			Implement optimal instrumentation	Citywide, multi-service communications	Create citywide data management policy	Achieve full situational analysis	Achieve operational optimization	Pursue predictive analysis
Core	14.1	Number of police officers per 100,000 population						
	14.2	Number of homicides per 100,000 population	■	■	■			■
Supporting	14.3	Crimes against property per 100,000	■	■	■			■
	14.4	Response time for police department from initial call	■	■	■	■	■	■

Fire and Emergency Response Indicators

Core	10.1	Number of firefighters per 100,000 population						
	10.2	Number of fire related deaths per 100,000 population	■	■	■	■	■	■
	10.3	Number of natural disaster related deaths per 100,000 population	■	■	■	■	■	■
Supporting	10.4	Number of volunteer and part-time firefighters per 100,000 population						
	10.5	Response time for emergency response services from initial call	■	■	■	■	■	■
	10.6	Response time for fire department from initial call	■	■	■	■	■	■

Figure 12.19

PUBLIC SAFETY TARGETS

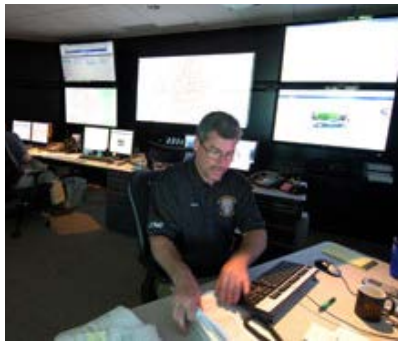
*In the checklist below, targets specifically pertaining to the public safety responsibility are in **bold,** universal targets are not.*

TECHNOLOGY

Enabler	Public Safety Targets How smart cities deploy and use ICT to enhance public safety	Implementation Progress None	Partial	Over 50%	Complete
Instrumentation & Control	Implement optimal instrumentation	☐	☐	☐	☐
Connectivity	Connect devices with citywide, multi-service communications	☐	☐	☐	☐
Interoperability	Adhere to open standards	☐	☐	☐	☐
	Use open integration architectures and loosely coupled interfaces	☐	☐	☐	☐
	Prioritize use of legacy investments **(Supplement: including physically stored data)**	☐	☐	☐	☐
Security & Privacy	Publish privacy rules	☐	☐	☐	☐
	Create a security framework	☐	☐	☐	☐
	Implement cybersecurity	☐	☐	☐	☐
Data Management	Create a citywide data management, transparency and sharing policy	☐	☐	☐	☐
Computing Resources	Consider a cloud computing framework	☐	☐	☐	☐
	Use an open innovation platform	☐	☐	☐	☐
	Have access to a central GIS	☐	☐	☐	☐
	Have access to comprehensive device management	☐	☐	☐	☐
Analytics	Achieve full situational awareness	☐	☐	☐	☐
	Achieve operational optimization	☐	☐	☐	☐
	Achieve asset optimization	☐	☐	☐	☐
	Pursue predictive analytics	☐	☐	☐	☐

Figure 12.20

ADDITIONAL RESOURCES



Target: Pursue predictive analytics:

Miami-Dade Police Department: New patterns offer breakthroughs for cold cases

Florida's Miami-Dade Police Department recognized that reducing street crime is key not only to its citizens' quality of life, but also to the vitality of an essential economic driver – tourism. By working with IBM to analyze cold robbery cases against its historical crime data, the department's robbery unit is uncovering insights that are key to solving them. And as the successes mount, the unit's detectives are embracing a new crime-fighting tool as a way to give them a second chance on what used to be dead-end cases.

Target: Create a data management sharing policy:

Small city deploys big city crime-fighting tools

To begin responding to high-priority calls before an officer is dispatched, the Ogden Police Department needed improved access to the data in its many systems. The department chose Fusion Core Solution, a web portal based on Council member Microsoft's platform and Esri ArcGIS mapping software. Department analysts now can provide important information to officers who are en route to a call, thereby increasing officer safety and effectiveness and reducing call handle times.

Target: Pursue predictive analytics:

How digging through the deluge of social media data could lead to safer cities

A data scientist at Pacific Northwest National Laboratory, a Council advisor, has created a social media analysis tool capable of analyzing billions of tweets and other social media messages in just seconds. The idea is to discover patterns and make sense of the data – and ultimately – surface useful information that can enhance public safety and health.

Target: Consider a cloud computing framework:

Sheriffs department enhances mobility, improves public safety with cloud services

San Bernardino County Sheriff's Department relies on modern technology to help protect and serve the citizens of the largest county in the United States. It began to investigate cloud-based IT solutions to replace its on-premises hardware and software and settled on Microsoft Office 365 ProPlus for its 3,400 employees. This video from Council member Microsoft explains why.

CHAPTER 13

SMART PAYMENTS AND FINANCE

"More with less" is one of the promises of smart city technology -- and nowhere is this more true than in payments and finance. By leveraging the techniques explained in this chapter, city governments can spend less while offering citizens more benefits, more convenience and more inclusion.

Today cities are the hub of world economic growth, generating an estimated 80% of global GDP, according to the World Bank. Yet many cities are severely challenged by rising (or slowing) population growth, by aging or inadequate infrastructure, by increasing operational costs and by "do more with less" austerity pressures.

So how can they compete effectively? How can they pay for the smart infrastructure improvements that attract and keep new businesses, skilled workers, tourists and other accoutrements of a robust economy?

They can start at city hall.

Cities bring in revenue – from the money drivers put in parking meters to the sales tax shoppers pay to the fees developers shell out for building permits. Money flows the other way too, of course, from salaries paid to city employees to goods and services procured from vendors.

In fact, cities make huge volumes of payments to suppliers, to employees and to citizens receiving benefits. They also collect big amounts in taxes, fines and use payments. This makes payment systems an important target for modernization.

Payments touch every aspect of our lives.

> ***Digitalizing payment mechanisms.*** *Digitalizing a city's disparate payment mechanisms into an integrated whole provides greater efficiency and oversight.*
>
> *Figure 13.1*

Removing cash from the economy creates far-reaching and cumulative benefits for all participants — citizens, merchants, tourists and government — improving life for the city at-large. That's because cash causes problems while increasing costs. By digitalizing both disbursements and collections, a city generates significant savings and increases operational efficiency.

But in many cities, that economic engine needs a tune-up. New digital tools – sometimes referred to as e-government or mobile

government solutions – can drive more efficient service delivery. For example:

- **City dashboards** allow cities to measure progress toward stated goals against a set of key performance indicators (KPIs). With the help of KPIs, cities can continually monitor and improve their strategies.

- **E-procurement** moves the entire procurement process to an integrated electronic platform. This allows a city to get real-time access to a database of suppliers to make price comparisons. The Korean On-Line E-Procurement System (KONEPS) delivered an estimated $8 billion in savings in 2010. And the SmartPay program of the U.S. General Service Administration reports estimated savings of $70 per transaction ($1.7 billion annually) when electronic payments replaced written purchase orders.

- **Electronic payment systems** "digitalize" a city's disparate payment mechanisms (licenses, social service payments, transit payments, parking meters) into an integrated whole, providing greater efficiency and better oversight. Electronic disbursement of salaries and benefits reduce costs to 60%, according to research by Council member MasterCard. Reducing the cash in a city's ecosystem also reduces the grey economy, since digitalization provides more transparency and control while increasing collections.

- **Advanced revenue collection and payment systems** enable individuals and businesses to submit tax, application permits and the like online. These electronic forms and autofill features can save money and time while reducing errors. Cities can also strengthen compliance by integrating business analytics, big data, business rules and workflow. Some cities report revenue increases of 5% or more as a result.

Cash is costly:
Collecting cash and coins from city parking lots and terminals creates huge costs for cities. By digitalizing disbursements and collections, a city generates significant savings and efficiencies.

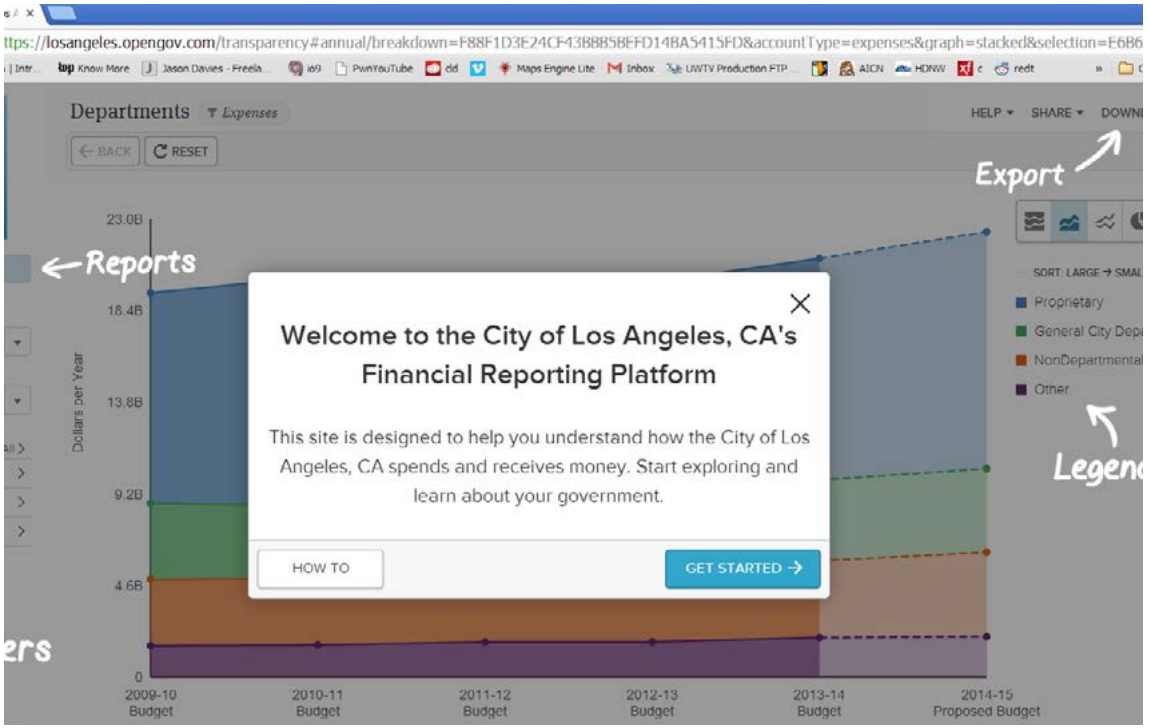
Figure 13.2

Technology + transparency: A win-win for cities

Another important reason for a financial tune-is to enable greater transparency into city operations. When citizens have visibility into city finances they may be more inclined to vote yes on the next bond issue to pay for an infrastructure upgrade.

In early 2014, Edmonton, Alberta added data on its operating budget to the city's open data catalog. Cities often post their budgets online, but the Edmonton approach will allow citizens to actually manipulate or reformat it. Mayor Don Iveson told the local media that it's about freeing up the information the city has and that citizens have paid for. "Open government," he said, "is about trusting that our public is going to add value to our decision making if they can see more of the information."

Similarly, Los Angeles Mayor Eric Garcetti launched a new website to make it easier for people to review his city's finances. It features interactive graphs of the current and past budget, including multi-year trends and departmental revenue and expenditure details. Increasing transparency also allows cities to get more visibility and control over civil servants' spending as well as over the use of public benefits. For instance:



- **Virtual payment cards** can be generated on-the-fly and used only for a specific amount and with a specific supplier. This avoids loss of control over expenses when multiple people get corporate cards or access to payment instruments. Likewise, travel and expense (T&E) can be loaded and controlled remotely and given to city employees for specific purposes.

> ***Promoting transparency:*** *Los Angeles, California residents can examine their city's finances via interactive graphs comparing current and past budgets.*
>
> *Figure 13.3*

- **Prepaid benefits cards** give government agencies much greater control over the use of public funds. For instance, usage can be limited by time of day, category of merchants, or geographical area. Prepaid cards can be used for all kinds of city programs, including student benefits, cafeteria cards, childcare subsidies, pensions, etc. The city of Toronto is saving roughly $2.5 million per year by eliminating checks in favor of prepaid benefits cards.

Numerous systems can help cities become more efficient and more transparent. In this chapter we'll introduce a smarter approach to financial management and payments. We'll also step outside city hall to explore ways to promote smarter payment practices across the city.

What this chapter won't cover

Cities rely on a wide range of financial tools to pay for civic improvements – taxes, grants, bond issues, public-private partnerships and a host of emerging alternative funding mechanisms. Those tools are ***not*** covered in the Readiness Guide. In March 2014, the Council in collaboration with the Arizona State University Center for Urban Innovation published the Smart Cities Financing Guide. It offers detailed analysis and case studies of 28 of the most promising financing tools available to help cities and regional governments pay for smart city projects. You can download the current version of the Guide at the Council website. Frequent updates are anticipated as new financing opportunities and best practices emerge.

Trends shaping financial management systems

Major trends are affecting cities and raising challenges that argue against doing business as usual. These trends make a smarter approach to financial and payment systems even more critical, both as an economic enabler but also as a source of cost savings. These trends include digitalization, ubiquity, convergence, transparency and personalization. Each one has benefits... and dangers too.

Digitalization. Smartphones and other digital devices are everywhere. But digitalization can go far beyond what we see today. For instance, where pay-by-weight waste collection is in place, a simple chip can automate payment. Likewise, many cities have mobile apps that enable residents to pay water bills or pay for parking spaces with a mobile phone. We will see even more of that in the future. But the digitalization trend also triggers challenges for cities, such as development of the required connectivity, interoperability and robust security.

> ***Smart Cities Financing Guide.***
>
> *Download the Guide containing detailed analysis and case studies of 28 municipal finance tools at the Council's website.*
>
> *Figure 13.4*

Ubiquity. City employees are no longer constrained to stay in the office to communicate. Field workers – from public safety personnel to transit operators – typically carry smartphones, tablets or laptops on the job. As valuable as these tools can be, they raise security issues if privileged information on them gets in the wrong hands.

Convergence. Urban consumers now have much more than music and pictures on their

Reducing time and inconvenience:

MOBILE TRANSIT APP A BIG HIT IN FRANKFURT

Rhein-Main-Verkehrsverbund GmbH (RMV), one of Europe's largest transport associations, saw a 30% growth in mobile ticket sales in 2014 over the previous year.

"The RMV mobile ticket is designed to enable an easy and fast way to buy a transit ticket. With a few clicks you can buy a ticket whether you are on the train platform or on your way to the bus stop. Customers no longer have to deal with long waiting times and searching for change. Frequent journeys can be stored in the app as favorites, further speeding up ticketing," said Knut Ringat, RMV Managing Director.

Developed by Council member Cubic Transportation Systems, the RMV app offers unique features over other mobile solutions, including the number of payment options. Customers can choose to register for an RMV account online and link their mobile ticket payment to their bank card or mobile phone bill, or pay via "girogo," the contactless smart card that does not require a Personal Identification Number (PIN) and signature, which is offered by Germany's Sparkasse bank.

> ***Reduced time and inconvenience.*** *Mobile transit apps mean customers no longer have to wait in long lines and search for the right change when using public transit.*
>
> *Figure 13.5*

smartphones – they may also have payment instruments and loyalty cards. Because they connect to the Internet from multiple devices, they cannot store and use local data. Instead, that data needs to follow them around. To allow that "follow me everywhere" capability, payment systems must provide secure and convenient solutions based on cloud computing.

Transparency and control. Many new services allow citizens to make better choices – for instance, by delivering price comparisons or nutrition tips. And this also applies to public institutions. Citizens increasingly expect full visibility into public expenditures and return on investment.

Personalization. People want applications, offers and services tailored to their individual needs and delivered at just the right time – for example at the point of sale while shopping. As they become accustomed to personalization, they will expect it from their city government too.

The inclusion challenges cities can't ignore

In many parts of the world, smartphones, and tablets seem ubiquitous. But a large portion of the global population does not yet have access to digital technology.

Similarly, the World Bank reported in 2014 that 2 billion adults worldwide are unbanked. But the situation is improving. According to a Gallup report, "The number of adults worldwide who report having an account at a formal financial institution or through a mobile device grew by an estimated 700 million between 2011 and 2014. Now, 62% of the world's adult population has an account, which is up from 51% in 2011."

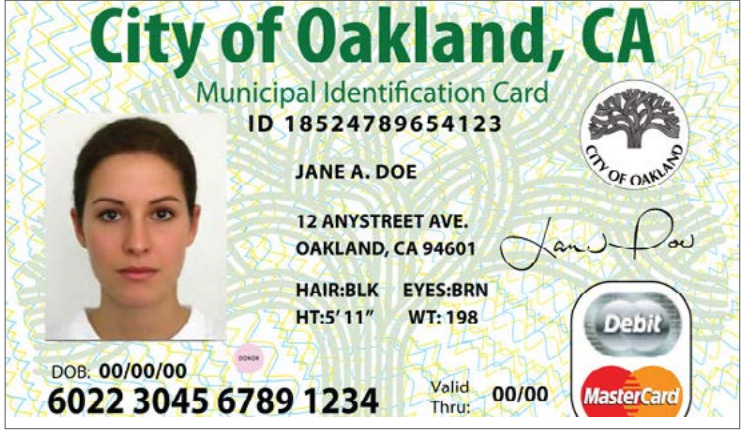
Also, given the migratory nature of society today, many cities are seeing increasingly large segments of their populations who do not speak the native language.

All of these circumstances – lack of Internet access, digital technologies, banking services and language barriers – present challenges to cities, especially in financial services. Citizens without Internet access still need a way to take advantage of city services. Those who don't use traditional banking still need a way to submit and receive payments. Those who don't speak the native language still need a way to understand things like city tax and permitting requirements.

Thankfully, we are starting to see advanced technologies that promote inclusivity. Among them:

Virtual city halls and kiosks. In Nice, France, a "virtual city hall cabin" was set up in a shopping mall in 2013. The "cabin" is equipped with Cisco high-definition video equipment that allows residents to interact face-to-face with a remote agent who receives and processes requests. The point is to bring public services closer to places residents typically frequent (such as municipal libraries and shopping malls), with extended operating hours. Although convenience is one objective, this scenario also enables citizens without Internet access to connect to city services without making a trip to city hall.

Prepaid cards for unbanked citizens. Cities can provide their financially excluded citizens with prepaid products seamlessly collect and make payments. In 2013, Oakland, California became the first municipality in the U.S. to issue a city ID prepaid debit card to provide a government ID for residents lacking an official form of identification and to provide optional, secure financial services and products to those unbanked and under-banked. All city residents able to provide proof of identity and residency in Oakland are eligible for the card.



Prepaid cards for unbanked citizens.

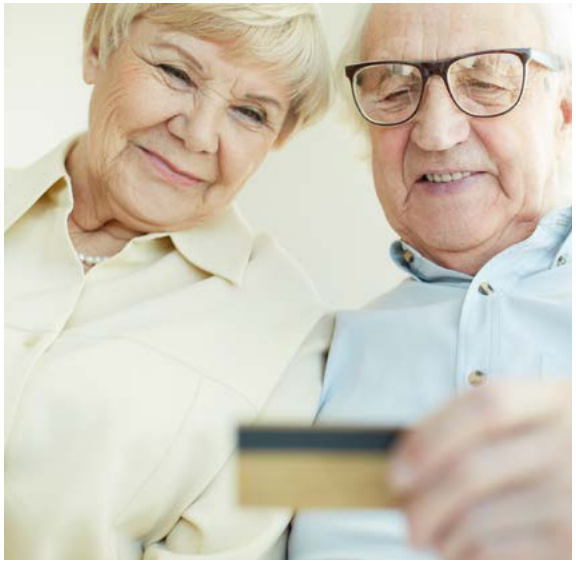
In 2013, Oakland, California became the first municipality in the U.S. to issue city ID prepaid debit cards.

Figure 13.6

Mobile apps with translation capabilities. As cities create apps that give access to city services, they can overcome language barriers via translation technology. For example, the city of Costa Mesa, California launched its Costa Mesa Connect app in partnership with New York-based PublicStuff. The app features One Voice Translation to support over 17 languages. When a resident submits a request in another language, the request is automatically translated into English for city staff. Any subsequent updates on the request are automatically translated back into the resident's preferred language.

Doing more with less:

LONDON BOROUGH OF BRENT IMPLEMENTS PREPAID CARDS



In 2012, in an era of unprecedented budget cuts, UK Local Authorities sought ways to reduce costs and improve efficiency while protecting front line services. In particular, a number of local authorities looked for improved solutions to distribute local benefit payments and services. The main goal was to reduce the costs of their systems, but also to improve the ability of local authorities to track and manage the funds and recover unspent monies. Additional goals included reducing fraud and leakage from the system.

The London Borough (LB) of Brent was one of the first local authorities to launch a prepaid card for disbursing benefit payments to their Adult Social Care group of recipients. After learning lessons with a first pilot, the Borough partnered with Prepaid Financial Services, a payment provider, and Council member MasterCard to redesign and re-introduce a new program, designed to serve both government needs for more efficient distribution of benefits and services, and citizens' need for a safe, convenient way to receive and use payments.

For clients of the program, the main benefits are not having to generate and send in their own paperwork, 24-hour access to their spend information and balances through the online portal, and care-givers are paid much more quickly. The Borough has encountered very few problems in persuading people to use prepaid cards; they are seen as a great benefit since they are more secure than cash.

> ***Doing more with less.***
> *In the first eight months of the borough's new prepaid card introduction, reclaim rates rose to 90% to 95% and identified surplus balances of approximately £330K.*

Figure 13.7

Benefits of smart payments and finance

Before we give you specific guidance for improving financial management and payment, let's examine how those improvements enhance a city's livability, workability and sustainability.

Livability

Making convenience a priority with smart payments. Long lines at the counter, long hold times on the phone and slow response to emails don't cut it in today's fast-paced world. Smart payments offer faster, more convenient solutions. A few examples:

- The New Delhi (India) Municipal Council introduced smart cards that residents can use to pay their utility bills.
- In London, services such as PaybyPhone enable consumers to pay for parking from their mobile phone; no need to carry change. They can even top up the meter remotely, saving a trip back to the parking spot.
- Instead of standing in line to buy tickets, public transit riders in Sydney, Australia use their prepaid Opal cards to tap on a card reader at the start of a trip and again at the end. And not only do Opal cards offer conven-

ience for bus, ferry and train riders, they also offer fare incentives, including free travel after eight paid journeys in a week.

Offering one-stop city services. By modernizing IT infrastructure with e-government solutions, cities can transform service delivery in exciting ways. No longer do constituents have to work their way through a maze of city departments when they are trying to take care of city business. By securely integrating previously siloed information from multiple departments into a single system view, city staff and constituents alike can be more efficient. A couple wanting to get married, for instance, can log on and apply for a marriage license, reserve a city facility for their reception and pay required fees in a single transaction. With every interaction, they build an identity with the city which allows them to consume a wide range of services through a single, secure portal.

Providing financial peace of mind. Connected, mobile citizens will benefit from emerging digital form factors – digital wallets, for example – that provide a single interface for all of their payment mechanisms, loyalty programs, transportation tokens and more. Using technologies such as near-field communications (NFC), contactless wallets of the future will be the repositories for ID cards, social and health programs, transportation cards – enhancing livability by having everything at hand and recognized in a second.

Using consumer data to unearth trends.
Public transit operators can leverage payment data to adjust transportation capacity in real time.

Figure 13.8

Using consumer data to unearth trends. Once cities use data analytics to understand citizen behaviors and preferences, they can modify systems to better meet their needs. For instance, public transit operators can analyze payment data to adjust transportation capacity in real time. Or city public health officials might take a cue from disease detectives in British Columbia. They tracked and ended an outbreak of hepatitis A by analyzing food purchase histories on grocery store loyalty cards.

Workability

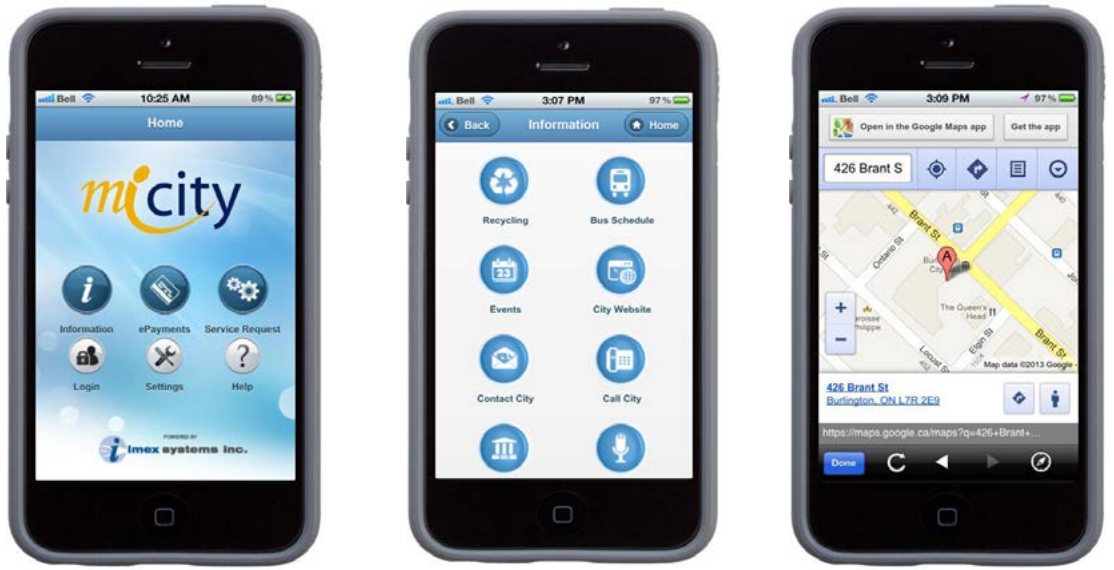
Nurturing a business-friendly environment. A smart city creates the best possible economic environment. One way is through the use of smart payment systems for city government. Another is by integrating a city's own systems with payment networks to make it easier for consumers and local businesses to conduct commerce globally.

Attracting new businesses. Cities that offer a welcome climate for companies and highly skilled workers build wealth through the creation of jobs and tax income. Streamlining permitting and licensing processes, leaving out unnecessary steps and reducing paperwork are all ways cities can make it clear they are open for business.

Increasing the velocity of money. By enabling quick payroll and benefits disbursements

Offering one-stop city services:

TOWNSHIP LAUNCHES NEW TECHNOLOGY FOR CUSTOMER SERVICE IMPROVEMENT



King Township, in Ontario, Canada, became one of the first municipalities in Canada with a fully integrated mobile app that works in conjunction with its web portal and online services to provide Anytime, Anywhere and Any Device access to information and e-services.

This platform provides enhanced convenience to the residents and businesses of King Township to access municipal services and information, while helping to improve internal service delivery efficiency. The miCity Mobile App runs on both Apple and Android platforms and supports both smart phones and tablets.

Unlike other mobile apps used by other municipalities, which are typically stand-alone applications, the miCity app is tightly integrated with the township's portal, citizen relationship management system and online services, including full GIS integration to ensure timely, relevant and consistent information and e-services via both mobile devices and desktop computers. The miCity app is an extension of Council member Imex Systems' platform called iGov, which is an integrated e-government framework.

"With an integrated miCity mobile app and iCity online services, we are able to offer enhanced convenience and better user experience for our residents using state-of-the-art technology," said Mayor Steve Pellegrini. "We are proud of what we are able to offer, despite being a small municipality. King Township has transformed into a Smart Township and has become a model for other municipalities for its leadership in customer service."

> ***Offering one-stop city services.***
> *The miCity app is an extension of Council member Imex Systems' platform called iGov which is an integrated e-government framework.*
>
> *Figure 13.9*

through the types of e-government and smart payment solutions mentioned earlier, individuals get quick access to their money so they can spend it at city merchants. M-Pesa, a successful payment innovation in Kenya, has made it quick and easy for employers to pay workers through mobile remittances, even for people who do not have banking accounts.

Enhancing security and reducing fraud. The migration to smarter payment and financial systems is a tremendous protection for business, consumers and the city itself. With the right acceptance tools and payment instruments, merchants know if customers are trustworthy. And they can be paid quickly to reduce working capital requirements.

Creating a welcoming environment for visitors. Travelers have different needs than residents. Coming from afar, they need convenient and interoperable payment solutions. They also need helpful information in an unknown environment. To attract travelers and tourists, cities need citywide payment systems that can interoperate with those from other parts of the world. For instance, by using their mobile commerce wallets, visitors can be recognized as such, contacted in their native language, and provided with relevant information, since the system will know the hotel they are staying at, their plane departure times, etc. Integrating their hometown payment instrument into smart city systems enables them to navigate as seamlessly as if they were at home.

Sustainability

Improving planning. Payments are an incomparable source of insight on residents' ways of living, commuting and consuming. Through analysis of payment data, city governments can adapt city infrastructures and services to citizens' preferences while decreasing inefficient spending. For instance: Putting a new post office at the best location possible to maximize its use, based on insights gained from shopping patterns. Similarly, cities can tailor transportation and other public services based on shopping data.

Supporting public policies. Environmental challenges increase the need for innovative solutions to reduce waste, reduce emissions, save energy and foster green transportation. Payment is central to making solutions accessible. Here are a few examples: NFC-enabled public charging stations that enable electric vehicle users to easily pay and recharge; freeway and bridge tolling payment solutions with automatic detection of car registration plates; city parking payment solutions; smart payment devices connected to household energy consumption to help citizens make the most of their solar panels.

> ***Creating a welcoming atmosphere for visitors.***
>
> *To make the most of globalization, city leaders need to ensure they can welcome business travelers and tourists from around the world by offering them a seamless payment experience.*
>
> *Figure 13.10*

Increasing the velocity of money:

EGYPT DELIVERS PAYROLL SAFELY AND EFFICIENTLY WITH GOVERNMENT PREPAID CARDS

Egypt is a cash-based society with only 10% of nearly 90 million Egyptians having a bank account. Cash is widely used for salaries, pensions, purchases and bill payments, and it's often kept at home to use for purchases and to pay bills. A significant portion of the population receives government funds as employees or pensioners.

The Egyptian Ministry of Finance (MOF) aim is to raise the rate of sustainable growth that promotes the economic and employment opportunities for all Egyptians, and support rising standards of living and improved quality of life for all in the country.

To achieve its mission of full potential of inclusive citizenship and more effective financial governance, the MOF always seeks the widest financial inclusion initiatives and collaboration between the public and private sectors.

Payroll was distributed primarily in cash from the government. Managing disbursement of regular and recurring government payments to over six million government employees was very costly, time consuming and posed a challenge to keep clear and concise records.

The MOF, the Central Bank of Egypt and other partners worked with Council member MasterCard to develop a government prepaid payroll card to reduce costs, promote transparency and expand electronic payments in the primarily cash-based country.

More than 1.5 million cards have been issued to government employees in Egypt, making the program the largest public sector payroll program in the AP and MEA region. An important outcome of the program was that government employees were able to gain access to their funds at both domestic and international POS and ATMs.

> ***Increasing the velocity of money.***
> *More than 1.5 million cards have been issued to government employees in Egypt, making the program the largest public sector payroll program in the AP and MEA region.*
>
> *Figure 13.11*

Saving resources. The flow of out-bound and in-bound paper checks, paper invoices, envelopes, etc. alone can add up quickly – especially when you consider how many city agencies around the world are still paper-based. Automating processes to enable electronic invoicing and pay-by-phone, pay-by-portal and related technologies can make a huge dent in the number of trees lost to old-fashioned practices.

Smart finance systems and payment targets

The best practices and targets listed below will help cities foster smarter approaches to financial management. Several targets are specifically related to smart finance and payment systems and this next section will focus on them. We will also address several targets from the Universal chapter and how they apply here as well. If we fail to mention a Universal target below, it does not mean that it does not apply to city finance and payments. Rather, we simply felt it did not require additional explanation.

Instrumentation and control

Ensure access to robust banking services. Cities in the developed world may take convenient, ubiquitous banking as a given. In other parts of the world, however, it is a significant issue. Access to banking services is the key underlying prerequisite to smart payments. It has various implications, from the need for a network of capable ATMs (automated teller machines) to a sufficient number of bank offices.

City leaders must encourage a widespread, safe banking system. If cash and credit cards are currently the basic form factors, the city should encourage smarter versions such as NFC-enabled cards and mobile phones linked to banking. Electronic payments are also key, as more and more transactions are done remotely. As an illustration, the city of Nice, France massively communicated the benefits of contactless cards. By pioneering that technology, the city created a favorable climate for adoption and the benefits that followed.

Implement optimal instrumentation. There are at least two payment areas where cities need to ensure that the right devices are deployed:

- *Acceptance devices.* Parking meters, ATMs, utility meters, vending machines and point-of-sale terminals are increasingly used to make payments. Acceptance networks must adapt to emerging payment methods, such as contactless cards and phones, as well as electronic wallets.

- *Payment form factors.* Smart payment devices do more than paying. For instance, digital wallets gather all customers' existing

> ***Implement optimal instrumentation.*** *In some parts of the world, convenient, ubiquitous banking is a significant issue. Access to banking services is a prerequisite of smart payments.*
>
> *Figure 13.12*

payments cards in a single device and also combine them with rewards and loyalty cards. They also enrich their functionalities with innovative features to facilitate day-to-day life. In Hong Kong and London for instance, the mass transit systems rolled out contactless electronic cards that people can use to pay for transit, but can also use in shops.

Connectivity

Connectivity and telecommunications are crucial for the development of smarter financial systems and payments. The smart cities model relies heavily on a fast, secure, real-time transfer of information.

Connect devices with citywide, multi-service communications. Smart cities need connectivity throughout to allow stakeholders to carry out transactions anywhere, anytime. Access to high-speed wireless Internet is a prerequisite. So is good coverage, including areas such as subways and mass transit systems where people spend significant time. Everyone also benefits from a fast and secure network, as it decreases the risk of fraud and reduces processing time to create a seamless experience.

Connect all financial systems with a citywide, data platform. Cities need to collect and use data in real time to have complete situational awareness into financial flow. A holistic view that integrates financial data from all city departments is key to understanding trends and making informed projections about future investments. It is also essential in providing transparency to citizens.

Interoperability

Interoperability maximizes the value of smart financial systems and payments.

Adhere to open standards (including across all finance and payment infrastructures). Adopting open standards has significant advantages. It ensures fast and broad participation, minimizes risk (through investment in tested standards) and drives procurement efficiency (by offering access to greater choice and lower prices). It also facilitates participation by foreign consumers, tourists and business travelers.

Open standards must be used at multiple levels including 1) the communications technology, 2) the interaction between payment devices and 3) the data exchanged between the devices. NFC is the perfect example. This contactless communications standard has been broadly adopted by leading merchants, issuers and city leaders around the world.

Cities should give preference to global standards to make it easier to do business globally and to attract tourists from other countries.

> ***Connect devices with citywide, multi-service communications.*** *Smart cities need connectivity throughout to allow stakeholders to carry out transactions anywhere, anytime.*

Figure 13.13

Connect all financial systems with a citywide data platform:

CITY MEETS THE FUTURE WITH ACCOUNTABILITY AND EFFICIENCY

The city of Redmond, Washington – home to Council member Microsoft's corporate campus and a number of the software giant's partner companies – is proud of its responsiveness and the wide range of services it offers to constituents. Aiming to take the city into the future, policymakers developed a visionary technology plan.

Redmond sought to make its business processes more efficient and transparent. It started by replacing an ERP system that was unable to meet public-sector needs and could not accommodate the way the city's employees worked. The city implemented Microsoft Dynamics AX 2012 for public sector organizations together with other software tools. Now, with streamlined operations and employees empowered with meaningful data, Redmond can provide citizens greater service quality and more effective communications.

The city's work culture is transforming for optimal transparency and accountability. As city project leaders realized what the new ERP system and other technologies would help employees accomplish, they took advantage of opportunities to revise business processes for greater efficiency and simplicity. Those included a new chart of accounts, workflows and approvals for spending and invoices, budgeting and other tasks.

From eliminating duplicate data entry to replacing disparate tasks with streamlined workflows, Redmond is generating efficiencies by using the financial management capabilities in the new ERP system. "We can now decentralize many functions and assign resources to more important functions or, in some cases, actually reduce the level of full-time employees dedicated to certain tasks," says Redmond Mayor John Marchione.

> ***Connect all financial systems with a citywide data platform.*** *Instead of calling the finance group to ask for information, employees throughout the city of Redmond can now access their Role Centers in Microsoft Dynamics and easily find what they need.*
>
> *Figure 13.14*

Use open integration architectures and loosely coupled interfaces. Companies are increasingly adopting open integration architectures and exposing their APIs so that third parties can integrate with their systems. In the payments industry, companies such as MasterCard are adopting this approach. Cities should also adopt a similar strategy when developing their payment infrastructure to rapidly "bulk up" their payment ecosystem and provide more value for all participants.

Prioritize legacy investments. Most cities simply cannot afford to replace all of their financial systems overnight, which means priority must go to making the most of existing investments while formulating a roadmap for prudently moving forward with upgrades. Often cities can continue using old software by sending data to new software modules that add value on top.

Enable multi-channel access to an integrated customer and business service platform. Cities can't assume that every citizen and every business has a smartphone, computer or reliable Internet access to avail themselves of city resources, sign up for benefits, pay their bills, etc. Public kiosks in downtown centers and libraries are one way to bridge the digital divide. Integrated customer and business service platforms also must accommodate people with special needs – different languages and disabilities, for example.

> ***Enable multi-channel access to an integrated customer and business service platform.***
> *A virtual city hall in a Nice, France shopping mall is equipped with Cisco technology that allows two-way audio and video communication between citizens and a city agent.*
>
> *Figure 13.15*

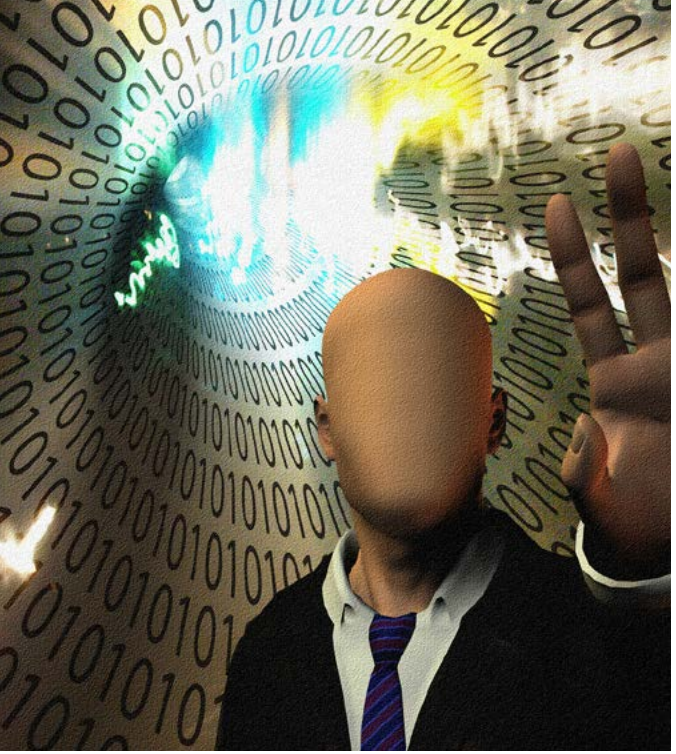
Have access to comprehensive device management. Implementing smart payments will expand the number of devices and the volume of data on a city's network. Comprehensive device and network management will improve security, resilience and reliability of the payment system, deliver cost savings and enforce compliance with city data management, security and privacy policies.

Security and privacy

A key goal of a payment system – smart or otherwise – is to enforce trust between participants. Similarly, a city gathers significant amounts of financial data from citizens and businesses when they apply for permits, licenses and other services. A security or privacy breach, therefore, threatens a city's overall integrity.

Publish privacy rules (and apply them to the city's financial and payment systems). Cities should publish and enforce clear rules on privacy that apply equally to financial data. From a privacy perspective this includes:

- The respect of anonymity – data should not be "personified" when analyzed
- The type of information that can be captured from the client
- What can be shared
- Who has access to it
- How the information is stored and used
- How participants can access it and edit or delete it



> ***Publish privacy rules (and apply them to the city's payment systems).*** *Cities must publish clear rules on privacy that apply equally to financial data.*

Figure 13.16

Create a security framework. Cities also need to define the levels of security required for payment, such as two-factor authentication or PIN numbers. Digital wallets are a good example. They secure several payment means, as well as other documents (loyalty cards, etc.) in a single application. This avoids having one's payment references in multiple locations.

However, cities need to recognize that overly stringent rules can discourage participation – they must strike the right balance. Remember as well that security specifics may already be defined by law or by commercial terms.

Implement cybersecurity. As we've noted, smart cities generate mountains of financial data. They also connect critical infrastructure to the Internet. Those actions create many benefits, but they also create new threats. It's best not to leave it to each individual department to come up with a security plan. Instead, implement and enforce best practices citywide.

Data management

Create a citywide data management, transparency and sharing policy. Given the sensitivity of financial data, we want to emphasize the importance of a citywide policy for how data is governed, stored and made accessible. Best practices call for a clear governance directive that establishes the chain of authority and control over data assets and spells out who makes access decisions and who determines accountability. This citywide policy should cover both private and public data and ensure that data from each department is made available to others. It must also align with the policies in the security and privacy targets discussed previously. A city-wide data management plan will increase the city's agility (ability to quickly build new applications as needed) and accuracy (by ensuring everyone is working with correct data). It can also lower costs by reducing errors and eliminating unnecessary duplication.

Computing Resources

With close to three trillion payment transactions globally every year, payments involve large volumes of data. True value can be derived from payment systems if that data can be analyzed.

Consider a cloud computing framework. Cloud computing is a valid consideration for every city responsibility, but it is virtually a requirement for smart payments. To be usable, the payment solution has to allow information to be securely stored yet accessible anytime, from any place and any device. Only a cloud computing framework can meet these stringent requirements. Cities may want to consider a hybrid approach – the public cloud for storage and processing, but a local or private cloud for elements with higher-level security and privacy requirements. Either way, cities should ensure that the cloud service they choose includes data encryption, effective data anonymization and mobile location privacy.

Analytics

Analytics based on payments data can have a significant positive impact on local commerce. It can also inform and improve government policies.

Achieve full situational awareness (including local commerce trends). Develop a deep understanding of local commerce trends by analyzing payments data. Insights can include macro indicators like retail sales that help decipher the state of the economy and set policy direction. Micro indicators such as tourist spending behavior by city of origin can help identify places to target for marketing and promotional activities.

Achieve operational optimization. Capture and analyze transactional data to get useful insights – for example, citizen usage of public services. Insights such as the number of people using the city's mass transit system (from ticket purchase/validation) versus driving into the city (from toll fees or parking payments) can help cities set policies to reduce congestion. Likewise, accurate monitoring of spending in post offices or licensing offices can allow a better allocation of staff and an improved management of opening hours.

> ***Achieve full situational awareness (including commerce trends).*** *Analyzing payments data that includes macro indicators like retail sales help cities decipher the state of the economy and set policy direction.*
>
> ***Figure 13.17***

Implement a KPI dashboard. Use a city dashboard to measure progress toward stated goals against a set of key performance indicators (KPIs). With a dashboard city officials can continually monitor and improve their management strategies when new data suggests a course change. A city and its dashboard is one key to ensuring efficient management of a city's services across multiple sectors – transportation, energy and water for example. Comparing performance on standardized KPIs with other municipalities can be an effective way to promote best practices.

Pursue predictive analytics. Payments data can predict people's preferences and significantly improve the city's ability to plan for the future. Cities should develop and leverage this capability. For example, a city might adapt its development plan after learning that people are shifting their spending from neighborhood convenience stores to larger stores at the city outskirts. Predictive models can also be set up to determine the most appropriate locations for commercial or public services.

Consider a cloud computing platform:

FÈS IMPROVES TRANSPARENCY AND SERVICE DELIVERY WITH CLOUD POWER

As in any modern city, the government of Fès must support a host of civic needs, manage its budget and attract private and foreign investment, all while coping with a population migration from rural areas to the urban core. In 2013, the African Development Bank (AfDB) chose Fès as the pilot city to test the City Dashboard, powered by the Windows 8 operating system and the Microsoft Azure cloud computing platform, and designed to help cities monitor their service performance.

Fès city officials and decision makers can use the dashboard to monitor up to 70 quantitative and qualitative socioeconomic, service-visibility and quality-of-life indicators of urban prosperity and service performance. The city will gather data from local, regional and national government sources, as well as from NGOs and the private sector, and manage the data with Council member Microsoft's Azure SQL Database. Fès intends to deploy a public interface for the dashboard, so city residents can use it to monitor or access public services themselves.

With the City Dashboard, decision makers in Fès now have easy, quick, direct access to municipal, national, international, and commercial data – and the insights that they need to make decisions. Fès can build more transparent, more participatory governance, which will make it easier for the city to plan more effectively, attract more private and foreign direct investment, and deliver better services to its residents

After the success of the Fès pilot, the AfDB intends to replicate the program in other cities in Morocco and throughout Africa. The City Dashboard will be a key tool in helping the AfDB identify issues and customize its urban development programs for the greatest impact on the lives and prosperity of urban residents in Africa.

> ***Consider a cloud computing platform.*** *With the City Dashboard, Fès can build more transparent, more participatory governance.*
>
> *Figure 13.18*

Three essential assets to achieve payment insights for cities

Council member MasterCard is a world leader in payments data and analysis. The company suggests the three assets shown in the chart are essential to achieving deep insights from payments data. You may find it useful to pass along to your ICT staff as they begin to evaluate options.

Asset	Characteristic	Factors
Data Sources	**Get access to transaction data** • Directly or through partnership • Maximize quality and "representativeness" **Combine with other available data** • Structured or unstructured	Quality / representativeness Availability / diversity Confidentiality / compliance
Flexible Technology	**Ability to store, structure, cleanse and process** • With large databases • Including unstructured data **Sharing and analytics tools to deliver insights** • From basic to advanced, for business users to data scientists **Integration into existing tools and systems**	Ability to manage unstructured data including open source tools such as Hadoop Data cleansing process in place Data visualization tools Data analysis and mining tools
Expertise	**Ability to deliver value and insights** • Specialists in all aspects of Big Data • Conversion of data into actionable insights • Advanced analytics and statistical modeling	Organization structure to support Big Data Availability of analytics resources and skills Specialists in regulation, privacy laws and data usage

Figure 13.19

Consider a cloud computing framework:

ONTARIO CITY EXPECTS TO SAVE $100,000 ANNUALLY WITH INFRASTRUCTURE PLANNING

With the ability to visualize infrastructure and analyze maintenance costs - including how long major assets such as roads or pipes will last - cities can save time and money in the planning process and millions in construction and maintenance costs. Even modest-sized cities often own more than $1 billion in assets and spend millions each year maintaining them.

Cambridge, Ontario has more than 250,000 infrastructure assets with a total value of $1.6 billion, including more than 300 miles of roads and more than 1,200 miles of underground water mains, sewage and storm pipes. The city is using Council member IBM's new infrastructure planning software (video) to examine millions of disparate pieces of information to perform what-if analyses to help make better decisions. Algorithms process the data and predict which assets will fail and when, helping city staff look across all departments and decide, for example, whether a sewer pipe should be re-lined or replaced entirely, or if a roadway should be resurfaced at the same time. It also incorporates a financial planning tool to help more effectively use funding for each project. Through better project coordination, less time spent on capital forecasting, and improved asset management, the city is expected to save at least $100,000 per year.

"When developing new infrastructure, it should be from the ground up – underground sewer pipes to surface streets and storm drains. We should only have to dig up a street once to fix all of its underlying systems," said Mike Hausser, director of asset management and support services with Cambridge. Using IBM's Intelligent Operations software based on cloud computing standards, Cambridge is able to coordinate efforts in servicing, maintaining and updating its infrastructure, which can lower costs for city departments and improve the quality of services to citizens.

> ***Consider a cloud computing framework.*** *Using IBM's Intelligent Operations software based on cloud computing standards, Cambridge is able to coordinate infrastructure upgrades and a financial planning tool to help more effectively use funding for each project.*
>
> *Figure 13.20*

ISO 37120: A yardstick for measuring city performance

In 2014, the International Organization for Standards announced an ISO standard that applies strictly to city performance. The document -- known as ISO 37120:2014 -- establishes a set of open data indicators to measure the delivery of city services and quality of life. It defines common methodologies that cities can use to measure their performance in areas such as energy, environment, finance, emergency response, governance, health, recreation, safety, solid waste, telecommunications, transportation, urban planning, wastewater, water, sanitation and more.

In the table at right we have indicated how the standards related to Finance correspond to the Council's Payments and Finance targets identified on the next page.

Payments and Finance Indicators

			Ensure access to robust banking services	Connect financial systems with citywide platform	Multi-channel access to integrated platform	Integrate all transport modes for optimization	Create a citywide data management policy	Achieve full situational analysis	Achieve operational optimization	Achieve asset optimization
Core	9.1	Debt service ratio (debt service expenditure as a percentage of a municipality's own-source revenue)	■	■	■	■	■	■	■	■
Supporting	9.2	Capital spending as a percentage of total expenditures	■	■	■	■	■	■	■	■
	9.3	Own-source revenue as a percentage of total revenues	■	■	■	■	■	■	■	■
	9.4	Tax collected as a percentage of tax billed	■	■	■	■	■	■	■	■

Figure 13.21

PAYMENTS AND FINANCE TARGETS

*In the checklist below, targets specifically pertaining to the payments and finance responsibility are in **bold,** universal targets are not.*

TECHNOLOGY

Enabler	Payments and Finance Targets How smart cities deploy and use ICT to enhance their payments	Implementation Progress None	Partial	Over 50%	Complete
Instrumentation & Control	**Ensure access to robust banking services** Implement optimal instrumentation **(including acceptance devices and new payment form factors)** Connect devices with citywide, multi-service communications				
Connectivity	Connect devices with citywide, multi-service communications **Connect all financial systems with a citywide data platform**				
Interoperability	Adhere to open standards **(including across finance and payment infrastructures)** Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments **Enable multi-channel access to an integrated customer and business service platform**				
Security & Privacy	Publish privacy rules **(and apply them to the city's financial and payment systems)** Create a security framework Implement cybersecurity				
Data Management	Create a citywide data management, transparency and sharing policy				
Computing Resources	Consider a cloud computing framework Use an open innovation platform Have access to a central GIS Have access to comprehensive device management				
Analytics	Achieve full situational awareness **(including local commerce trends)** Achieve operational optimization Achieve asset optimization **Implement a KPI dashboard** Pursue predictive analytics				

Figure 13.22

ADDITIONAL RESOURCES

Making convenience a priority with smart payments:

Toronto's Benefits Card: Doing More with Less

Toronto faced a growing need to streamline the disbursement of social benefits and to reduce the cost of collecting the funds for those recipients, since one in four do not have a bank account to receive direct bank deposits. The city developed a new MasterCard prepaid card that can be instantly and securely issued Toronto Employment and Social Services offices. Funds are loaded on the prepaid card, which is then usable anywhere by the recipient.

Target: Implement optimal instrumentation (including acceptance devices and new payment form factors)

Transport for London Video Case Study

Transport for London (TfL) first introduced contactless payments on London buses in 2012 and two years later extended them to cover all modes of travel on the world's largest contactless pay-as-you-go network – covering bus, rail, Tube and tram. This video from Council member Cubic Transportation Systems highlights the tremendous results TfL has seen since introducing contactless payments.

Target: Create a security framework

Two Factor Security for Mobile Transactions

IBM scientists developed a mobile authentication security technology based on the radio standard known as near field communication (NFC). As this video explains, the technology from Council member IBM provides an extra layer of security when using an NFC-enabled device and a contactless smartcard to conduct a mobile transaction.

Target: Implement optimal instrumentation (including acceptance devices and new payment form factors)

Moving Beyond Cash: Improving Lives with Smarter, More Efficient Digital Payments

With payments at the heart of a city's economic activity and success, the efficient handling of funds is increasingly important. Digitizing payments permits greater convenience for citizens and tourists and greater transparency for government. It enables cities to better deploy resources and gain data-driven insights that lead to more effective city planning. Learn more in the white paper from Council member MasterCard.

Promoting financial inclusion:

Nigerian National ID Card

At the May 2013 World Economic Forum on Africa, the Nigerian National Identity Management Commission and Council member MasterCard announced the planned issuance of 13 million National Identity Smart Cards as a pilot program. The financial inclusion initiative offers citizens the safety, convenience and reliability of electronic payments and better economic prospects for 100 million Nigerians who have not previously had access to financial services.

CHAPTER 14

IDEAS TO ACTION

In this chapter, you'll learn how a simple roadmapping process can put you on the path to a smart city. We've hinted at this next point before, but now we're just going to say it: Technology is the easy part. The hard part is turning ideas into action. Fortunately, help is at hand from those who have gone before. In reviewing hundreds of successful pilots and interviewing dozens of experts, several themes have emerged, which we have shared on the pages that follow.

If you've completed the other chapters in this Guide, you now have a set of targets to guide your smart city efforts. But you don't yet know where to apply those principles first or how to translate those concepts into on-the-ground realities. In these next pages, we'll explain how a roadmap can be the bridge between ideas and action. We'll cover:

- The importance of a roadmap
- The elements of a roadmap
- The process of building a roadmap
- Success strategies for a roadmap.

Please note that the Smart Cities Council does NOT believe in roadmaps in isolation. Rather, the roadmap should be linked to a city's vision document or comprehensive plan. We believe wholeheartedly in digital technology. But that technology should be in service to a city's larger goals.

The importance of a roadmap

Why a roadmap? The path to a smart city is a long one. It can easily take 5, 10, even 15 years to make smart technologies pervasive. It is essential to have a clear, consensus goal to motivate citizens. And clear targets to guide the course corrections that will be needed along the way.

As we use the term in this Guide, a roadmap is a simplified outline of the major steps to becoming a smart city. It is NOT a vision document or a master plan or a detailed project plan. Those other things come into play, but you also need a high-level, "30,000-foot view" of your future. As experts point out, academics think about the "why" of smart cities while technology companies focus on the "what." Yet you also need to figure out the "how"... and that's where a roadmap comes in.

Overcoming smart city hurdles

A roadmap can help you overcome obstacles to a smart city transformation. One such hurdle is human nature. People are naturally resistant to change. Yet we live in an era where change is constant. As a result, an entire management science has arisen around "change management" – around successfully transitioning companies to a desired future state.

Cities face a similar challenge... but they can't simply order residents to attend a change management seminar. Nor can they fire the ones who won't go along. Instead, city government must influence and inspire the population. A roadmap is a powerful tool in that effort.

Effecting change is made even more difficult by the stove-piped nature of most city governments. For at least the last 100 years, cities have been divided into departments, each with its

Figure 14.1

own specialty and each with a high degree of autonomy. Although it's not necessary to abolish departments to become a smart city, it is necessary for those departments to collaborate more effectively and to share resources. As you will read below, the roadmapping effort is a "forcing function" that obliges departments to work together.

Becoming a smart city is further compounded by overlapping boundaries. Urban challenges – crime, transportation, water supply, economic development, etc. – don't stop neatly at city borders. Jurisdictions overlap as well. Many metropolitan regions have dozens of cities and townships within their sphere. They also embrace hundreds of school districts, water districts, transit authorities, port authorities, human services agencies and other organizations. Consider the Greater Chicago metropolis by way of example. It crosses 14 counties in three states and contains approximately 350 municipalities, 350 school districts and 140 library districts.

Meanwhile, cities are also subject to rules and regulations from federal agencies, state or provincial governments, county or parish governments, public utility commissions and so on. And, to top it off, cities must contend with myriad advocacy groups, special interest groups, neighborhood associations, business associations and other groups whose agendas can sometimes be at cross purposes. The United States provides an example. By one count, it has roughly 20,000 municipal governments, 13,000 school districts and 37,381 special authorities.

As Brookings Institution scholar Bruce Katz explained in 2011, "an excess of municipal governments (and the general absence of metropolitan governments) means that there is no 'one stop shop' for the application of innovative technologies. The public institutions that make decisions about transport are different from the ones that make decisions about education or water. These separate entities rarely coordinate with each other to integrate technology (and share information) between themselves or with utilities and other private or quasi public entities."

Done right, roadmapping is a process that involves and pulls together these disparate groups.

Other roadmapping benefits

In addition to the advantages mentioned above, a smart city roadmap has these additional benefits:

- **Maximizing synergies and minimizing costs.** Considering the big picture can help a city find ways to share infrastructure and share costs – doing away with unnecessary duplication of ICT investments.

> ***Overcoming smart city hurdles.*** *Urban challenges don't stop neatly at city borders as evident in the Greater Chicago metro area which crosses 14 counties in three states. Roadmapping can help pull together disparate regional groups.*

Figure 14.2

- **Identifying the best places to start.** Picking the "low-hanging fruit" – projects that have a big return for a relatively small investment in money and time – usually makes sense. If a city starts with quick, "big bang" projects, it can build momentum and public support. It can also help pay for future projects with savings from the early ones.

- **Enabling cities to build in stages.** With a plan in place, you can be confident everything will work together in the end because you're adhering to principles and standards that ensure interoperability and collaboration. With such a framework, a city can move forward one step at a time, knowing that individual projects will be compatible with each other, even if they are built at different times.

- **Increasing public support.** A roadmap paints a picture of future improvements in livability, workability and sustainability. It can dramatically increase public understanding and cooperation. It can also rally support and financing from the private sector.

- **Attracting talent and business.** Cities everywhere want to woo talented professionals and job-creating businesses, but both are increasingly choosy when deciding where to establish themselves. They are attracted to cities that have a strong, compelling vision for a better future and a path to get there. Your roadmap, in other words, is also a recruiting tool.

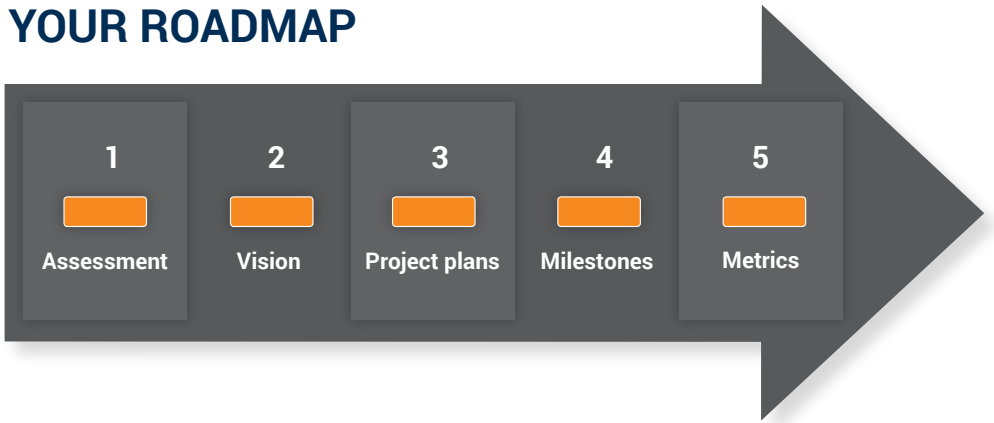


Figure 14.3

The elements of a roadmap

Many authorities recommend that your roadmap include these five elements at a minimum:

1. **An assessment** of where you are
2. **A vision** for where you want to go
3. **Project plans** for the key components
4. **Milestones** to mark progress
5. **Metrics** to measure and prove success

Assessment – a clear picture of where the city is now, measured in terms of the key performance indicators you will use to quantify success. For instance, in pages to follow you'll learn how Vancouver, B.C.'s action plan included baseline numbers to indicate the city's current level of performance.

Vision – a clear picture of the ultimate outcomes, expressed in terms of citizen benefits. The vision should not be expressed solely as technical achievements but also as the lifestyle and workstyle improvements the technology makes possible. It is essential to build that vision with citizen involvement. First, you'll get better and more diverse suggestions. Second, you'll build consensus and commitment. You'll also want to re-imagine what your city's departmental organization should look like.

Project plans – "blueprints" for the most important components of the smart city. Possibilities include master plans for land use and the built environment; for digital infrastructure (communications and computing resources); for data; for transportation; for business and commerce, and for city services. These plans are also helpful for creating visibility around smart city drivers.

Milestones – waypoints at which you measure progress, share lessons learned and discuss course corrections and strengthen commitment. For instance, Vancouver has annual implementation updates. (Click to view an overview of Vancouver's 2011-2012 Implementation Update.) It also holds an annual Vancouver Cities Summit, a discussion platform for business and urban leaders to exchange ideas and best practices. And it issues periodic updates in various media to keep citizens informed and enthused (see Figure 14.4)

Your residents can be a valuable tool in the measurement process. Social media can help you reach out to them to see how technology adoption is progressing, further connecting government and people.

Metrics – key performance indicators that quantify success. Examples include carbon footprint, average commute time, percentage of citizens with broadband, energy efficiency achievements, water efficiency achievements, new businesses formed, patents filed, students graduated, doctors and hospital beds per capita, percentage of city services available online, etc. In some cases, it is possible to choose metrics that also let you calculate your return on investment.

Installing metrics early in your smart city efforts can ensure transparency and improve citizen buy-in. Vancouver's action plan has a list of very specific targets. For instance, it seeks to double the number of green jobs from 2010 to 2020, and double the number of companies who have "greened" their operations. It seeks to reduce greenhouse gas emissions by 33% over 2007 levels. It has similar easy-to-measure targets for all 10 of its sub-components.

> ***Milestones to mark progress.*** *Vancouver has annual implementation updates and monitors what's been accomplished so far and what still needs to be done as 2020 approaches*

Figure 14.4

MOBILIZING 35,000 VANCOUVERITES TO BUILD AN ACTION PLAN

In 2009, Vancouver Mayor Gregor Robertson put together a Greenest City Action Team. Its job was to construct a plan to transform Vancouver into the greenest city on earth. Although only part of the plan references digital technology, all of it represents a sterling example of engendering citizen involvement.

More than 35,000 people participated in the process in one way or another. Many of them monitored progress online via social media (and continue to do so). Others took part in face-to-face workshops and events. More than five dozen city staff, 120 different organizations and 9,500 individuals actively contributed ideas and feedback.

Those contributors had a strong preference to create opportunities immediately as they worked for long-term success – to build a strong local economy and vibrant neighborhoods while creating a city that meets the needs of generations to come.

The resulting Vancouver Greenest City 2020 Action Plan was adopted by the Vancouver City Council in July 2011. The plan addresses three overarching areas of focus: carbon, waste and ecosystems. It is divided into 10 smaller plans, each with a long-term goal for 2050 and a shorter-term target for 2020.

> ***Vancouver's action plan.*** *The No. 1 goal of Vancouver B.C.'s 2020 Action Plan was to secure the city's international reputation as a mecca of green enterprise by doubling the number of green jobs and doubling the number of companies actively engaged in green operations.*
>
> *Figure 14.5*

VANCOUVER PLAN GOALS

The Vancouver Greenest City 2020 Action Plan includes 10 "sub-plans," each with a long-term goal plus metrics to measure success.

	Goal	Targets
1. Green Economy	Secure Vancouver's international reputation as a mecca of green enterprise	• Double the number of green jobs • Double the number of companies actively engaged in greening operations
2. Climate Leadership	Eliminate Vancouver's dependence on fossil fuels	• Reduce community-based greenhouse gas emissions by 33% from 2007 levels
3. Green Buildings	Lead the world in green building design and construction	• Require all buildings constructed from 2020 onward to be carbon neutral in operations • Reduce energy use and greenhouse gas emissions in existing buildings by 20% over 2007 levels
4. Green Transportation	Make walking, cycling and public transit preferred transportation options	• Make the majority (over 50%) of trips by foot, bicycle and public transit • Reduce the average distance driven per resident by 20% from 2007 levels
5. Zero Waste	Create zero waste	• Reduce solid waste going to the landfill or incinerator by 50% from 2008 levels

Continued on next page

VANCOUVER PLAN GOALS

	Goal	Targets
6. Access to Nature	Vancouver residents will enjoy incomparable access to green spaces, including the world's most spectacular urban forest	• All Vancouver residents live within a five-minute walk of a park, greenway or other green space by 2020 • Plant 150,000 new trees by 2020
7. Lighter Footprint	Achieve a "one-planet" ecological footprint	• Reduce Vancouver's ecological footprint by 33% over 2006 goals
8. Clean Water	Clean Water Vancouver will have the best drinking water of any city in the world	• Meet or beat the strongest of provincial and federal drinking water quality standards and guidelines
9. Clean Air	Breathe the cleanest air of any major city in the world	• Always meet or beat the most stringent air quality guidelines from Metro Vancouver, British Columbia, Canada and the World Health Organization
10. Local Food	Vancouver will become a global leader in urban food systems	• Increase citywide and neighbourhood food assets by a minimum of 50% over 2010 levels

Figure 14.6

The process of building a roadmap

There's no "standard" way to create a smart city roadmap. Below we've suggested one approach that combines advice from many experts. It includes six steps:

1. Find a champion
2. Assemble a team
3. Borrow from the larger vision
4. Establish metrics
5. Prioritize your targets
6. Use experts to produce specific plans

> ***Asssemble a team.***
> *Many practitioners suggest that cities start by setting up an interdepartmental task force.*

Figure 14.7

Find a champion

The best roadmapping strategy is to involve all important stakeholder groups. Even so, the effort is unlikely to succeed without a champion. Typically this is the mayor or city manager. But some successful efforts have been led by private developers, civic groups, local universities, city council members or other prominent individuals.

The champion's job is to sell the overall vision to city employees and city residents, and to the financial and technical partners the city must recruit. The job requires energy and salesmanship throughout the life of the project. Most experts call for a strong external leader – typically an elected official – teamed with a strong internal advocate – typically someone in a staff position who can lead the day-to-day activities.

Assemble a team

When you assemble your team, you will be balancing two needs. On the one hand, you need expertise from many different areas, which suggests a large team. On the other hand, you need to be fast and efficient, which argues for a small team. Some experts feel the ideal situation is a small group at the core that meets on a regular basis with a much larger group of experts and stakeholders.

Many practitioners suggest that cities start by setting up an interdepartmental task force. Since a smart city is a "system of systems," every decision taken in one area has an impact on others. It is essential to take a cross-functional approach. Some cities bring in a representative from every major department. Others form a core team and consult with other departments as needed. The planning and ICT departments are almost always involved. It's also common for the mayor to lead the task force or to designate a senior staffer.

The task force must have the authority to demand cooperation. Equally important, it should have oversight of departmental projects, at least to the extent of ensuring that

those projects adhere to established standards. Even if departmental infrastructure will not be interconnected immediately, you want the ability to do so when the time is right. And that requires that departments adhere carefully to standards for interoperability, security, privacy, data management, etc.

Many cities will move from an outside task force to an inside smart city department that will, in some ways, resemble today's well-accepted ICT departments. Like ICT, the smart city department will have cross-cutting responsibilities. Unlike ICT, however, it will not have specialization as its goal. Rather, its role will be one of coordination, setting overall standards and ensuring that 1) all departments have a common smart city platform to build upon and 2) all individual projects are coordinated with the larger smart city vision.

Some cities put external stakeholders on the task force. However, the most common method is to use city employees and paid consultants for the working team, then to hold meetings to gather input from important stakeholder groups. Some cities own and operate most services – transportation, electric power, water, telecommunications, etc. In other cases, the private sector provides all or most of those services, with the city government providing boundaries and oversight. Cities that do not control their own infrastructure must consult closely with the electric, gas and water utilities that service their territory.

Skilled smart city suppliers can also be a resource at this stage, especially those experienced in master planning and systems integration. Even if the city does not hire them immediately, they can provide directional guidance and recommendations based on their experience helping many different cities.

Although the Smart Cities Council does not do consulting for pay, it does work with selected Spotlight Cities in the early stages of their planning. The Council advises those cities in their use of the Readiness Guide. And it assembles ad hoc teams of experts for brief "mentoring" sessions to get cities "unstuck."

Borrow from the larger vision

We've emphasized that a smart city roadmap should be in service to larger community goals. Many cities maintain 10- or 20-year plans that are updated regularly. Others have vision documents, typically around goals for sustainability or economic development. And most large private developments have a master plan that has given careful consideration to the region's strengths, needs and cultural preferences.

Many cities also have plans for particular neighborhoods, such as ecodistrict plans or revitalization plans. For instance, the Loop Media Hub Ecodistrict, led by Council advisor David Sandel, is a St. Louis community initiative. It hopes to accelerate economic growth by providing one gigabit (1000 megabits) of Internet access to each building along the city's Loop Trolley right-of-way.

Your smart city roadmap should draw from these plans to establish your goals, priorities and metrics. Smart technology should be the means to an end. So first you need to determine what that end should look like. Every city has a unique mix of strengths, challenges and cultural preferences. Thus, every city will have different goals. Is your economy based on manufacturing? On tourism? On high-tech services? Every city should tailor its roadmap to buttress its strengths and compensate for its challenges.

For instance, cities emphasizing a lower carbon footprint (as with the Vancouver, B.C. example featured earlier) might prioritize projects that impact emissions, such as smart grid, energy efficiency and electric vehicles. Cities aiming to become high-tech hubs might emphasize such things as broadband connections and mass transit.

If your city has no long-term plans, even for individual districts, then you may want to include a visioning exercise as an early step in your roadmapping process.

EcoDistricts

Starting small:

BUILDING A SMART CITY ONE ECODISTRICT AT A TIME

Portland, Oregon-based EcoDistricts seeks to inspire cities to remake themselves from the neighborhoods up. The nonprofit organization works with city builders and entrepreneurs, policymakers and innovators to create vibrant neighborhoods and smart cities. It disseminates district-scale best practices to create the neighborhoods of the future.

An EcoDistrict is a neighborhood with a broad commitment to accelerate local sustainability. EcoDistricts commit to achieving ambitious sustainability goals and tracking the results. Success is measured around eight performance areas, including: energy, water, equitable development, community identity, access and mobility, habitat and ecosystem function, health and well-being, and materials management.

Although every EcoDistrict is different, many include elements such as district energy, green job creation, livability enhancements, stormwater strategies and comprehensive transportation planning. The EcoDistricts organization has created a tool to guide cities and urban development practitioners from concept through implementation, with an emphasis on process management and community collaboration.

> ***Starting small.*** *The EcoDistrict Framework provides tools to take a neighborhood-by-neighborhood approach to building a smart, sustainable city.*
>
> *Figure 14.8*

Establish metrics

At this point, you have a team in place and you have broad goals pulled from your city's long-term vision.

A valuable next step is to establish metrics to measure progress towards those goals. A comprehensive smart city roadmap should have 1) measurable goals for livability, workability and sustainability and 2) timely reports of progress toward those objectives.

Some of those metrics will be "inward-looking" as a way for city government to monitor its own performance. But we urge you to include metrics that speak directly to citizens and their quality of life.

Elsewhere in this chapter and in the appendix, you will find examples of city plans and metrics to study for ideas. You may also want to consult published "city indicators." Examples include the Global City Indicators Facility (GCIF), Mercer Quality of Living Survey, the USGBC LEED for Neighborhood Development and the Circles of Sustainability Urban Profile from the UN Global Compact Cities Programme.

Prioritize your targets

With your vision and your metrics in place, you are ready to prioritize the targets you developed in earlier chapters to achieve those goals. We have placed a summary checklist at the end of this chapter. Use it to consolidate the work from the previous chapters and determine which targets to emphasize first.

How do you choose your priorities? These four steps will help:

1. Start with the fundamentals
2. Consider overall goals
3. Bolster your weak spots
4. Seek out quick paybacks

Each of these four steps will screen out some of the possibilities. If you apply these filters in order, you'll end up with a much shorter list of possible first projects.

Start with the fundamentals. Certain targets are so essential that every city should put them in place at the beginning. Or, at the very least, get started on them right away, even if they also do other projects in parallel. Review the five targets below to see if your city is missing any of these basics:

- Citywide multi-service communications
- Adhere to open standards
- Publish privacy rules
- Create a security framework
- Create a citywide data management, transparency and sharing policy

Prioritize your targets.
Start with the fundamentals. Certain targets are so essential that every city should put them in place at the beginning.

Figure 14.9

These five targets have the most profound effect on a city's ability to transform itself. Put another way, these five targets are the ones that will get you in the most trouble if you fail to get them right. Imagine, for example, leaving each individual department to figure out cybersecurity on its own. Some departments may have access to specialized expertise in-house or via consultants. But others are likely to fail at this challenging task, putting the entire city at risk.

Reminder: You don't have to build all of these things yourself, but you must ensure that they are in place. In some cases, the private sector may step up. (Many cities already have city-wide communications in place, for instance.) In other cases, you may be able to borrow ideas from cities that have gone before rather than start from scratch. (You can already find several solid privacy frameworks, for instance.) In other cases, your city may have un- or under-utilized assets that can be put into service. For instance, many cities have unused "dark fiber" – fiber optic cables that were installed but never put into service – that can be used for citywide communications.

Consider overall goals. Once you're comfortable that you have the fundamentals in play, filter your possible projects against your city's overall goals. As explained earlier, look to broader city vision documents and plans that set out long-term goals. Your smart city roadmap should prioritize projects that make progress against those objectives.

If your plan calls for the expansion of tourism, for instance, you'll want to prioritize projects that contribute to that objective. If your long-term plan calls for you to accommodate a large influx of new residents, you should emphasize projects that help you answer that imperative.

Bolster your weak spots. If you still have too many possibilities, you can narrow your choices by looking for projects that shore up your weak spots. The checklists in each chapter (and the summary checklist at the end of this chapter), contain a column to note where you are weak or strong.

Seek out quick paybacks. Finally, if you still have more candidates than you can tackle, look for easy wins. Give preference to projects that can be completed quickly and that have a rapid return on investment. Time and again, we hear from smart city experts that it is essential to demonstrate success early. For your long-term smart city transformation to succeed, you must have some early, short-term wins. These early successes will build enthusiasm and momentum. And, done right, they will create value streams that can help to pay for future projects.

> ***Payback from smart payments can be quick – and significant.***
> *Accepting smart payments, as in the Nice, France public bicycle sharing station above, makes it easy for citizens to access city services and also reduces the amount of time cities spend managing tokens or cash.*
>
> *Figure 14.10*

Seek out quick paybacks:

8 AREAS THAT CAN PRODUCE WINS QUICKLY

Although every city is different, here are seven areas that have proved to be excellent places to look for quick payback. By the way, payback isn't always financial. Sometimes it comes in other forms, such as popularity rankings, business startups or civic enthusiasm.

Smart transportation. This sector is the number one source of smart city projects. Most cities suffer from congestion and most citizens put traffic at the top of the list of things they want solved. According to some studies, congestion reduces a city's gross domestic product by somewhere between 1% to 3%. Smart transportation may not result in fare decreases. But it often reduces costs for the operators. And it almost always rewards citizens with lower congestion and shorter travel times.

Energy efficiency. Energy efficiency programs can often get underway without large expenditures. Many gains are possible through simple behavior changes – for instance, learning ways to save water, substituting more efficient light bulbs or learning to postpone non-essential electric use to non-peak times. What's more, many energy services contractors will undertake work for no upfront costs. Instead, they take a portion of the savings.

Smart grids. The payback from a smart grid is not necessarily in lower electric rates. Rather, it may come in the form of reduced outages and greater reliability against storms and sabotage. In areas subject to hurricanes, tornadoes, tsunamis, earthquakes or floods, resilience is highly valued. City governments can gain great approval if they improve reliability and resiliency – and face great wrath if they do not.

> ***Seek out quick paybacks.*** *The payback from a smart grid is not necessarily in lower electric rates. Rather, it may come in the form of reduced outages and greater reliability.*
>
> *Figure 14.11*

> ***Seek out quick paybacks.*** *Smart street lighting can be an excellent prospect for a first smart city project. The Council's Smart Street Lighting 101 eBook can help you get started.*

Figure 14.12

Smart water networks. Council member Itron estimates that 30% of all the water pumped worldwide does not reach its destination. A smart water network can pinpoint leaks and theft, gaining a quick payback in regions where water is scarce and costly.

Smart street lights. A confluence of several factors make smart street lighting an excellent prospect for a first project. First, the latest generation of LED lighting makes possible big savings in energy costs. Second, the same LEDs that save energy also save on "truck rolls." They last much longer, so maintenance crews don't have to spend as much time replacing lamps. Third, by networking the street lights – adding communications to each one – you make possible numerous smart applications, including remote diagnostics and control. Fourth, once you have a "canopy network" in place for street lights (and paid for by the savings in energy and maintenance), you can use that network for other smart city applications. After all, street lights already have power, already exist throughout the city and already sit up high – the perfect places to play host to a citywide network. The cities of Paris and Bristol in the UK are working with Council member Silver Spring Networks to install canopy networks for intelligent street lighting and other city services.

Public safety. Smart policing can have a dramatic impact on crime rates and public confidence. By feeding current and past crime statistics into analytical programs, cities can predict where crime is most likely to occur. And by equipping officers with cameras, laptops, tablets or smartphones, they can reduce the time spent on bureaucratic paperwork and increase the time on patrol.

Digital government services. You can often get a quick win by converting a government service from "manual" operation to a more convenient online or smartphone version. Done well, such projects can save money for the city while simultaneously improving citizen satisfaction (no more standing in line). There are dozens if not hundreds of possibilities, including licenses, permits, registration for social services, purchase of fare cards, reporting potholes and many, many more.

Setting up simple e-government apps can be a matter of months or even weeks. For example, Council member Civic Resource Group International offers a next-generation digital platform called CivicConnect. CivicConnect provides a tightly integrated suite of information-rich smart city applications, including portal management, transportation demand management, 311 citizen requests, open data and more.

Smart payments: Payback from smarter payments can be quick – and significant. Cash and other physical means of payments are generating huge costs for city administrations, as well as being very risky and needing secured transfers. By digitalizing all disbursements and collections, a city can generate significant savings and increase its operational efficiency. One example: By switching city service benefits from direct deposits and check cashing services to a prepaid card, the city of Toronto generated huge savings for both social assistance recipients and the city. Public estimates claim that more than $250 a year can be saved for a single client receiving $600 a month, and the city itself expects net savings of at least $2.5 million annually by eliminating the cost of issuing checks. This program was rolled out in less than a year.

Seek out quick paybacks:

DUBUQUE, IOWA: INVESTING IN SUSTAINABILITY

Roy Buol will tell you that the theme of making Dubuque a more sustainable city was central to his successful run for mayor in 2005. He'll tell you how much the issue resonated with the thousands of voters he spoke with in the course of knocking on thousands of doors. But one thing he won't do is take top credit for Dubuque becoming the model of a sustainable midsize city that it is today.

To Buol, that credit goes to the 60,000 citizens of Dubuque who worked to establish a unified vision of what sustainability means to them as a community. "My role was really to focus and channel a set of beliefs and priorities that was already there," Buol explains.

One key question was where to start. After the first few months of planning, several ideas made it to the table, reflecting the wish lists of a variety of groups. The filtering process took the form of a two-day workshop that dove deeply into issues of payback, practicality and timing. Moderated jointly by Council member IBM and key city officials, and involving no fewer than 83 people with diverse perspectives, the sessions produced both a clear consensus on where to focus and a roadmap for action.

The decision to lead off with a water conservation initiative was in many ways an outgrowth of Dubuque's existing efforts to revitalize its Mississippi River waterfront areas. But another key factor was the pragmatic desire to take advantage of a water meter replacement program that was already in the works, which would effectively lower the risk and cost of implementing it.

> ***Seek out quick paybacks.***
> *As its first sustainability project, Dubuque chose water conservation, an outgrowth of existing initiatives which lowered risk and cost of implementation.*
>
> *Figure 14.13*

Consider digital government services:

NEW TAIPEI USES SENTIMENT ANALYSIS TO GAUGE CITIZEN ATTITUDES

With over 3.9 million citizens and more than 500 administered institutions and schools, New Taipei city government began constructing and integrating the public cloud and service cloud, not only to strengthen city government operations and that of its subordinate agencies, but also to determine public sentiment regarding government services.

One of the biggest challenges was that complaints filed by citizens and their subsequent status were processed manually, and saved in various data sources. This meant that it took a lot of time and resources to perform this task. It was a major bottleneck.

Additionally, the user experience left a lot to be desired. The major complaint was the slow response time from the NTPC government regarding their complaints or requests. This was aggravated by the high number of inconsistencies in the responses that the citizens received.

New Taipei city government's public cloud and service cloud, whose main architecture is built on top of the CityNext Big Data framework from Council member Microsoft's Asia-Pacific Research & Development product team, comes with a sentiment analysis tool that enables the administration to use big data analytics to determine the general feedback and sentiment of citizens regarding government services. With sentiment analysis, NTPC officials can better understand the prevailing issues within their city and associate these with attached geographical information.

> ***Consider digital government services.*** *The New Taipei City Government uses a public and service cloud, big data and sentiment analysis to better understand citizen attitudes about government services.*
>
> *Figure 14.14*

Quick win from a smarter grid:

COMMUNITY ENERGY STORAGE HELPS SMOOTH SOLAR POWER IN CALIFORNIA

California utility companies are required to meet one-third of the state's electricity needs with power produced by renewable generation sources by 2020. But the high penetration of renewable generation has created concerns regarding grid stability, power quality and safety.

One California desert city is a primary example. It is served by a utility substation located 20 miles out on a 69-kV transmission radial tap that crosses high, windy terrain. The challenging environment and unique design constraints led the utility to consider a pilot microgrid project in which photovoltaic-generated energy would power the city if an outage occurs on the utility source.

The utility was concerned about reverse power flow from the photovoltaic-generated energy during low-load periods that can create safety issues for the system and the people working on it. It was also concerned about the time required for the microgrid to form an island in response to an outage. The utility sought an energy storage expert to help determine the most effective and reliable means for storing renewable energy at the microgrid and contacted Council member S&C Electric Company.

S&C proposed its PureWave® CES Community Energy Storage System for the pilot project. The three PureWave CES units were installed in close proximity to the solar generators. The batteries store excess solar generation, eliminating the possibility of reverse power flow locally and at the feeder level.

During an outage soon after deployment, the energy storage units provided uninterrupted service to utility customers for the entire 25-hour outage duration. In an ideally balanced case, wherein daily photovoltaic generation and consumption are equal,, islanding could be extended almost without limit.

> ***Quick win from a smarter grid.***
> *The payback from a smarter grid is not necessarily in lower electric rates. Rather, it may come in the form of reduced outages and greater reliability as a California utility found after deploying a microgrid with S&C's energy storage system.*
>
> *Figure 14.15*

Use experts to produce the specific plan(s).
At this stage, you have a prioritized list of targets plus ideas for your first projects. You may even have a cross-departmental implementation calendar that looks several years ahead.

If you are not already consulting with experts, now is the time to bring them on board. Their job will be to produce specific, detailed project plans and engineering specifications. (If you are building a district or city from scratch, then the experts' job will be to produce a master plan.)

> ***Use experts.*** *Finding the right experts is an important task. They must have a holistic, big-picture outlook to help your city find cross-departmental synergies.*
>
> *Figure 14.16*

Finding the right experts is an important task. They must have a holistic, big-picture outlook to help your city find cross-departmental synergies. But they must also have access to specialized knowledge to produce detailed technical specifications. Ideally, they will also have experience in smart city projects.

"Outsourcing" all or part of your project implementation can have important benefits. First, few city employees will have the up-to-the-minute technical skills to ensure that the city is getting state-of-the-art solutions. Second, few city employees have the time to take on such a complicated extra job. Smart city projects demand focused effort. Most city employees – and most city leaders – are focused on too many initiatives to truly drive the smart city charge, even if they have the technology skills. Outsourcing allows for a passionate focus on the project. And outsourcing can survive and bridge a change in government if elections or appointments occur in the middle of the project.

Where do you find such experts? Many cities have had success working with regional universities. Many cities bring in consulting firms to administer the overall process, trusting those consultants to bring in other specialists as needed. And many cities have found success working directly with experienced smart city suppliers like the Council members listed in this Guide's appendix.

The suppliers in the appendix have demonstrated exceptional smart city capabilities. They have collectively worked on thousands of projects that relate to smart cities. They know what works in real life, what problems are likely to occur, and which technologies are truly ready for prime time. It is no exaggeration to say that they represent the planet's very best smart city suppliers.

And they've also demonstrated a vitally important characteristic – the willingness and ability to collaborate with others. No single company can create the totality of a smart city. It takes a small army of specialists to build out the "system of complex systems" that is a smart city. Membership in the Smart Cities Council signals a firm's commitment to collaborating with other companies to produce the best possible solutions.

Success strategies for a roadmap

Much of this Guide gives advice with a technical flavor. However, when it comes to building a compelling and effective roadmap, the most important advice pulls from common sense. Cities should:

- Think big... but start small
- Work together... but move fast
- Emphasize synergies and interdependencies
- Borrow from the best
- Harvest good ideas

Think big... Earlier we said that a smart city roadmap should be subservient to a city's long-term vision. Don't hold back when setting those long-term goals. Be bold. Aim high. With the help of digital technology and willing citizens, virtually any city can achieve a greater level of health, happiness and prosperity. Yes, it will take longer for some cities. But the beauty of the digital revolution is that it offers hope to all, regardless of location. Indeed, in some cases digital technology allows cities in emerging economies to leapfrog cities from the developed world. Since they have much smaller investments in legacy infrastructure, they can jump straight to the better technologies now available.

> ***Start small.*** *With your grand plan in place, start small at first. Pick a project that has a small upfront investment, a quick turnaround and a rapid payback.*

Figure 14.17

... but start small. With your grand plan in place, start small at first. Pick a project that has a small upfront investment, a quick turnaround and a rapid payback. Ideally, this first target will be a consensus priority – something that is near the top of the list for all of the key stakeholder groups. Invest in one or a few select projects with the biggest and fastest payback. On the financial side, this allows you to apply the savings from the first project(s) to finance the next one(s). On the public relations front, it allows you to get an early win that builds support and momentum.

Starting small can also mean taking a neighborhood-by-neighborhood approach. Many cities start their smart city journey by designating one area for a pilot project. Districts – neighborhoods, if you prefer – are small enough but big enough too. They are small enough to be manageable and nimble. But they are big enough to have a critical mass of constituents and to gain some economies of scale. And they are small enough to innovate quickly but big enough to have a meaningful impact.

If the neighborhood approach is not right for your city, you might look for other self-contained environments such as industrial parks, campuses, leisure complexes, transport hubs, etc.

Work together... Time and again, we hear that collaboration is key to successful smart city projects. "When it comes to achieving the high-tech, sustainable, and smart cities of the future, there is one word that sums up the pathway to success: partnership," explained Terry Kirby in The Guardian in May 2013. Kirby and other observers say those partnerships should include (at a minimum) local governments, local utilities, local universities, local business groups, local developers and property owners and relevant advocacy groups (such as those that promote sustainability).

Smart city pioneers agree that collaboration is key – and that it can be surprisingly hard to achieve given the "stove-piped" structure of many city governments and the sometimes adversarial relationship between the public and private sectors. First, city governments need to get better at collaborating internally after decades of working in departments with strict boundaries. Second, cities need to get better at collaborating with business and with the public.

Gartner analyst Andrea Di Maio argued in 2012 that "technology is mostly irrelevant unless policymakers, city managers, heads of department and city CIOs get the fundamentals right. What really matters is how different sectors cooperate and how they can exchange meaningful information. Of course there is technology involved, but that's not enough to make cities smart.

> ***Move fast.*** *Identify "hot spots" or priorities to enable a quick start on the journey to becoming smarter.*

Figure 14.18

Cooperation requires solid governance and a roadmap that is respectful of 1) the different – and potential diverging – business objectives and timeframes of different stakeholders and 2) the inevitable resource constraints."

... but move fast. Those who hesitate may not be lost, but they will be passed by. As part of your planning, identify "hot spots" or priorities to enable a quick start on the journey to becoming smarter. For one thing, cities are in constant competition with each other to attract business, talent and creative types. Cities need to begin their smart city journey soon, or they will forever be playing catch-up to their rivals.

In addition, starting fast with an easy win can help with the political realities. Many elected officials operate on a relatively short horizon. Yes, they may have long-term goals for their cities. But they must operate within the constraints of frequent elections. They must show short-term progress along the way if they hope to be re-elected.

Emphasize synergies and interdependencies. Done well, your roadmap will consider the totality of the city, not just one or two important departments. In the beginning and at every progress review you should be looking for inter-departmental synergies.

If, for example, you target water alone, you will fail to capture the interdependencies with other departments such as energy. For instance, pumping water for irrigation and human consumption can represent 20% of a city's overall energy budget. Often a city can slash its energy bill just by shifting pumping to off-peak hours when there is less demand on the power grid. Likewise, the same communications system that carries messages for smart water meters can often handle smart electric meters as well, doing away with the expense of a second network. These kinds of synergies and savings don't show up when systems are studied in isolation.

In previous chapters, we've highlighted the interdependencies between different responsibilities. For instance, the built environment relies heavily on services from energy, telecommunications and water systems. Likewise, public safety relies heavily on services from telecommunications, energy and transportation

The roadmapping phase is when you put the theories of synergy and interdependency into practice. All the more reason to work together – to construct a task force that gets input from all the departments.

Borrow from the best. Study those who've gone before. It's smart to learn from your mistakes. It's even smarter to learn from the mistakes of others. And it's smartest of all to learn from the successes of others. Hundreds of cities have embarked on smart city initiatives big and small, so there's no need to invent your smart city plan from scratch. Study their roadmaps and plans (most are public documents).

Harvest good ideas wherever you find them. You'll find links to several smart city plans and related tools in the appendix of this Guide. The Smart Cities Council website can also help. You'll find success stories in the examples and case studies section. And you'll find advice on building plans in the visioning and roadmapping tools section.

> ***Harvest good ideas.***
> *The old port city of Santander, Spain has garnered international attention for the thousands of sensors that is making it smarter.*
>
> ***Figure 14.19***

Now you're ready to get started. It will be hard work, but it will also be rewarding. The roadmap you create will be the jumping off point for a better city for current residents and the generations that follow.

CREATING YOUR ROADMAP

Priority 1-high 2-medium 3-low	Enabler	Universal Targets How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress None	Partial	Over 50%	Complete
☐	**Instrumentation**	Implement optimal instrumentation • Supplement: for all transportation modes (Transportation) • Supplement: across the watershed (Water and Wastewater) Ensure universal high-speed broadband access (Telecommunications) Ensure a citywide wireless network (Telecommunications)	☐	☐	☐	☐
☐	**Connectivity**	Connect devices with citywide, multi-service communications	☐	☐	☐	☐
☐	**Interoperability**	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments • Supplement: including physically stored data (Public Safety) Enable distributed generation with interconnection standards (Energy) Enable multi-channel access to an integrated customer transportation account (Transportation)	☐	☐	☐	☐
☐	**Security & Privacy**	Publish privacy rules Create a security framework Implement cybersecurity De-identify patient and student data for storage in the cloud (Health and Human Services)	☐	☐	☐	☐

Continued on next page

CREATING YOUR ROADMAP

Priority 1-high 2-medium 3-low	Enabler	Universal Targets How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress None	Partial	Over 50%	Complete
	Data Management	Create a citywide data management, transparency and sharing policy				
		• Supplement: including energy usage data (Energy)				
		• Supplement: including water usage data (Water and Wastewater)				
		Architect a single health history for citizens (Health and Human Services)				
	Computing Resources	Consider a cloud computing framework				
		Use an open innovation platform				
		Have access to a central GIS				
		Have access to comprehensive device management				
	Analytics	Achieve full situational awareness				
		• Supplement: across the watershed, and informed by weather data (Water and Wastewater)				
		Achieve operational optimization				
		• Supplement: for sustainability, efficiency, and cleanliness and safety (Water and Wastewater)				
		Achieve asset optimization				
		Pursue predictive analytics				
		• Supplement: integrate all transport modes for multi-modal transportation optimization (Transportation)				
		Automate fault and outage management (Energy)				
		Automate fault and leak management (Water and Wastewater)				
		Segment and personalize programs for customers (Energy)				
		Enable dynamic, demand-based pricing (Transportation)				

Figure 14.20

ADDITIONAL RESOURCES

Quick payback with smart street lights

San Diego's LED Street Lighting Project

Lorie Cosio-Azar, Project Officer for the city of San Diego Environmental Services Department, explains why Council member GE's energy-efficient LED street lighting fixtures and wireless lighting controls will save her city more than $250,000 annually.

Lighting Up the Future, Together

Streetlights are important civic assets that consume approximately 40% of a municipality's energy budget. Replacing existing streetlights with networked LED luminaires enables tremendous energy savings. Learn more in this video from Council member Silver Spring Networks.

Multiple paybacks from smart grid technologies

Space-Time Insight at Sacramento Municipal Utility District

The payback with a smart grid isn't necessarily lower electric rates. Learn how Sacramento Municipal Utility District is using situational intelligence applications to increase grid reliability and integrate new energy technologies such as wind and solar power, electric vehicles, energy storage and demand response in this video from Council member Space-Time Insight.

Have access to a central GIS

OGC Smart Cities Spatial Information Framework

Location information can provide valuable insight that smart cities can use to improve the lives of citizens. The Open Geospatial Consortium Smart Cities Spatial Information Framework highlighted in this white paper from Council advisor OGC provides guidance on planning and implementing open spatial standard architectures, which are key to driving interoperability and efficiency in GIS projects.

Emphasizing synergies and interdependencies

Improving government interoperability: A capability framework for government managers

This comprehensive white paper by the Center for Technology in Government, a Council advisor, provides guidance for government managers as they begin to move beyond the vision of a more effective government to the reality. It defines government interoperability as the mix of policy, management and technology capabilities needed by a network of organizations to deliver coordinated government programs and services.

APPENDIX

On the pages that follow, learn more about the work of the Smart Cities Council and its partner companies and advisors who rank among the world's foremost experts on smart cities.

About the Smart Cities Council

There is no other organization like the Smart Cities Council. We act as a market accelerator and advisor to cities – advocating for the transformation of urban areas into more livable, workable and sustainable communities. The Council is a coalition of leading technology companies with deep expertise in areas such as energy, water, communications and transportation. We have come together to provide a collaborative, vendor-neutral framework to guide cities through their smart city planning and implementation. We envision a world where technology and intelligent design are harnessed to create smart, sustainable and prosperous cities. We work to create cities that exemplify our three core values: livability, workability and sustainability. Visit www.smartcitiescouncil.com to learn more.

The Future of the Readiness Guide

This Readiness Guide is the first collaborative and comprehensive framework for a smart city, against which cities can assess their readiness to innovate – identifying a path, taking next steps and measuring progress. It was prepared with input from best-in-class companies across many industries. In addition, more than 50 of the world's foremost independent experts on smart city development from academia, research and advocacy have reviewed and contributed to the Guide. Version 1.0 was released at the Smart City Expo World Congress in Barcelona, Spain on Nov. 19, 2013. This is Version 2.0. We will continue to revise and update it.

City master plans

As noted in the Ideas to Action chapter of this Guide, cities don't have to reinvent the wheel when planning a smart city roadmap. To provide ideas and inspiration, we've gathered a selection of visioning/roadmap/master plan documents from cities around the world. If you have others you'd like to recommend, please direct them to Editorial Director Liz Enbysk: liz.enbysk@smartcitiescouncil.com

Belfast City Masterplan

Birmingham's Smart City Vision

Chicago Technology Plan

Digital Masterplan for Dublin

Imagine Austin

Jobs and Growth Plan for London

New York City Digital Leadership 2013 Roadmap

Philadelphia 2035 Citywide Vision

Portland Plan

Stockholm Vision 2030

Global Alliances

In 2015 the Council introduced the Global Alliances of Smart Cities Councils – an opportunity for regional stakeholders everywhere to affiliate with the Council and leverage our best practices. The first licensee, Smart Cities Council India, launched soon thereafter. To discuss becoming a Global Alliance licensee, please contact Council Exectuive Director Philip Bane: Philip.Bane@smartcitiescouncil.com

Council Partners

On the pages that follow, you will meet our partners and advisors. We invite you to join with us too. Learn more by contacting Council Chairman Jesse Berst. Jesse.Berst@SmartCitiesCouncil.com

Smart Cities Council

INTRODUCING SMART CITIES COUNCIL LEAD PARTNERS

Cities seeking expert guidance regarding their smart city initiatives will discover valuable partners in the companies featured on the pages that follow.

IBM
Itron
Alstom
Microsoft
GE
Cisco
S&C Electric Co.
Bechtel
Qualcomm
MasterCard
Enel
Ooredoo
Daimler
Cubic Transportation Systems
Allied Telesis
Schneider Electric
Verizon

Partners are listed according to the date they joined the Council; longest-standing members appear first.

As a leading producer of smart technologies and services, IBM is pleased to lend its expertise to the Smart Cities Council's efforts to support and educate city leaders, planners and citizens.

Cities everywhere are reinventing themselves to better integrate across functions and collaborate with new partners to create and nurture the strong, differentiating identities that attract new citizens and businesses.

Combining world-class business, industry and technology expertise, IBM is able to apply innovation to help cities achieve their objectives. Drawing on thousands of client engagements across virtually every industry, only IBM offers the experience that today's challenges demand.

IBM smarter cities resources:

- *Smarter Cities press kit*
- *Smarter Cities web page*
- *White Paper: Smarter, More Competitive Cities*
- *People for Smarter Cities*
- *Smarter Cities You Tube Channel*

IBM worked with the city of Madrid to improve city life for three million citizens through a project that will use IBM's Smarter Cities technology to improve the efficiency of city services and provide citizens new tools to interact and communicate with the city council.

Leveraging big data and analytics, IBM helped Madrid transform its supplier management model by allowing the city to manage and pay each service provider based on the attainment of service levels. The platform integrates information provided by citizens with other data streaming in from sensors, devices, cameras, inspectors and suppliers as well as data from human resource management, job scheduling and geographic information systems to provide a comprehensive view of city services.

By helping Madrid manage an inventory of more than five million assets – ranging from park swings to traffic cameras – and the contracts of service suppliers, the project will deliver results for citizens by improving the management of public services such as street maintenance, lighting, irrigation, trees and green spaces and waste management.

"By enabling cities to better manage energy and water resources, Itron believes that, with collaboration and innovation, we can help cities not only adapt to address challenges, but also thrive. By drawing on today's best minds and technology, the Smart Cities Council and its members are committed to achieving just that."

– Russ Vanos, Itron's senior vice president of strategy and business development

Itron is a world-leading technology and services company dedicated to the resourceful use of energy and water. We provide comprehensive solutions that measure, manage and analyze energy and water. Our broad product portfolio includes electricity, gas, water and thermal energy measurement devices and control technology; communications systems; software; as well as managed and consulting services. With thousands of employees supporting nearly 8,000 customers in more than 100 countries, Itron applies knowledge and technology to better manage energy and water resources. Together, we can create a more resourceful world. Join us: www.itron.com

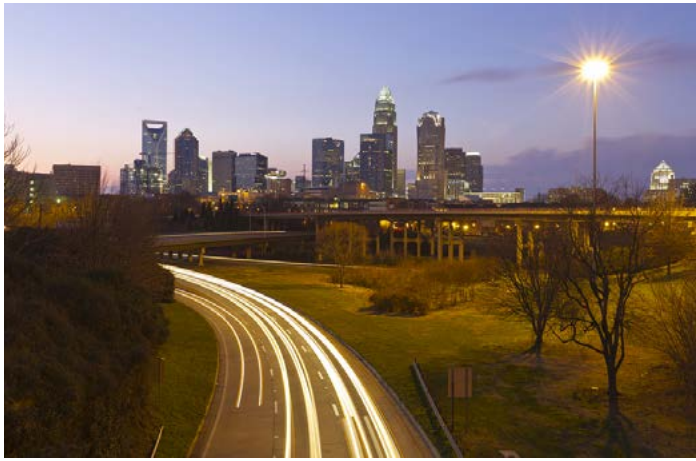
As a founding member and lead partner in the Smart Cities Council, Itron is helping to advance Smart City initiatives at a time when it is critical to take action. We believe Smart City initiatives will be incredibly important in the 21st century. Currently, more than half of the world's population lives in towns and cities for the first time in history, which puts a strain on energy and water resources. In addition to the strain on resources, there is also an incredible amount of energy and water lost due to waste – approximately 30% of all treated water is lost and electricity losses cost utilities $24B per year. In order to ensure sustainability and viability of our cities for future generations, smart technology needs to be utilized to reduce waste and empower people to manage and conserve resources.

Itron is collaborating with Microsoft to provide actionable data to help cities meet their objectives to reduce their carbon footprint and lower energy consumption. Learn more >

Smart City innovation has turned Uptown Charlotte into a living laboratory. Envision Charlotte Executive Director Amy Aussieker shares insights about the project. Learn more >

Itron's water AMI solution helps the City of Kalgoorlie, Australia to manage resources more effectively and provide greater control over water wastage. Learn more >

Itron's Mobile AMR solution allowed Alabama Gas Corporation to reduce CO2 emissions with fewer vehicles while gaining greater meter reading efficiency. Learn more >

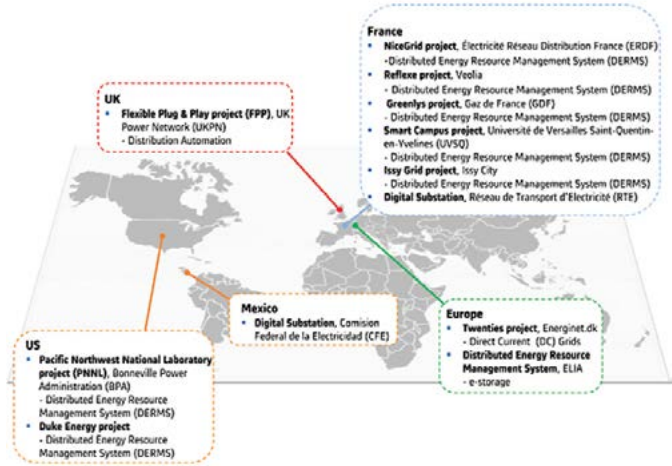


Envision Charlotte: Itron teams up with partners to connect consumers with water usage and conservation information.

Read article >

ALSTOM

> *Alstom developed a number of demonstration projects in leading smart grid countries, in partnership with governments, utilities, industries, academic and research institutions.*



As a leading producer of smart technologies and services, Alstom Grid is pleased to lend its expertise to the Smart Cities Council's efforts to support and educate city leaders, planners and citizens.

To meet today's increasing global energy demands and challenges, networks must evolve and become smarter. Alstom Grid enables an efficient transmission and distribution of electricity and supports the development of Smart Grids and Supergrids with engineered solutions for applications in utility and industry settings; updating existing grids, integrating and customizing solutions such as alternating current and direct current substations, from medium up to ultra-high voltages. Alstom Grid is a key player in developing and implementing solutions to manage electric grids in the new era of increasing renewable energies and distributed energy resources, by enabling real-time, two-way management of electricity and information.

At the heart of the Smart Grid revolution, its solutions provide immediate benefits in many eco-city projects, thus enabling end-consumers to benefit from better energy consumption. Alstom Grid's knowhow is displayed in over 30 large scale demonstration projects in the US and Europe, with partners from both the public and private sectors.

The North Carolina Smart Grid Project in the USA led by the US Department of Energy (DoE) is designed to integrate distributed energy resources into the electrical grid efficiently in order to help the DoE reach its smart grid targets for 2030, including a 40% improvement in system efficiency. The NiceGrid smart district project developed with the French Distribution System Operator ERDF, located in the city of Nice (French Riviera), aims at developing several microgrids with integrated renewable energy sources and electricity storage with a scalable and cloud-based IT platform.

Clean grid

Learn more >

Global grid

Learn more >

Smart grid

Learn more >

Electrical network systems

Learn more >

Video overview

See video >

Microsoft

Founded in 1975, Microsoft is the worldwide leader in software, services, devices and solutions that help people and businesses realize their full potential. Microsoft CityNext is an extension of that vision with a people-first approach to innovation that empowers government, businesses and citizens to shape the future of their city. People-first means harnessing all the ideas, energy and expertise of a city's people as it creates a more digital, healthy, educated, safe, and sustainable place to live.

With a broad suite of platform and productivity solutions for a mobile-first, cloud-first world, a vast global network of partners, and a history of successful education and social programs, Microsoft CityNext helps cities find the right answers for their local challenges and opportunities.

With Microsoft CityNext's partners, we are committed to helping cities:

- **Transform operations and infrastructure** with Microsoft CityNext and our partners' solutions by connecting systems, data, and people across departments to make information more accessible and services more affordable

- **Engage citizens and businesses** by enabling **r**eal-time communication services through devices and apps to provide additional value to citizen services, reach a broader population of citizens, and engage citizens and businesses more deeply with intelligent experiences. This includes connections between governments and citizens, governments and businesses, and other governments.

- **Accelerate innovation and opportunity** through programs that prepare youth to become the next generation of highly skilled workers, nurture entrepreneurs' bold ideas, and create jobs that help cities compete in the global marketplace by delivering excellent education, use data from the Internet of Things to develop new services and businesses, and attract talent and new business with a modern infrastructure.

Through a people-first approach and strategic partnerships, cities can enable sustainable cycles of innovation, opportunity, and progress for years to come.

Find out how Microsoft CityNext and our partners are enabling cities worldwide to harness the new era of innovation.
Learn more ->

Microsoft CityNext helps city leaders turn their smart city vision into reality.
Learn more ->

Connect with us on Twitter, Facebook, and YouTube to receive updates on new customer stories, partners, and more.

Learn more about how Microsoft CityNext and our partners are helping cities become smart with a people-first approach at http://microsoft.com/citynext

Imagine a world that connects data to people to machines, making lives better in the cities where people work, live and explore. It's a world where city leaders could tap into endless intelligence to eliminate costly redundancies and develop a more workable and livable community.

That world is here, and it's powered by Predix™ , GE's cloud platform for the Industrial Internet. Through GE's Intelligent Environments for Cities solution, communities around the world will experience pioneering solutions from such businesses as GE Software, GE Lighting, GE Healthcare and GE Power & Water. At GE, we look at innovation through a broad lens. By taking breakthroughs in one business and applying them to others, we push expectations and change the idea of what's possible – all for the benefit of cities around the globe.

GE Software is bringing the Industrial Internet to life by connecting minds and machines through innovative technology. In building our applications and GE Predix, we combine decades of experience manufacturing industrial machines with cutting-edge data science and analytics expertise. The Predix platform has helped our developers save both GE and our customers time, energy and money, and now we are releasing it so that your developers can leverage its advanced computing power and built-in integrations to develop innovative applications across industries. We have transformed our business and invite you to join us on this path as we ignite the next Industrial Revolution together. Learn more at gesoftware.com and predix.io.

Seeing More than Light

One of GE's Intelligent Environments for Cities solutions uses LED street lighting and wireless sensors to connect, collect and analyze data, harnessing the power of the Industrial Internet to solve countless challenges facing cities and communities across the globe.

Cities on both U.S. coasts are piloting the Intelligent Cities technology to help solve these challenges and enhance the quality of life for residents and visitors. In San Diego, California, sensor technology has been added to existing GE LED streetlights, with a focus on parking solutions in its urban core. The city of Jacksonville, Florida is piloting the solution to access real-time data and focus on increasing efficiency through energy savings and better asset management of street lights.

From curbing street-lighting costs to improving traffic monitoring, enhancing pedestrian crosswalk detection, mitigating illegal dumping and monitoring adverse weather conditions, the potential solutions from this technology are endless. Learn more about the pilot programs.

> *GE works on things that matter. The best people and the best technologies taking on the toughest challenges. Finding solutions in energy, health and home, transportation and finance.*

GE supports the Smart Cities Council's vision to transform urban areas into more livable, workable and sustainable communities. As a technology company, sustainability is embedded in GE's culture and business strategy. Working to solve some of the world's biggest challenges inspires our thinking and drives our actions.

Visit www.ge.com to learn more.

As world populations shift to urban areas, community leaders are pressed for answers to related problems. These include overcrowding, pollution, budget and resource constraints, inadequate infrastructures and the need for continuing growth.

Cisco Smart+Connected Communities solutions use intelligent networking capabilities to bring together people, services, community assets and information to help community leaders address these world challenges. By connecting the unconnected, we can do amazing things to address these real world challenges and create a more sustainable environment.

Cisco Smart+Connected Communities -- help transform physical communities to connected communities and achieve economic, social and environmental sustainability.

Transforming communities >

Retrofitting existing cities with smart solutions is the urban challenge of the 21st century.

Learn more >

> *City transforms economic sustainability with public cloud.*

S&C ELECTRIC COMPANY

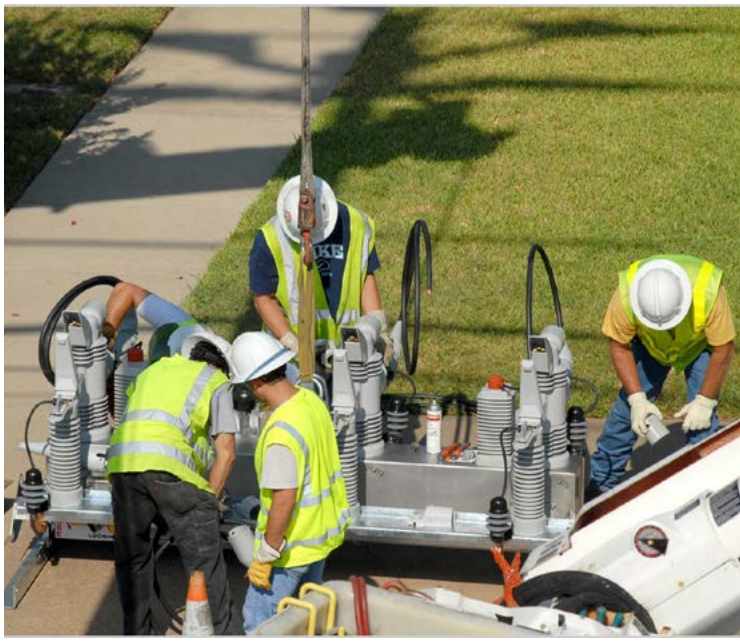
Excellence Through Innovation

S&C proudly supports the Smart Cities Council in advocating the evolution toward smart, sustainable cities.

S&C Electric Company's innovative solutions for distribution automation and power delivery are helping cities around the world transition to cleaner and more reliable supplies of electricity required in the 21st century. S&C's groundbreaking technologies can reduce the length and frequency of power outages, improve energy efficiency, support advanced microgrids and grid-scale energy storage, and make it practical to use such variable renewable-energy sources as wind and solar power on a larger scale.

With its unmatched heritage of innovation and performance, S&C delivers both products and services to address not only today's power grid challenges, but tomorrow's as well.

Additional information is available at sandc.com.



Chattanooga, USA deployed S&C's self-healing smart grid solution to improve power reliability. The system is exceeding outage reduction goals of 40%.

Additional resources:

- **Reducing Momentary Outages for Florida Power & Light:** *Press release* *Video*
- **S&C Ties California Utility's 2-MW Solar PV Project to the Grid:** *Case study*
- **Oncor's Microgrid Solves Electrical Distribution Challenges:** *Video*
- **Energy Storage to Smooth Solar Power:** *Case study*
- **Utility-Scale Energy Storage System Islands Remote Town During Outages:** *Video* *Case study*
- **Improving Reliability by more than 50% with Self-Healing Technology:** *Case study*
- **What do outages cost cities?** *Video*
- **Microgrids: An Old Idea with New Potential:** *White paper*
- **The Role of Energy Storage in Smart Microgrids:** *White paper*
- **Smart Microgrid at Illinois Institute of Technology:** *Case study*

Bechtel is pleased to support the Smart Cities Council's aspirations to foster the creation of smarter cities around the world by sharing our experience delivering major infrastructure projects and knowledge of planning, financing and sustainable solutions.

As a company, we work hard to build a more sustainable world. In our work with cities and governments we enhance local communities and improve the quality of life for people around the world. Time and again our work has demonstrated that the only limits on human achievement are those that we place on ourselves.

Bechtel is a global leader in engineering, procurement, construction and project management. Bechtel's diverse portfolio encompasses energy, transportation, communications, mining, oil and gas and government services.

We have been privileged to contribute towards some of the most significant urban infrastructure projects around the world, including the Channel Tunnel, Hong Kong International Airport, the Athens Metro system and work on more than 20 new cities and communities. In order to deliver projects of such magnitude successfully, we combine smart planning, technical know-how and an integrated approach to make visions become a reality. We look forward to sharing the benefits of this experience and our knowledge of planning, financing and sustainable solutions, to support the Council's aspirations to foster the creation of smarter cities around the world.

Since its founding in 1898, Bechtel has worked on more than 22,000 projects in 140 countries on all seven continents. Today, our 53,000 employees team with customers, partners and suppliers on diverse projects in nearly 50 countries. We stand apart for our ability to get the job done right - no matter how big, how complex or how remote. www.bechtel.com

Bechtel is the co-manager of the U.S. Department of Energy's Los Alamos National Laboratory. The lab provides advanced research in supercomputing and virtual reality with significant applications to Smart City issues such as energy, transportation, the environment and resilience.

> *For local, state and federal government personnel, good situational awareness can help save lives and better protect assets.*

Qualcomm Incorporated is the world leader in 3G, 4G and next-generation wireless technologies. Qualcomm Incorporated includes Qualcomm's licensing business, QTL, and the vast majority of its patent portfolio. Qualcomm Technologies, Inc., a wholly-owned subsidiary of Qualcomm Incorporated, operates, along with its subsidiaries, substantially all of Qualcomm's engineering, research and development functions, and substantially all of its products and services businesses, including its semiconductor business, QCT. For more than 25 years, Qualcomm ideas and inventions have driven the evolution of digital communications, linking people everywhere more closely to information, entertainment and each other. Qualcomm innovation and technology can be used by cities worldwide to provide smart, efficient and sustainable services, including:

Cellular Grid Connectivity – ubiquitous consumer coverage, high bandwidth and real-time communications of 3G and LTE cellular networks that enable critical smart grid functionality such as advanced smart metering, demand response, distribution automation, and outage management.

Home Area Connectivity – unsurpassed whole home coverage, performance and reliability in an energy efficient manner.

Connected Vehicle – anywhere/anytime emergency assistance services, remote monitoring and diagnostics, advanced driver assistance features, GPS and GLONASS-enabled position-location features and services.

Wireless Electric Vehicle Charging – a simple, no fuss way to charge your electric vehicle. No cables, no wires, just park and charge.

Mobile and Wireless Health – broadband technologies enabling mHealth devices and services for chronic disease management, remote patient monitoring, diagnostic care, as well as products associated with general health, wellness, fitness, and aging.

Mobile Learning – mobile broadband technologies enabling personalized experiences within collaborative communities, transforming the work of teachers/students in K-20 schooling.

Qualcomm leverages its wireless expertise, innovative technologies and vast industry reach to provide capabilities and services that enable government customers – federal, state, and local.

Learn more >

Smart cities

Learn more >

Internet of Everything

Learn more >

Wireless technologies

Learn more >

MasterCard shares the Smart Cities Council's vision of a world where digital technologies and intelligent design are harnessed to create smart, sustainable cities with high-quality living and high-quality jobs.

MasterCard is a global payments and technology company. We operate the world's fastest payments processing network, connecting consumers, financial institutions, merchants, governments, cities and businesses in more than 210 countries and territories.

Our products and solutions are advancing the way consumer and business cardholders around the world shop, dine, travel, and manage their money, enabling transactions that drive global commerce and improve peoples' lives.

Passionate about innovation, MasterCard is constantly seeking to develop and test new payment channels and digital solutions that are safe, simple and smart.

Payments touch every aspect of our lives. Removing cash from the economy creates far-reaching and cumulative benefits for all participants — citizens, merchants, tourists and government —improving life for the city at-large.

Cities are becoming smarter, and whether it is to simplify internal processes, facilitate micro payments (transit, commerce...), optimize collection of funds or improve disbursement methods, MasterCard is developing inventive ways to support Cities digital strategy, drive local business growth, fuel commercial development, increase citizen's satisfaction and reduce costs.

Special and Unique Offers with MasterCard Priceless Cities. www.priceless.com

> *London bus passengers speed up their journey times with contactless card payments.*

London bus cards >

The global journey from cash to cashless: boosting economic growth and advancing financial inclusion.

Learn more >

Digital sharing and trust project: understanding the five online personas.

Learn more >

Enel is a multi-national power company and a leading integrated player in the world's power and gas markets, with a particular focus on Europe and Latin America. The Group operates in over 30 countries across four continents, generating power from over 90 GW of net installed capacity and distributing electricity and gas through a network spanning around 1.9 million km. Enel, with its 61 million end users worldwide, has the largest customer base among its European peers and is among the leading power companies in Europe in terms of installed capacity and reported EBITDA.

Enel was the first utility in the world to replace the traditional electromechanical meters with smart meters, making it possible to measure consumption in real time and manage contractual relationships remotely. Today, around 32 million Italian retail customers are equipped with smart meters developed and installed by Enel. The Group is deploying an additional 13 million smart meters to its customer base in Spain as well as running pilot tests for the smart cities of Búzios (Brazil) and Santiago (Chile). This innovative tool is key to the development of smart grids, smart cities and electric mobility.

Enel is strongly committed to renewable energy sources and to the research and development of new environmentally friendly technologies. Enel Green Power (EGP) is the Group's publicly listed renewable energy generation company, operating over 9.8 GW of net installed capacity of hydro, wind, geothermal, solar, biomass and co-generation sources in Europe, the Americas and Africa. Enel Green Power is, technology-wise, the most diversified renewable company among its global peers.

Enel website >

Enel on sustainability >

Enel on innovation >

> *Strongly committed to renewable energy sources.*

Headquartered in Doha, Ooredoo is Qatar's leading communications company and is dedicated to supporting the Qatar National Vision 2030.

Ooredoo has an active strategic and supportive role in shaping the telecom and ICT strategies in Qatar as part of its goal to make the country one of the best-connected nations in the world. The "smart city" concept is central to the long-term development vision of Qatar, placing technology at the heart of new projects to enable a smart economy, smart mobility, a cleaner environment and smart governance.

To support this vision, Ooredoo has developed and launched a host of next generation technology from smart infrastructure (4G+ and Fibre), smart entertainment, connected cars, next-generation education, health and workplace solutions, intelligent transport and smart stadiums, demonstrating the company's leadership in driving the latest and the best technology.

Ooredoo is spearheading this technological boost by working with a number of leading enterprises including KT Corporation of Korea and Lusail Real Estate Development Company, to ensure the development of smart city technology.

> *Ooredoo is a leading communications company providing services in the Middle East, North Africa and Southeast Asia.*

Ooredoo is becoming a leader in the provision of the network infrastructure required to build the Smart Cities of the future, and is leading the efforts for the first-ever Smart City in Qatar – the state-of-the-art Lusail City – which will be supported by Ooredoo's faster and bigger network. Residents and businesses will have access to a variety of smart services powered by a citywide Ooredoo Fibre network and managed through a centralised control centre.

The company has introduced a host of cutting-edge Ooredoo Machine to Machine (M2M) services to Qatar, enabling companies to connect business assets directly with each other or with a central command centre, removing the need for human involvement, and introducing new solutions directly into homes and businesses.

Ooredoo has also launched The Smart Living-Baytcom Project – a 'Proof of Concept Demo House' filled with smart living concepts.

Ooredoo website >

DAIMLER

About Daimler AG:

> *As a pioneer of automotive engineering, we continue to shape the future of mobility today.*

Daimler AG is one of the world's most successful automotive companies. With its divisions Mercedes-Benz Cars, Daimler Trucks, Mercedes-Benz Vans, Daimler Buses and Daimler Financial Services, the Daimler Group is one of the biggest producers of premium cars and the world's biggest manufacturer of commercial vehicles with a global reach. Daimler Financial Services provides financing, leasing, fleet management, insurance and innovative mobility services.

The company's founders, Gottlieb Daimler and Carl Benz, made history with the invention of the automobile in the year 1886. As a pioneer of automotive engineering, we continue to shape the future of mobility today: Our focus is on innovative and green technologies as well as on safe and superior automobiles that appeal to and fascinate our customers. For many years now, Daimler has been investing continually in the development of alternative drive systems with the goal of making emission-free driving possible in the long term. So in addition to vehicles with hybrid drive, we now have the broadest range of locally emission-free electric vehicles powered by batteries and fuel cells. This is just one example of how we willingly accept the challenge of meeting our responsibility towards society and the environment.

Daimler sells its vehicles and services in nearly all the countries of the world and has production facilities on five continents. Its current brand portfolio includes, in addition to the world's most valuable premium automotive brand, Mercedes-Benz, the brands smart, Freightliner, Western Star, BharatBenz, Fuso, Setra, Thomas Built Buses, moovel and car2go. The company is listed on the stock exchanges of Frankfurt and Stuttgart (stock exchange symbol DAI). In 2014, the Group sold 2.5 million vehicles and employed a workforce of 279,972 people; revenue totaled €129.9 billion and EBIT amounted to €10.8 billion.

About Business Innovation:

Since 2007 the Business Innovation department has been Daimler's lab for innovative business ideas that reach out well beyond the company's core business of automotive manufacturing. Business Innovation tracks current trends and monitors technological, social and cultural developments with a view to developing new and profitable business solutions. Numerous pilot projects initiated in recent years have already led to the establishment of successful corporate units such as car2go, moovel or the Mercedes-Benz Driving Academy. There are now Business Innovation teams based all over the world. As well as at the headquarters office in Stuttgart, they are to be to be found in Istanbul, São Paulo, Beijing, Buenos Aires and Sunnyvale, California.

Cities around the world are facing the growing problem of aging and overburdened infrastructure, needing to carry more people but without the ability to move those people effectively. What's the answer? Cubic is doing this through NextCity, our vision for the future of urban mobility.

At Cubic, we love to solve problems and help travelers pay their fares quickly and safely through the revenue management and Intelligent Transport Systems (ITS) systems and tools we deliver to choose the smartest and easiest way to travel and pay for their journeys.

We also enable transportation authorities and agencies to manage demand across the entire transportation network – all in real time.

Today, all of our payment and information technology and services have been merged into an overarching vision called NextCity. Through NextCity and its subsystems, we are able to extract the data from our electronic payment systems and other system sensors. This data becomes actionable information for transportation operators to understand what their ridership is doing – where they come from, where they go, the routes they take and the times at which they travel. Better understanding of demand allows for better understanding of supply and capacity needs.

This data also empowers the travelers with information they can use to choose the best mode of travel as well as to know what and where the slowdowns or service alerts are to aid their journey planning.

Transport for London in partnership with Cubic is transforming the payment experience in one of the world's biggest cities. Learn more >

NextCity takes us further than we've ever been before. Learn more >

Innovative solutions for intelligent travel.

Allied Telesis maintains a long history of helping cities implement their visions of interconnected, smarter operations on a city-wide basis.

Using the Company's resilient switching products and sophisticated network monitoring services, cities around the world have deployed IP video cameras, and made hospitals and homes smarter and more livable. Allied Telesis wireless solutions allow cell-based or blanket technologies to cover anything from small businesses to large venues with exceptional bandwidth and service.

We are at the start of a revolution with Smart Gigabit Cities around the globe. Cities that enable people to communicate at gigabit speeds on wireless and wireline networks are well positioned to attract the best and brightest business leaders, while enabling economic prosperity. The Internet of Things (IoT) and Smart Gigabit Cities are synonymous, and represent key aspects of any city revitalization process.

Smart Gigabit Cities deploying integrated safety solutions from Allied Telesis are able to protect and serve their communities by integrating a plethora of sensor types, providing a geospatial representation of their installed area, and taking the operations of a municipality to a new level of efficiency and safety. Using Allied Telesis EtherGRID solutions, city planners can fully integrate historical data about operations in their cities with sensor inputs, give a real-time view of current events, and utilize advanced spatial analytics. These capabilities provide planners and city managers the tools needed to elevate planning and decision-making to a new level of effectiveness.

Smarter solutions for a smarter planet.

Allied Telesis website
Learn more >

Communications solutions
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Education solutions
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Healthcare solutions
Learn more >

Transportation solutions
Learn more >

As a leading provider of smart city solutions and services, Schneider Electric is pleased to lend its expertise to the Smart Cities Council's efforts to support and educate city leaders, planners, and citizens.

A global specialist in energy management with operations in more than 100 countries, Schneider Electric offers integrated solutions across multiple market segments, including leadership positions in Utilities & Infrastructures, Industries & Machine Manufacturers, Non-residential Buildings, Data Centres & Networks and the Residential sector. The group is focused on making energy safe, reliable, efficient, productive and green, through an active commitment to helping individuals and organisations make the most of their energy.

Schneider Electric delivers urban efficiency. The group is a trusted partner in cities around the world and works collaboratively with visionary city leadership, engaged stakeholders, and a dynamic network of partners to address each city's unique challenges. With solution and services expertise in the critical infrastructure areas of energy, buildings, water, transportation, public services and integration, Schneider Electric is able to effectively bridge traditional information silos. The group's innovative solutions and pragmatic integration capabilities combine both operational and information technology, for impactful implementations that deliver the short-term, visible, maximum return on investment results that cities need.

Learn more about Schneider Electric's smart city solutions.

Schneider Electric helps to advance a smart city at the foot of the Sierra Nevada mountains

Learn more >

German city consolidates building management and cuts energy use with Schneider Electric solutions

Learn more >

White papers:

- *Urban Mobility in the Smart City Age*
- *The Smart City Cornerstone: Urban Efficiency*

Verizon's Smart Cities solutions empower municipalities to solve some of today's biggest challenges -- including public safety, traffic and energy management, intelligent transportation and precision agriculture -- using a powerful combination of advanced networking, cloud computing, security and device management. By making cities "smarter," local governments, in collaboration with Verizon, are able to become more efficient, resilient, address aging infrastructure, generate more revenue and better protect the local communities they serve.

Verizon's Smart Cities solutions help municipalities quickly and cost-effectively support initiatives for managing buildings, roadways, utilities and transportation systems. Using applications such as fleet and asset management, smart lighting, condition-based maintenance and smart grid technology -- enabled by Verizon's network and cloud infrastructure -- Verizon helps city planners develop sustainable platforms to use resources more efficiently. The goal is to help generate non-tax city revenue, create safer municipalities, engage constituents and promote urban renewal -- all of which can attract businesses, residents and workers.

Verizon smart cities and Internet of Things resources:

- *News article: Verizon Accelerates Move to Smart and Sustainable Cities:*
- *Video: Verizon on Smart Cities*
- *Webinar replay: "The Art of Smart Cities"*
- *Case study: Building Smarter and Safer Communities*
- *Case study: Helping the City of Charlotte Envision a More Sustainable Future*
- *Case study: City of Napa Improves Visibility and Efficiency with Networkfleet*
- *Infographic: Moving to a Smarter City*
- *News article: Verizon Delivers Smart Energy As-A-Service*
- *News article: The Future of Smart Grid Technology*

On the Verizon website:

- *Verizon Smart Cities Solutions*
  - *Solutions for State & Local Government*
  - *Solutions for Public Safety Services*
- *Verizon Grid Wide Utility Solutions*

Smart Cities Council

INTRODUCING SMART CITIES COUNCIL ASSOCIATE PARTNERS

Council Associate Partners are leaders in their sectors. Learn more about them on the pages that follow.

ABB
Alphinat
SunGard Public Sector
CH2M
Imex Systems
Neptune Technology Group
Siemens
Enevo
OSIsoft
Saudi Telecomm
Black & Veatch
Organic Energy Corp.
Urban Integrated, Inc.
Space-Time Insight
Elster
Bit Stew Systems
Silver Spring Networks
Civic Resource Group International
Badger Meter
Entrigna
Apex CoVantage
Veolia
Intel
West Monroe Partners
Spire Metering
TROVE
K2 Geospatial
Clevest

Partners are listed according to the date they joined the Council; longest-standing members appear first.

ABB strongly supports the Smart Cities Council's goals of livability, workability and sustainability"

"Cities today are home to over 50 percent of the world's population and account for 80 percent of global GDP. By 2050, an additional 2.9 billion people will be living in cities, and urban dwellers will represent 70 percent of the world's population. About 90 percent of this growth will be in developing economies as people are drawn to urban areas by the perceived economic advantages. These cities will need new and intelligent infrastructure to meet the needs of their citizens and businesses.

Other cities that are not facing dramatic population increases are setting goals to ensure their long-term prosperity. With businesses and workforce becoming increasingly mobile, they are shaping their futures around competitiveness, liveability and sustainability.

An effective way to support these city goals is by using technology to more intelligently monitor, optimize and control key systems and infrastructure. In other words, to operate as a 'smart city'.

Many intelligent power and automation solutions already exist to enable cities to automate their key public and industrial services in the areas of:

- City Communication Platforms
- Electricity Grids
- Water Networks
- Transport
- Buildings
- District Heating and Cooling

ABB's heritage in power and automation is one of continued innovation and delivery on behalf of our customers, spanning over 125 years. Our products and solutions are at the heart of a city's critical infrastructure, relied upon for everything from the supply of power, water and heat, to the automation of factories and the buildings we live and work in."

ABB Smart Cities portal: *Smart Cities >*

ABB Smart Grids portal: *Smart Grids >*

As a leading producer of smart technologies and services, Alphinat is pleased to contribute to the Smart Cities Council Readiness Guide and other materials to help accelerate the move to smart, sustainable cities.

Alphinat is a software editor of SmartGuide® the leading "one stop" Web, Mobile and Cloud Solution Development Platform that enable cities to easily create, deploy and manage intelligent personalized web applications.

With our partners we are looking to give client cities constituents a simpler user experience that can, guide them to an optimal experience in a mobile or traditional browser-based environment. SmartGuide provides organizations and other software editors with the agility to quickly deliver efficient online services to their stakeholders unleashing the full value of existing IT assets. An Alphinat partner is delivering intelligent e-services for municipalities in the Netherlands in SaaS and on-premises modes incorporating SmartGuide® into their suite giving municipal clients the ability to quickly deploy intelligent online services. Citizens no longer need to fill in data already known to the government. Furthermore, these online services are accessible on Smartphone or tablets.

SmartGuide allows municipalities to deliver e-services with personalized, real time data exchange. With these intelligent e-services, municipalities greatly enhance the quality of their online service delivery and increase citizen satisfaction. The e-services offered automatically determine whether a citizen is entitled to a particular service such as a tax refund or a parking permit. These complex real-time validations delivered by the digital service bureau result in tremendous time savings for citizens and the community.

Alphinat technology can benefit city of all sizes by helping them modernize, automate and render cost-effective a many business processes at a fraction of the cost associated with conventional customized solutions. Alphinat is headquartered in Montreal, Quebec, with offices in Paris, New York and Zurich.

For more information, visit:

- **Alphinat website >**
- **Alphinate DGME case study >**

SUNGARD® PUBLIC SECTOR

SunGard Public Sector is a leading provider of software and services for local governments, public safety and justice agencies and nonprofits. More than 150 million citizens in North America live in municipalities that rely on our products and services.

For more than 30 years, SunGard Public Sector has leveraged ground-breaking technology and our innate understanding of the needs of the public sector toward the development of public administration and public safety software. SunGard Public Sector's products enable our customers to experience the future happening today. Visit us online at www.sungardps.com.

SunGard Public Sector's software products not only enhance the way municipalities, public safety and justice agencies, and nonprofits conduct business – they redefine the way citizens and employees interact with government.

The City of Oviedo, Florida has been a SunGard Public Sector customer since 1995. In 2004, the city switched its implementation to SunGard Public Sector's Horizon Government Cloud, a powerful resource for local governments seeking to do more with less. Prior to switching to Horizon, the City of Oviedo found the cost of equipment, expertise and time to maintain their existing premise-based computer system challenging. When financial resources became limited, the city began seeking alternative solutions. The switch to Horizon has ultimately helped Oviedo become smarter with the way they do business. Read more >

Located just a few miles northeast of Atlanta, Johns Creek, Georgia can go an entire winter without seeing snow. But that changed in January 2014, when the entire Atlanta area was rattled by ice storms and heavy snow. To keep residents of Johns Creek apprised of the situation, the local police department started centrally distributing information through its Facebook and Twitter accounts on a regular basis. Johns Creek Police Department is a customer of SunGard Public Sector and a user of SunGard Converge Police-to-Citizen (P2C), which allows the department to share public information with citizens in a central way and lets citizens search police records and download reports. The proprietary P2C system, called JCPD4Me, is interoperable with social media platforms like Twitter and Facebook, which means that citizens can get this information and interact with the police department through the platforms they already know. Read more >

ch2m.SM

At CH2M, we naturally take pride in the projects we deliver, but we never forget what our work is really about: clean water to drink, affordable energy, sustainable cities for families now and in the future, more closely connected communities and so much more. Every project we take on is a chance to move the world forward one more step, and we think that's an incredible privilege.

We're excited by tough challenges — the tougher they are, the more excited we get. We love to take on our clients' most complex infrastructure and natural resource problems, turning them upside down and inside out, solving them in ways nobody has thought of before. Together, we create new pathways for human progress, breathing fresh life, energy and enterprise into every community we touch.

Our partners and clients include governments, cities and businesses in more than 50 countries. To meet their biggest engineering challenges, we tap deeply integrated capabilities across our organization — in transportation, water, environmental, nuclear, oil & gas, industrial and urban environments. And we draw on the exceptional skills and creativity of 25,000 teammates with an outstanding track record of expertly executing projects both big and small.

We love what we do, but we care just as much about how we work. Deep respect for our family of employees, our clients and the communities we serve guides us at every step. We aim to meet each day with integrity, an adventurous spirit, and dedication to the well-being of people in our lives and work.

Read all about some of our projects in these sectors:

- **Energy >**
- **Transit & Rail >**
- **Water >**

Imex Systems helps build the next generation of smart hovernments and smart cities that are livable, workable, sustainable and prosperous. Imex Systems integrates city government, city infrastructure and citizens to create a smart city that improves the quality of life for citizens, enhances economic development, and fosters sustainability.

Our iGov technology platform and services enable governments to provide "Any Time, Any Where, Any Device and Any Channel" convenience for citizens to access government services, while helping governments automate and optimize business processes to improve internal operations. iGov helps measure and manage performance, find bottlenecks, and continuously improve service delivery to reduce costs. Other benefits include:

- Leveraging common re-usable technology components to reduce costs of smart city implementation and maintenance.
- Breaking down departmental silos to create a centralized collaborative approach.
- Increased engagement with citizens through web and social media channels.
- Proactively communicating with citizens during emergency situations through multiple channels.
- Integrating infrastructure – water/sewage, waste, power, tansportations and buildings for smart operations.
- Providing transparency through open data.
- Enhancing financial and digital inclusion.
- Reducing governments' carbon footprint.

The miGov mobile service delivery platform puts the government at citizens' finger¬tips by providing real-time messaging and service delivery. Governments can communicate instantly and effectively with their citizens on a wide range of topics, from a change in service, to an emergency situation.

Our payment systems help governments manage their revenue using a variety of payment methods and technologies, from traditional cash transactions to cutting-edge mobile payments. We offer pre-paid credit cards to efficiently manage benefit payments while reducing costs, and providing greater citizen convenience.

Our on-premise and cloud solutions are affordable for small towns and scalable, to meet the needs of large governments in both emerging and advanced markets.

Visit our website at www.imexsystems.com to learn more about our products, solutions and services.

Neptune Technology Group Inc. is a pioneer in the development of automatic meter reading (AMR) and advanced metering infrastructure (AMI) technologies for more than 47 years.

Neptune has continually focused on the evolving needs of utilities – revenue optimization, operational efficiencies and improved customer service. The company offers a fully integrated migration path for its utility customers to meet their needs now and in the future.

Each utility has its own unique needs, based on size, geography, infrastructure and other factors. Neptune makes it a point to understand your specific needs so that we can offer a solution that suits you the best. That's how we strive to become your ***most valued partner.***

Once we understand the challenges that your utility is facing, our people are trained to help you determine the best meter reading systems and tools that can be used to meet those needs, maximizing accuracy and efficiency while reducing costs and labor. And while providing for your present needs, Neptune helps utilities to always keep an eye toward the future not only with advanced technology but also with systems that allow for easy migration to adapt to changing requirements.

At Neptune, we have a rich history of innovation in meter reading systems on which we continue to build.

See/read about how Neptune is helping water utilities keep an eye on the future:

- Indio Water Authority General Manager, Brian Macy, uses Neptune's R900 System to help reduce Non-Revenue Water
- Neptune Territory Manager, Andy Bohn, helped Indio Water Authority share data through all their department
- Read more about Indio as well as other case studies

Learn more at: https://www.neptunetg.com

SIEMENS

The megatrends urbanization, climate change, globalization and demographic change will shape the future of cities. With the need to improve the quality of life and economic competitiveness, cities have to become more resource-efficient and environmentally friendly.

Technologies are major levers and base for further sustainable city development. An effective infrastructure contributes to economic prosperity, improving quality of live. Urban residents need clean air, potable water as well as security. They need efficient buildings, a reliable power grid and capable mobility solutions.

The complexity involved requires a holistic view and sustainable solutions for cities. Siemens has the portfolio, know-how and consulting expertise to make cities more livable, competitive and sustainable.

Infrastructure is the backbone of our economy. It moves people and goods, it powers our lives, it fuels growth. Across the world, more and more people are struggling with systems that are aging or overwhelmed. Siemens offerings include:

- Total integrated power solutions for safe, reliable, efficient power distribution
- Smart grid technologies that balance supply and demand, prevent power outages and integrate renewable power cost-effectively
- Integrated mobility solutions that move people and goods faster, safer and with fewer resources
- Smart building technologies that drive energy efficiency, reduce costs, and protect and secure all assets

Siemens website >

Infrastructure & Cities Sector >

enevo

Enevo is pleased to support the Smart Cities Council and contribute to its Readiness Guide.

Enevo brings together software and telecommunication engineers, data analysts, network gurus and seasoned waste management experts to create smart logistics optimizations solutions for the waste management and recycling industry. We help both commercial waste management companies and public organizations to operate more resource efficiently.

Until now collecting waste has been done using static routes and schedules where containers are collected every day or every week regardless if they are full or not. Our flagship solution Enevo ONe changes all this by using smart wireless sensors to gather fill-level data from waste containers. The service then automatically generates schedules and optimised routes which take into account an extensive set of parameters (future fill-level projections, truck availability, traffic information, road restrictions etc.). New schedules and routes are planned not only looking at the current situation, but considering the future outlook as well.

Collection based on Enevo's smart plans significantly reduces:

- Costs
- Emissions
- Road wear
- Vehicle wear
- Noise pollution
- Work hours

Enevo ONe provides organizations up to 50% in direct cost savings in waste logistics. And that's not all. Reducing the amount of overfull containers means less litter and happier customers! Enevo ONe provides a significant increase in efficiency across the whole value chain.

Visit the Enevo website >

Learn more about Enevo ONe >

OSIsoft provides an open infrastructure to connect sensor-based data, operations and people to enable real-time intelligence. The flagship product, the PI System, enables your organization to capture and leverage sensor-based data across the enterprise to improve efficiency, sustainability, quality and safety.

The PI System empowers organizations across a range of industries in activities such as exploration, extraction, production, generation, process and discrete manufacturing, distribution and services to leverage streaming data to optimize and enrich their businesses. For over thirty years, OSIsoft customers have embraced the PI System to deliver process, quality, energy, regulatory compliance, safety, security and asset health improvements across their operations. Founded in 1980, OSIsoft is a privately held company, headquartered in San Leandro, California, U.S.A, with offices around the world.

> *"Sensor-based data is different and requires different approaches to manage and process before it can be used reliably, efficiently and continuously within big data analysis. Sensors can deliver continuous or fragmented time series data streams in immense volumes and high frequency. Whether batch processing or streaming sensor data for big data analytics sensor data needs manipulation, indexing, aggregation, contextualization and governance before delivering to big data analytics engines. It's essential to get this right otherwise the value of the data will be lost."*
>
> ***Richard Beeson***
> Chief Software Architect and CTO
> OSIsoft

Read the Gartner/OSIsoft white paper:
Architecting an Industrial Sensor Data Platform for Big Data Analytics: Continued

Additional resources:

- City of Calgary: Using Data to Predict and Mitigate Floods
- JuiceBox Charging Solution Leverages Data from Connected EV Network for Smart Charging and Grid Optimization
- Itochu's Innovative Cloud-Based Services Connect Japan's New Energy Ecosystem

OSIsoft website >

Saudi Telecom Company (STC) is the largest telecommunication services provider in the Middle East and North Africa. It is the leading operator within the Kingdom of Saudi Arabia, and its international presence extends to nine countries.

The company is working continuously to fulfill and satisfy the market requirements, keeping pace with the emerging technologies in the telecommunications sector and satisfying its customer's needs. STC has put in its consideration that this is the way to reinforce its position and identity in view of a changing world where the role and usage of telecommunications became more significant.

STC offers mobile, landline, television and Internet services. Its goals include becoming the next-generation leader in broadband.

Saudi Telecom Company is a member of the Telecom Council of Silicon Valley. The Council connects companies and individuals involved in the communications technology industry with one another for business development, collaboration and education. STC is the first telecom company in the Middle East to join the Council, which has over 100 member companies

Saudi Telecom website >

Black & Veatch is an employee-owned, global leader in building critical human infrastructure in the Energy, Water, Telecommunications and Government Services sectors. Since 1915, we have helped our clients improve the lives of people in more than 100 countries through consulting, engineering, construction, operations and program management.

In keeping with our Building a world of difference® mission, Black & Veatch is committed to the innovation and adoption of advanced technology solutions to build more sustainable cities and communities. Black & Veatch is at the forefront of the movement toward smarter, more integrated infrastructure systems that extend beyond company and industry boundaries. We deliver new sources of value through the integration of distributed infrastructure, smart sensors, communications networks, automation systems, and big data and analytics. These Smart Integrated Infrastructure (SII) solutions increase system-wide intelligence to improve the efficiency, reliability and resiliency of the fundamental services we rely on every day.

Black & Veatch SII solutions for Smart Cities include:

- **Design & Construction:** In addition to engineering, procurement and construction (EPC) services for core Energy, Water and Telecom infrastructure, we provide EPC services for distributed infrastructure systems including stationary storage, Electric Vehicle (EV) charging stations, microgrids and distributed generation systems.
- **System Integration:** As consultant, program manager and integrator, we combine our own expertise with our world- class partner network to plan and implement turnkey smart city solutions.
- **Smart Analytics:** Leveraging our ASSET360™ analytics platform and third-party technologies, we provide community-scale data management and analytics solutions that enable integrated management of resources such as energy, water and gas.
- **Operations Support:** We help clients with the ongoing lifecycle management of their smart systems – maintaining overall performance and supporting individual community participant needs.

Learn more: Smart Integrated Infrastructure

Related links:
Peoria, Arizona - Butler Water Reclamation Facility
Los Angeles: Echo Park Lake Rehabilitation
SDG&E Sunrise PowerLink project
Video: Powering the Charge for Electric Cars

Organic Energy Corporation is an advanced municipal solid waste (MSW) separation and re-purposing company. OEC specializes in maximizing the recovery and diversion of recyclables and resource feedstock from landfill bound MSW.

OEC currently holds five patents on the MaxDiverter™ sorting process and has numerous additional patents pending.

OEC is also the driving force and lead partner for EcoHub, an innovative collaboration of premier organizations working together to reclaim discarded resources to achieve a waste free society.

Using proven technology that has been organized and utilized in innovative ways, EcoHub allows for every piece of the waste stream to be collected using "one bin" and accurately sorted into separate resource categories. EcoHub's manufacturing partners then re-purpose these resources into new, viable products (e.g., paper products, building products, natural gas, etc) that can be distributed to the local community – a true closed-loop solution for the world's growing waste disposal problem.

With long-term access to the waste stream, OEC/EcoHub can help partner cities reduce costs, catalyze economic development and generate improved environmental outcomes.

Learn more about Organic Energy Corporation >

Learn more about EcoHub >

Urban Integrated Inc., part of The Urban Institute® group, is a leading software and consulting company for Smart City Solutions. In particular, [ui!] offers integrated cloud based services that bring together the various data sources across the city into one platform.

UrbanPulse consolidates and readies data from the various sources across the city into actionable intelligence, using big data analytics and algorithms for decision-making and automation. Users are the city government, businesses, utility providers and citizens. The solution is presented as an open cloud based platform and is available for others to build on top.

The Urban Institute was established in Germany to help cities define and realize their smart city strategies in line with the European Union directive Euro 2020., that foresees a 20% reduction in energy usage, 20% reduction in emissions, and a 20% increase in the use of renewables by 2020.

Making cities even smarter :

- Urban Integrated website
- The Urban Institute website
- Case Study City of Darmstadt, published by Microsoft

Space-Time Insight helps asset-intensive organizations make faster, more-informed decisions. Our real-time visual analytics applications correlate, analyze, and visualize large volumes of business, operational and external data, spatially, over time and across network nodes. Our award-winning software powers mission-critical systems for some of the largest organizations around the world, helping them reliably, efficiently and economically deliver services and rapidly plan for and respond to a full range of operating events.

Space-Time Insight provides solutions for utilities and government, among others.

Utilities: Space-Time Insight's breakthrough situational intelligence applications for utilities provide unprecedented 360-degree operational and planning insight by correlating, analyzing and visualizing IT, OT and external (XT) data sources spatially, over time and across network nodes. Our applications deliver greater capital and operational efficiency, safety, and reliability in a matter of months. Space-Time Insight's software helps some of the largest utilities around the world reduce costs, uncover revenue opportunities and deliver more reliable services to their customers. Learn more >

Government: Cities need a smarter way to work together across functional and organization divides to plan, justify, and allocate capital efficiently in support of building, operating, and maintaining the digital infrastructure of the Smart City. To deal with major events, either planned or unplanned, cities require a single, shared view of the situation they face. Space-Time Insight helps break down governmental organization and data silos by ingesting disparate data sources into its patented in-memory system, correlating the data across space, time, and node, and extracting the key information or events that become the basis for better, more informed decision making. Learn more >

View video about Space-Time Insight at Sacramento Municipal Utility District

Visit spacetimeinsight.com

As the new hallmark for a more sustainable future, smart communities start with a smart grid. They are the heartbeat that powers the community's critical infrastructure and the foundation for enabling power, water, transportation, public safety and other services to function in harmonious, mutually supportive concert. And when it comes to smart grid, Elster provides the solutions needed to vitalize our communities by bringing smart meter data to the people and processes that depend on it.

With smart grid and AMI solutions, plus street and area lighting, Elster is a one-stop shop for smart community solutions and is helping public power utilities everywhere unlock the value of their meter data.

In an Elster-enabled smart community, power demand and consumption are automatically controlled to reduce peak demand. Smart sensors monitor and control streetlights based on brightness and time. Municipal broadband communications platforms underpin smart grid operations – and also provide the community with free Wi-Fi. Utilities proactively notify customers about leaks before they become a problem.

When communities are smart, energy intersects with traffic control, electric vehicles, solar power, security systems – the list has no limits. The result? Happier customers, improved system reliability, enhanced operational efficiency and better environmental sustainability.

This is the smart community future. And it's enabled by Elster – today.

Learn more about Elster:
Elster Solutions website
Connexo: Simplifying the utility journey
Advanced Meter Fort Collins

Videos:
Transformer Optimization
Leak Detection
Nontechnical Loss
Outage Management
Smart Communities

Bit Stew Systems is the creator of the market leading platform for Software Defined Operations for the Industrial Internet.

Bit Stew's revolutionary information processing engine, MIx Core™ enables complex event processing, advanced analytics and sophisticated machine-intelligence. The MIx Core technology has proven scalability to provide end-to-end operational visibility for billions of connected devices and trillions of data points—making it the ideal platform for the Industrial Internet. This same MIx Core technology can also be embedded in devices, gateways and routers for intelligence and automation directly at the edge of the network.

Bit Stew's flagship product solution, Grid Director™ is built on MIx Core and designed specifically to meet the exacting demands of the utility industry. Grid Director offers customers complete visibility and control of their networks enabling more agile and informed decision-making that improves reliability, efficiency and performance. Grid Director provides real-time analytics, pattern recognition, dynamic event management, and rapid integration across enterprise systems and applications.

Incorporated in 2009, Bit Stew Systems is a venture-backed private company that is headquartered in Canada with offices in the USA, Australia and Europe. Bit Stew was named on the Gartner Cool Vendors in Energy & Utilities list for 2014 and the Frost & Sullivan Entrepreneurial Company of the Year – North American Service Solutions for Utilities.

Visit the Bit Stew Systems website >

Silver Spring Networks is a leading networking platform and solutions provider for smart energy and smart city networks. Silver Spring's pioneering IPv6 networking platform, with more than 20 million Silver Spring enabled devices worldwide, is connecting critical infrastructure around the globe to help improve energy reliability, enable cities to provide better services to citizens, and unlock the next generation of applications for the Internet of Things.

Silver Spring's innovative solutions enable utilities and cities to gain operational efficiencies, improve grid reliability, and empower consumers and citizens. Silver Spring's major utility customers include Baltimore Gas & Electric, CitiPower & Powercor, Commonwealth Edison, CPS Energy, Florida Power & Light, Jemena Electricity Networks Limited, Pacific Gas & Electric, Pepco Holdings, Progress Energy and Singapore Power, among others.

Silver Spring connects smart city infrastructure in cities on 5 continents including Bristol, Chicago, Copenhagen, Glasgow, Melbourne, Miami, Paris, Sao Paulo, San Francisco, Singapore and Washington, D.C. Silver Spring is partnering with Florida Power & Light for the world's largest connected lighting project, nearly 500,000 networked street lights across South Florida.

Silver Spring's smart city platform helps municipalities deploy canopy networks connecting critical infrastructure assets such as public lighting and others. These intelligent lighting systems dramatically improve system reliability, increase energy efficiency, lower operational costs, and enhance citizen safety and quality of life. Silver Spring's open, standards-based network also enables cities to establish a platform for future smart city applications and services such as traffic management, environmental sensors, smart parking, electric vehicle charging, electricity metering, water conservation, and many others.

Learn more at our website >

Civic Resource Group International's **mission – *Fulfilling the Promise of Technology* – is perfectly aligned with the Smart Cities Council's vision of "a world where digital technology and intelligent design have been harnessed to create smart, sustainable cities with high-quality living and high-quality jobs."**

CRG International is one of the world's leading providers of digital government solutions. The company develops innovative, highly secure digital solutions built on CRG's flagship product CivicConnect™, a first-of-a-kind fully integrated Mobile/Cloud/Data Platform delivered in a SaaS model (Software as a Service) for the broad public sector. With its major focus on the key "smart" sectors, such as public transportation, environmental/utilities, tourism/economic development, regional planning/MPOs and health care, CRG's work touches every facet of citizens' lives. The company's "Smart" Offering – CivicConnect combined with CRG's CivicConnect business-specific line of products such as "Smart City," "Water," "Traveler Relationship Management (TRM)" "Parking,' "Geo-Social Mapping," CivicAR™ (Augmented Reality for Public Sector) and "Community," among others, have been developed to address fast-changing public sector needs resulting from the massive move to the emergence of the Internet of Things.

Since 2000, CRG has been "fulfilling the promise of technology" for clients in the broad public sector by leveraging the award-winning CivicConnect™ Platform and deep domain expertise. CRG's impactful, engaging and cutting-edge products have a proven record of facilitating openness, transparency, safety and efficient service delivery for communities and their constituents. CRG is a new breed of company with a new approach, blending the best of technology, design and communications in the digital age to support Sustainable Communities, Efficient Public Services, Engaged Citizens and Overall Better Quality of Life.

In early 2015, CRG was named to CIOReview's Top 20 Most Promising Government Technology Providers list, recognizing CRG's role in leading the digital transformation of the broad public sector in both the U.S. and international markets.

Badger Meter's commitment to helping municipalities improve operational efficiency and conserve their precious resources, makes supporting the Smart Cities Council a natural fit.

Badger Meter offers end-to-end solutions that help water utilities generate needed revenue, monitor and conserve their resources and help them better serve their valued end water customers. Industry-leading smart water solutions include a comprehensive mechanical and electronic metering line, proven AMR/AMI technology and the powerful analytics tools that truly help in Making Water Visible® for thousands of cities.

Badger Meter smart water solutions:

- Increase visibility of water consumption through tools like BEACON® Advanced Metering Analytics, providing faster leak detection, revenue management, water conservation clarity, and easier data collection for compliance reporting.
- Enhance customer service for citizens through powerful apps that provide greater water usage visibility directly to their PCs, tablets and smartphones.
- Minimize deployment and system maintenance though a managed solutions approach that reduces required operational management of AMI and analytics, allowing water departments to do what they do best—delivering high quality water to customers.
- Future-proof technology by working with cities to ensure their water system design keeps pace with technology advancements for the long term.

Founded in Milwaukee, Wisconsin in 1905, Badger Meter has earned an international reputation as an innovator in flow measurement and control products, serving water utilities, municipalities, and commercial and industrial customers worldwide.

Learn more about Badger Meter Water Utility Solutions

Entrigna's software enables cities to radically change the way they make real-time decisions. Entrigna is excited to support the Smart Cities Council and help contribute to building tomorrow's cities today. Our software sits squarely in the "crunch" function of a smart city.

With the infrastructure to collect and communicate data, tremendous opportunity exists to derive value from the data by making real-time decisions and taking immediate action without human intervention. Entrigna's software provides the smart city a central "brain" to enable this capability, which goes far beyond reports and dashboards.

The human brain processes data in real time from senses and memory and applies several techniques seamlessly in parallel and in series to make decisions and take an action – e.g., if it's Monday, then I will do xyz; if I have 10 items on my To-Do list, I will prioritize them in this order; based on similar prior experiences, I think xzy is the best decision. It's a complex and amazing process.

Just like a human brain, Entrigna's software can ingest data from a variety of sources streaming in real time. The data can be anything that is collected and communicated through the smart city infrastructure such as water meter reading, traffic conditions, geo location of an individual, data from wearable devices.

With maximum flexibility to combine in parallel and in series, decision frameworks are configured to make "brain-like" decisions. These frameworks automatically run in real time (milliseconds) and do not require manual intervention by a person.

Mathematical and algorithmic techniques are leveraged to mimic a brain, such as a rules engine, complex event processing, optimization, regression, clustering/classification, natural language processing, machine learning and artificial intelligence.

Because of Entrigna software's unique design and architecture, implementation delivers a full set of functionality but at less than 50% of traditional timeliness and less than 50% traditional costs.

To learn more, please visit our website: www.entrigna.com.

Throughout the world, city leaders recognize LED lighting as the most efficient entry point on their journey to becoming a smarter city. Not only do LED lights deliver more than 50% in energy and operational savings, but this infrastructure upgrade can also provide a new network to support a wide range of smart city and smart grid applications, like enhanced public safety, air quality and traffic monitoring.

ProFieldLight, our award-winning mobile workforce management technology, helps ease the road to smart city implementation by effectively managing a variety of LED lighting initiatives. ProFieldLight ensures safety, reliability and on-time project completion so our customers reap the benefits of energy efficiency while protecting their bottom line.

No matter where you are on the road to Smart Cities, ProField® can light the way.

Visit: **Apex LED lighting solutions**

Around the globe, Veolia helps cities and industries to manage, optimize and make the most of their resources. The company provides an array of solutions related to water, energy and materials – with a focus on waste recovery – to promote the transition toward a circular economy.

Veolia's 187,000 employees are tasked with contributing directly to the sustainability performance of customers in the public and private sectors, allowing them to pursue development while protecting the environment.

To this end, the company designs and deploys specialist solutions to provide, protect and replenish resources while increasing their efficiency from an environmental, economic and social standpoint. Such initiatives are all part of Veolia's ongoing campaign to resource the world.

- We turn waste into materials
- We work to save water and energy
- We work with municipalites around the world

Learn more at our website >

Today the Internet of Things (IoT) has enormous potential to drive economic value and social change. But with 85% of things still unconnected and security threats pervasive, the industry has yet to tap IoT's enormous potential.

The Intel® IoT Platform breaks down these obstacles. It provides an end-to-end platform for connecting the unconnected – allowing data from billions of devices, sensors, and databases to be securely gathered, exchanged, stored, and analyzed across multiple industries.

Once largely a PC-oriented company, Intel® increasingly provides the vital intelligence inside a wide range of devices, from the lowest-power mobile devices to the most powerful supercomputers in the world.

Since introducing the industry's first commercially available memory chips in 1969 and the first microprocessor in 1971, Intel makes hardware and software products that power the majority of the world's data centers, connect hundreds of millions of cellular handsets and help secure and protect computers, mobile devices and corporate and government IT systems. Intel technologies are also embedded in intelligent systems including for automobiles, digital signage, automated factories and medical devices.

Related resources:
San Jose and Intel leverage IoT innovations
Smart Cities UK: Imperial College and Intel IoT Project
Urban Growth and Sustainability: Building Smart Cities with the Internet of Things
Pecan Street Project: Smart Grid and Internet of Things

West Monroe Partners is an international, full-service business and technology consultancy focused on guiding organizations through projects that fundamentally transform their business.

With the experience to create the most ambitious visions as well as the skills to implement the smallest details of our clients' most critical projects, West Monroe Partners is a proven provider of growth and efficiency to large enterprises, as well as more nimble middle-market organizations.

Our consulting professionals – more than 550 and growing – drive better business results by harnessing our collective experience across a range of industries.

West Monroe Partners is dedicated to helping cities leverage technology and update their processes to transform how they serve their citizens, optimize their physical assets, and how they partner with their employees.

- Learn about our work in Energy & Utilities
- Learn about our work in Healthcare
- Learn about our Advanced Analytics

Visit the West Monroe Partners website >

Spire Metering Technology is a leading manufacturer and global provider of flow- and energy-management solutions. Through continuous innovation, we transform cutting-edge technologies into affordable, reliable and simple-to-use tools for accurate utility measurement. SpireMT's technological innovations help cities, governments and industry leaders preserve our precious natural resources.

Water and energy usage have a significant impact on communities around the world. SpireMT's meters and metering systems help regulate water and energy consumption in commercial and residential buildings, along with municipal and government facilities.

Thanks to SpireMT's diverse product line, our partners can rely on our technology to overcome the challenges of measuring a variety of fluid types, including water, oil, electricity and chemicals. Our products satisfy all their project needs, from flow measurement to energy measurement to wireless telemetry systems, AMR/AMI systems and billing software for instantaneous results. By utilizing SpireMT's solutions, our partners are empowered to responsibly manage their resources. SpireMT's comprehensive utility metering systems help to ensure tomorrow by measuring today.

Spire Metering Technology provides a wide variety of flowmeter products to meet the demanding requirements of several applications, including:

- Water and wastewater
- Utility management
- Building automation

Learn more at our website >

For organizations striving to leverage big data to their competitive advantage, data science is the essential, but often unrecognized, ingredient. TROVE is a leader in this nascent and rapidly expanding field, going far beyond traditional analytics approaches to solve some of today's most complex data management problems.

The heightened levels of insight and knowledge enabled by this technology have never been more important to the world's cities as they are today. Becoming a smarter city and making informed decisions about growth, infrastructure and citizen services requires the ability to process vast – and ever-increasing – volumes of data -- and to understand data relationships that are not intuitively obvious. That's where TROVE can help – by taking the guesswork out of important business decisions.

TROVE delivers one-of-a-kind, data-powered predictive science that delivers previously undiscovered insights and value by combining an organization's own data with TROVE's 2,000+ attributes of external third-party data and its patented data fusion algorithms. These are algorithms that have been used by the Department of Defense and other intelligence agencies to dramatically improve the accuracy and effectiveness of critical strategic and tactical decisions. The technology has been field-proven by the most accuracy-sensitive organizations in existence and is now available for the rest of the world to leverage.

The result? Startling predictive insights and new ROI value in unexpected places. Smart cities don't guess. They predict problems before they occur. They proactively address growth challenges and anticipate citizen demands. They look forward, not backward and make smarter decisions based on facts.

TROVE can show you how. Find out how TROVE and its data science as a service (DSaaS) model brings advanced technology previously available to only the largest corporations to any city seeking new levels of insight to fuel the next era of business productivity.

To learn more about TROVE, please visit our website at TroveData.com.

Since 1995, K2 Geospatial has been committed to bringing spatial information and analysis tools within everyone's reach by developing software solutions that provide effective visual aids to decision-makers. K2's Map-Based Solutions connect, consolidate and publish data which are managed and stored in silos in different systems. Employees and citizens can then easily access the information, analyze it and have a real-time ability to decide.

These solutions are designed for land, infrastructures, buildings management as well as for environmental and public safety purposes. They are used by cities, regional governments, ports, airports, road authorities, railways, public utilities and natural resources companies.

K2's solutions are powered by JMap, a map-oriented integration platform designed to connect silos and offer easy-to-use interfaces dedicated to non-technical users. Furthermore, for software developers, JMap can be easily embedded in their existing solutions.

JMap is deployed and used by hundreds of organizations in North and South America as well as in Europe. Each day, thousands of employees and citizens from different organizations, in different contexts and with different requirements, use JMap to access their spatial and non-spatial data (from GIS, databases, sensors, GPS, RFid, Web Services, videos, etc.) in order to get a global and a real-time overview of their operations.

With JMap, cities easily implement Spatially Smart Solutions which improves their operational and strategic decisions.

Learn more about JMap >

Visit the K2 Geospatial website >

At Clevest, we share the Smart City Council's vision of cities that are livable, workable and sustainable. As a leading provider of mobile workforce automation solutions for smart grid and smart city field operations, Clevest is proud to support and educate city leaders, planners and citizens in building sustainable cities.

Clevest provides the only complete solution for mobile workforce automation, smart grid and smart city operations exclusively for utilities and city operational departments. Over 150 customers worldwide have chosen Clevest to transform their field operations by harnessing the power of our software and deep domain knowledge of mobile computing and field operations.

We are specialists at enabling cities to transform their field operations by rapidly automating and optimizing field installation, operations and maintenance of new smart technologies. Our solutions improve worker and citizen safety, reduce the environmental impact of field work and increase operational efficiency to drive down the cost to serve citizens.

Clevest Smart City solutions are purpose-built for city operations departments to effectively deploy, operate and maintain new metering, monitoring and control, and network communications technologies within their smart city infrastructure. In the control room, our solution enables real-time insight to the location and status of field workers, trouble events and field work locations in the visual context of city infrastructure. This allows the quick identification of work to be completed, seamless appointment bookings, and the automatic scheduling and assignment of work. In the field, our streamlined workflows help field workers quickly complete work on a mobile device, view contextual data on maps and stay safe with support from nearby workers and alerts to the control room.

Clevest offers the complete solution for the smart city mobile workforce to help deploy, operate and maintain your smart city infrastructure.

Learn more about Clevest

Learn more about our solutions

Smart Cities Council

ADVISORY BOARD

Built Environment

Architecture 2030
LOCUS: Responsible Real Estate Developers & Investors
Smart Growth America
Terrapin Bright Green
U.S. Green Building Council

Development Banks

Inter-American Development Bank
International Finance Corporation
World Bank Urban Advisory Unit

Energy and Utility Organizations

Advanced Energy Economy
American Council for an Energy-Efficient Economy
Climate Solutions / New Energy Cities
Electric Drive Transportation Association
Energy Future Coalition, UN Foundation
GridWise Alliance
Institute for Electric Innovation
Institute for Energy & Sustainability (IES)
Joint Institute for Strategic Energy Analysis

Environment and Water

Environmental Defense Fund
International Water Association
Natural Resources Defense Council
Water Alliance
Smart Water Networks Forum (SWAN)
The Climate Group
The Nature Conservancy
Teru Talk

Governmental Agencies

Dubai Real Estate Institute
New York City Transit Authority
Portland Development Commission
San Francisco Municipal Transportation Agency
Sustainable Streets

National Laboratories

National Renewable Energy Laboratory
Pacific Northwest National Laboratory

Public Sector Associations and Advocates

100 Resilient Cities
Center for Public Policy Innovation
City Protocol Task Force
CompTIA
EcoDistricts
Institute for Sustainable Communities
National Governors Association
Pew Charitable Trusts, American Cities Project
Pedro Ortiz, Senior Urban Consultant, World Bank
Public Financial Management – PFM Group
Research Triangle Cleantech Cluster
Rockefeller Institute for Government
Sault Ste. Marie Innovation Center
TM Forum

Standards Bodies

American National Standards Institute
Institute of Electrical and Electronics Engineers (IEEE)
International Electrotechnical Commission (IEC)
International Organization for Standardization (ISO)
International Telecommunication Union (ITU)
Open Geospatial Consortium

Trade Associations

Information Technology Industry Council (ITI)
Fibre to the Home Council - MENA
National Electrical Manufacturers Association (NEMA)
Research Triangle Cleantech Cluster

Universities

Arizona State University School of Public Affairs
Boyd Cohen, Universidad del Desarrollo
Carnegie Mellon Intelligent Coordination & Logistics Lab
Center for Technology in Government
ESADE Institute of Public Governance and Management
Illinois Institute of Technology
Institute of Transportation Studies, UC Davis
Plug-in Hybrid & Electric Vehicle Research Ctr UC Davis
Research Institute for Water Security, Wuhan University
Transportation & Sustainability Research Center, UC Berkeley
Universitat Autònoma de Barcelona
University of Ontario Institute of Technology
Waterloo Institute for Sustainable Energy, Univ. of Waterloo