

Industry Agenda

Expanding Participation and Boosting Growth: The Infrastructure Needs of the Digital Economy

Abridged Version

Prepared in collaboration with The Boston Consulting Group

March 2015



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Contents

- 3 Preface
- 4 Executive Summary
- 6 1. Introduction
- 8 Selected Additional Figures from the Full Report
- 17 Endnotes
- 18 Acknowledgements

Preface



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In May 2013, the World Economic Forum convened a cross-industry initiative to examine the ability of digital infrastructure to keep pace with the fast-growing demand for digital services. This initiative produced the report *Delivering Digital Infrastructure: Advancing the Internet Economy* in 2014. Building on this work, the Forum's Digital Infrastructure and Applications 2020+ initiative looks further into the future to identify the greatest challenges facing the information and communications technology environment in the next 5 to 10 years, in both developed and developing markets.

The initiative examines in depth the specific issues in providing infrastructure and applications to the 4.5 billion people, mostly in emerging markets, who remain unconnected. It brings together all relevant stakeholders, including communications services providers, digital services and applications companies, equipment manufacturers and device companies, to propose policies and other recommendations for overcoming these challenges and increasing the overall value chain. For the last 12 months, participants have jointly assessed digital infrastructure adequacy and, in particular, the impediments – technological, financial and political – to the investments necessary for maintaining and improving the telecommunications networks and digital system that make up the internet.

This report is part of the Forum's series on the Future of the Internet, a cross-industry umbrella platform that connects the dots across industry projects to help in understanding and managing the social, economic and political consequences of digital technology. The report, prepared in collaboration with The Boston Consulting Group, discusses the steps necessary for digital infrastructure to keep pace with the demand for digital services and facilitate the growth and development of a vibrant global digital economy in the medium and long term. Other recent Forum reports in this series include *Partnering for Cyber Resilience: Towards the Quantification of Cyber Threats*, *Data-Driven Development Pathways for Progress and Industrial Internet of Things: Unleashing the Potential of Connected Products and Services*.

This abridged report includes only the executive summary, the introduction, a selection of key figures and the summary recommendations. The full report will be launched at the East Asia Summit of World Economic Forum, Jakarta, Indonesia / 19 April - 21 April 2015

Executive Summary

The internet already plays an indispensable role in the everyday life of billions of people. Yet, the surface is only being scratched. The potential to bring new and more advantages to individuals around the world, and to provide benefits for billions more as they gain access, has few limits. While many benefits could have their biggest impact in emerging markets, these are unfortunately the countries where internet penetration and use often lag.

This report builds on the broad recommendations of the World Economic Forum's 2014 report, *Delivering Digital Infrastructure: Advancing the Internet Economy*, which explored serious obstructions to the continued growth of the digital economy over the next three to five years. This current report looks further into the future and seeks to identify the most important challenges facing the development of a healthy digital infrastructure for 2020 and beyond. It examines the particular difficulties of bringing connectivity's economic and social benefits to emerging markets, which in 2014 were home to 96% of all people who were not internet users.

Emerging markets face two broad issues in providing affordable internet access: building network capacity and expanding network coverage.

- A critical and urgent need exists for more licensed and unlicensed spectrum to be released and allocated to mobile usage. This should be done on a planned basis with sufficient notice to network operators. The primary goal for policy-makers and regulators should be to maximize the use, rather than the short-term value, of this precious asset.

- Too many areas of too many countries lack internet connectivity, and many of these areas are not economically viable for private companies to serve using traditional business models. Connectivity's economics are determined by a variety of factors (e.g. site security and the availability of electricity), with only some related to technology. Countries need to make smart choices and trade-offs.
- The first step is for governments to determine the specifics of their broadband access aspirations. The second is for each government to establish a country-specific operating and funding approach
 - one that is technology-agnostic, provides incentives for investment and allows for experimentation. Countries can learn from the different models being used to connect these economically unviable regions.

Encouraging broader internet usage, particularly in emerging markets, is critical to bringing more people online.

- Many developed countries have a 30-50% difference between the number of people reached by digital networks and the number actually online. This gap jumps to 55-75%, and up to 90% in some cases, in emerging markets.
- Research shows three main reasons for not adopting the internet: a perceived lack of need (mostly because of a lack of local-language content), followed by a lack of skills and, as a distant third, affordability.
- Local content in local languages is vital for attracting local users and serving local needs. Governments also can help drive digital

- engagement with their own online services.
- Network operators, content providers and others can accelerate internet adoption, especially the use of the mobile internet in emerging markets, by clearly conveying the value of internet use and simplifying the pricing of access.

The changing nature of consumer and business usage in both developed and emerging markets, as well as the rise of the Internet of Things (IoT), raise new infrastructure issues.

- The fast-increasing volume of digital traffic, as well as the growing need for providing low latency and handling far more uploads, pose new challenges for network infrastructure. The need for increased capacity is a critical issue in emerging markets, where the lack of fibre networks is a serious constraint, but it also affects the "last mile" almost everywhere. Security and privacy are major concerns as well, and are being analysed and addressed by other Forum initiatives.
- The technologies exist to help resolve several of these issues, but some are hampered by out-of-date policies, legislation and regulations. Legacy regulation needs to be rationalized, and experimentation is required with new commercial pricing models that can fund network investments without harming competition. Despite differing interests, network operators and content providers can find a mutually beneficial path that maintains the commercial nature of Internet Protocol interconnection contracts with no unfair discrimination. In addition, regulatory



barriers to adoption of low-cost and capacity-increasing technologies such as small cells need to be removed.

- The addition of 30-50 billion or more connected devices over the next five years represents an enormous opportunity for economic expansion and growth, but also a big infrastructure challenge. Serving the needs of expanding IoT traffic presents some unique spectrum requirements and the need for standardized and secure communication protocols. Policy-makers and regulators should consider the allocation of new types of spectrum for different IoT needs, while industry participants must accelerate discussions and actions around a standardization roadmap for IoT communication protocols.

As more of the world's population migrates to urban centres, the development of "smart cities" requires planning for and deploying information and communications technology (ICT) infrastructure.

- Over the next 15 years, more than 1 billion people will move to cities, and some 360 new cities with populations of 500,000 or more will be created. Almost 80% of these new cities will be in developing markets.
- Tools ranging from those that perform basic monitoring to advanced systems that enable predictive, analytics-based applications can all have a significant impact on citizens' well-being and the efficiency of their daily lives. Many of the ICT-based systems, apps and services that can address urban needs such as energy, transport, water and waste, social

services, and building management and services already exist.

- Many cities lack a comprehensive vision for building ICT infrastructure or for constructively using the massive data that they generate every day. The business cases for many ICT investments are complex, and it is difficult to finance large investments that have payback periods of many years, even a decade or more.
- The best solution is likely a combination of various elements with clear roles for public- and private-sector players.

As digital technologies become more pervasive, the need grows to unlock consumer and industry value by removing frictions that prevent users from transporting and accessing their data (particularly personal data and digital identities), while continuing to respect user privacy and data security.

- Consumers have started to compile digital assets that are tied to their online lives and distributed across multiple sites, apps and sectors. These data include, among other things, government records, healthcare files, financial information and basic identity content.
- This digital dependence creates new questions about consumers' ability to easily access and use their data, while at the same time raising privacy and security concerns related to use of their data by others.
- The interplay among consumer benefits, privacy and security risks as well as industry impact needs more time and experience before it can be accurately assessed. But it's not too soon to recognize that, left unaddressed, unwarranted

limitations on seamless or universal use of data could become a serious barrier both to people's ability to get basic things done as well as to overall digital growth and economic activity.

- Multistakeholder dialogue on near- and long-term initiatives is required to reduce sources of friction in the transportation, use and accessing of data, thereby unshackling consumers' digital lives. Common technical, policy and legal frameworks may need to be developed for high-priority data and the most important ways they are used.

1. Introduction



If “what’s past is prologue,” as Shakespeare observed in *The Tempest*, then the first few decades of the digital age point to an evermore potent future.

The internet already plays an indispensable role in the everyday life of billions of people. Almost 3 billion connected consumers and businesses search, shop, socialize, transact and interact every day using personal computers (PCs) and, increasingly, mobile devices.¹ The digital economy, which contributed \$2.3 trillion to the G20’s GDP in 2010 and an estimated \$4 trillion in 2016, is growing at 10% a year – significantly faster than the overall G20 economy. The growth is even higher in developing economies, at 15-25% annually. Not only is the digital economy an increasingly important source of jobs, but digital technologies are also enabling far-reaching social and political changes.²

Yet the surface is only being scratched. The potential to bring new and more advantages to individuals around the world, and to benefit billions of additional people as they gain access to the internet, has few limits. More than 1 billion new users will be added by 2020 as internet penetration expands, connection speeds improve and device prices fall.³ The digital economy’s contribution to GDP in the G20 will reach \$6.6 trillion a year, or 7.1% of the total.⁴ Moreover, these figures do not reflect the potential impact of the Internet of Things (IoT), which could involve 30-50 billion additional connected devices by 2020, helping to manage everything from home heating systems to automotive vehicles and jet aircraft. Cisco estimates the cumulative value of this fast-rising market at \$19 trillion in a few years’ time.⁵

The internet’s impact extends far beyond GDP. All kinds of economic activity, including business-to-business e-commerce, online advertising, consumer-to-consumer e-commerce and other consumer economic activity, are not well captured in GDP figures. The internet has a huge impact on productivity, giving businesses access to new markets, customers and suppliers. It enables new business models and saves endless amounts of time and energy for countless individuals every day. There are broader social impacts as well. Digital technologies are already transforming essential social services, such as education and healthcare,

and how people interact with their governments. In addition, the potential for massive improvements in universal utilitarian services, such as transportation and energy and power delivery, is clear.

Many of these benefits could have their biggest impact in emerging markets; unfortunately, these are the countries in which internet penetration and use often lag. Although several studies have shown a positive correlation between internet penetration and GDP growth, countries need to build critical scale first in order to take advantage of this.⁶ Studies by the World Economic Forum on network readiness⁷ and The Boston Consulting Group (BCG) on “e-intensity”⁸, the latter a combination of internet enablement, engagement and expenditure, show emerging markets trailing developed countries on key measures of internet infrastructure and use.

As technological advances and their applications race forward, they create new needs to be addressed and fresh issues to be resolved in all markets. The digital economy depends on adequate infrastructure to carry all that traffic and process all that data. Infrastructure requires investors, who want the ability to foresee a return. Benefits accrue unevenly for reasons of geography, economics, policy and opportunity. In many geographies and population segments, the business case does not work, despite substantial societal returns. The resulting gaps must be addressed.

The Forum’s 2014 report, *Delivering Digital Infrastructure: Advancing the Internet Economy*, explored serious obstructions to the digital economy’s continued growth over the next three to five years, with an emphasis on the developed markets of the United States and Europe. These impediments include lagging adoption of long-term evolution (LTE) technology, spectrum scarcity, the need to modernize policy and regulation, and disputes over IP (Internet Protocol) interconnection agreements, which are already constraining digital activity and interaction. For each one, it suggested solutions or avenues to find solutions, and argued that policy-makers, industry participants and other stakeholders need to work collectively to do three things:⁹

- Commit to actions that promote the digital economy’s long-term growth
- Remove impediments to expanding digital infrastructure

- Modernize policies to encourage investment and innovation throughout the internet system

This report builds on these broad recommendations and looks further into the future. It draws on interviews with more than 50 industry participants and observers (including experts from network operators, hardware manufacturers, content companies, application providers, academics and equity research firms). It also reflects the expertise of the Forum’s 38-person working group and a steering committee comprised of representatives from more than eight leading companies. It seeks to identify the most important challenges facing the development of a healthy digital infrastructure for 2020 and beyond, in both developed and developing markets. The following content is explored in the report:

Chapter 2. Providing affordable internet access in emerging markets, especially in rural areas

Chapter 3. Encouraging broader internet usage, particularly in emerging markets

Chapter 4. Addressing the infrastructure issues raised by the changing nature of consumer and business usage and the rise of the IoT

Chapter 5. Furthering the development of “smart cities” connected by information and communications technology (ICT), as more of the world’s population migrates to urban centres

Chapter 6. Unlocking consumer and industry value by removing frictions that prevent users from transporting and accessing their data (particularly personal data and digital identities), while continuing to respect user privacy and data security.

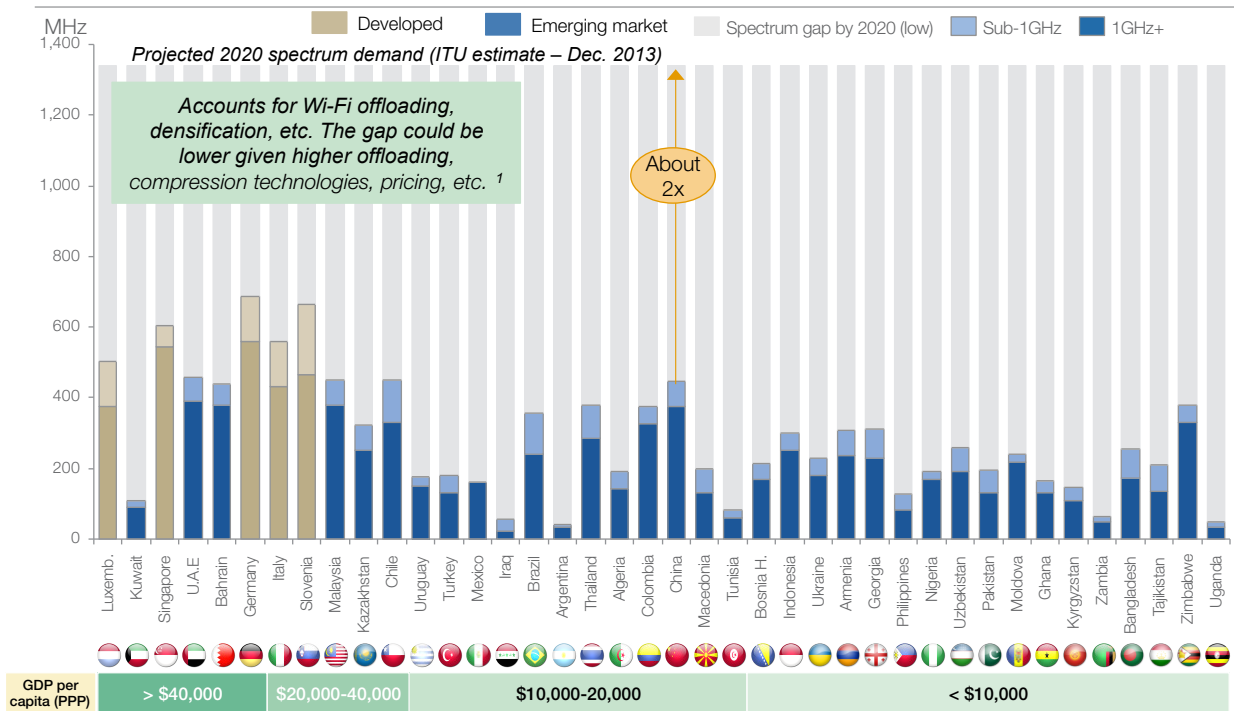
These are huge opportunities to further economic growth, human productivity and the quality of life for billions of people. Equally, in each of these areas, lack of attention, investment and innovation, in addition to misguided or inappropriate regulation, could seriously undermine the digital economy’s development. The following chapters examine each area in depth, including recommendations for both industry and governments on steps to take, beginning immediately, to ensure they minimize roadblocks and delays and realize the potential of digital technologies.

Selected Additional Figures from the Full Report



Figure 1: Significant Gap in Current and Required Spectrum by 2020

Gap significantly higher for emerging markets



Note: Current spectrum holding for each country represents a lower end of the scale; auctions may not be reflected. 1. Based on recent report entitled "Overestimating Wireless Demand: Policy and Investment Implications of Upward Bias in Mobile Data Forecasts" by Allok Mehta and J. Armand Musey. Source: GSMA, ITU.

Figure 2: Current Spectrum Snapshot: Potential for Higher Allocation and Utilization across Countries

		Asia			Middle East			Latin America			Africa			USA
Spectrum		China	Singap.	India	Qatar	S. Arabia	UAE	Brazil	Colombia	Bolivia	S. Africa	Angola	Nigeria	USA
"Coverage" frequencies (sub-1GHz)	450 MHz				3G			4G ³						
	700 MHz							4G ¹	4G ¹	4G ²				4G
	800 MHz			2G	4G									4G
	850 MHz	3G						2G/3G						2G/3G
	900 MHz	2G	2G	2G	2G	2G	2G	2G			2G/3G	2G	2G	
"Capacity" frequencies	1.8 GHz	2G	2G/4G	2G	2G	2G/4G	2G/4G	2G/3G			2G/4G	2G/4G	2G	
	1.9 GHz							2G	2G/3G	2G				2G/3G/4G
	2.1 GHz	3G	3G				3G	3G	4G	4G ³	3G/4G		3G	3G/4G
	2.3 GHz	4G											4G	
	2.5 GHz	4G	4G		4G	4G	3G/4G	4G						4G
3.5 GHz						3G/4G								
Total mobile spectrum		447	605	n/a	314	n/a	459	240	390	279	n/a	n/a	190	583

Allocation and clearance of established mobile spectrum has high potential in emerging markets (mostly locked in military and analogue TV)

Reforming potential to increase network capacity where spectrum becomes scarce resource

Ineffective roll out of allocated spectrum: US MNO have more than 583 MHz but only about 192 MHz are in use, 90% of which is used for 2G, 3G and 3.5G

Legend:

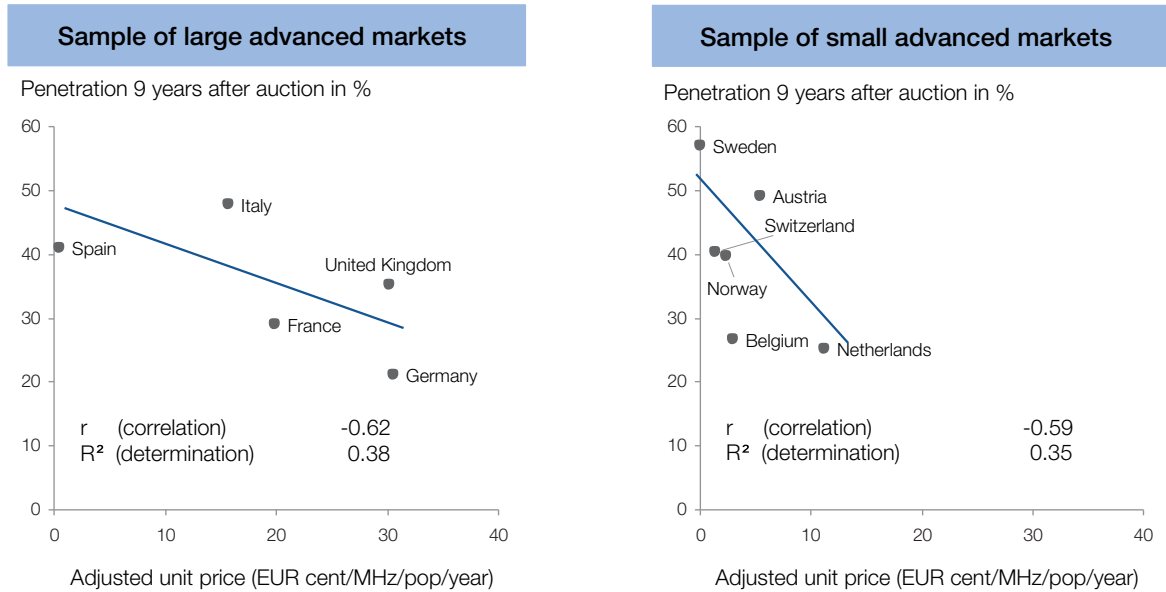
- Red: Spectrum not allocated to mobile
- Yellow: Spectrum allocated to low speed
- Green: Spectrum allocated to high speed

1. Announced to be auctioned. 2. Partial coverage only (i.e. large cities). 3. Allocated to mobile but not deployed. Note: 2.6 GHz included in 2.5 GHz; 1.7 GHz included in 2.1 GHz; For some countries, total spectrum varies strongly by region or is n/a. Source: GSM Arena; BCG analysis.

Figure 3: Empirical Indication that Higher Auction Prices Lead to Lower Penetration

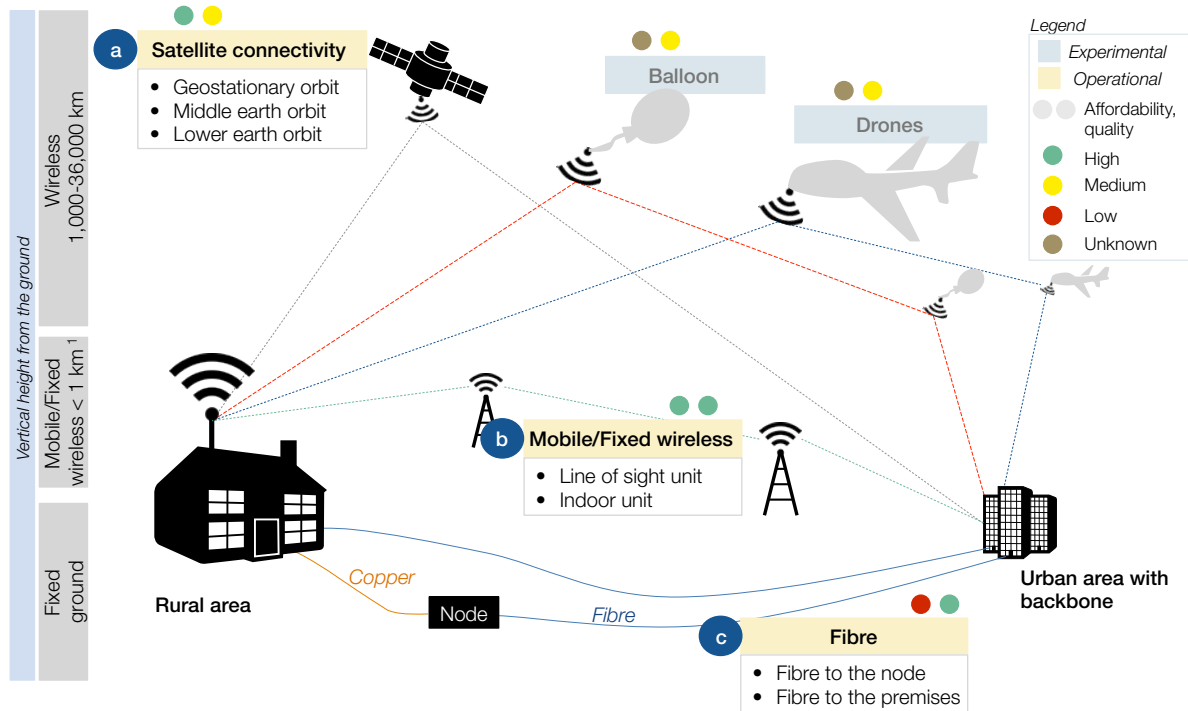
Reserve prices preferably reflect market value and government's strategic vision

Correlation of 3G auction prices and subsequent 3G penetration in Europe



Note: TDD frequencies not included since little value for 3G.
 Source: NRAs, Analysys Mason, 2012; BCG analysis.

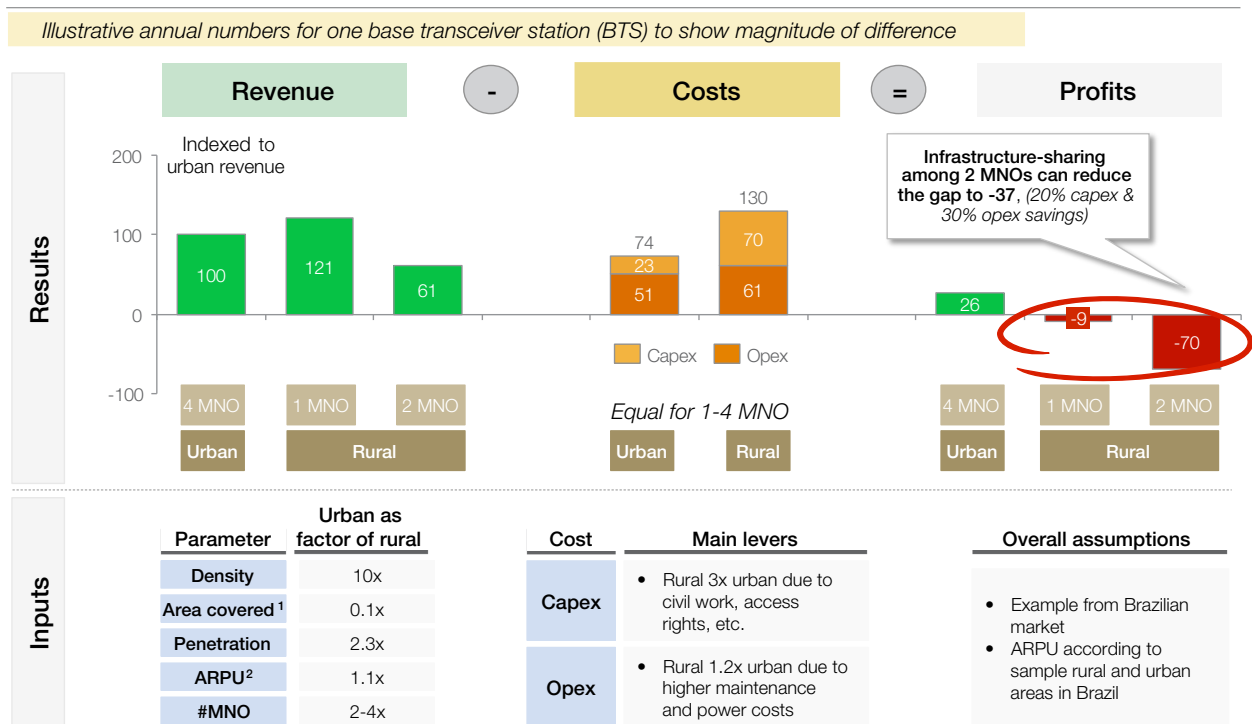
Figure 4: Choosing the Right Technology: Critical from a Cost, Service-Quality and Risk Perspective



Note: Affordability represents cost to consumer for different technologies. Variations within each technology are not captured on this chart. 1. Represents the typical installation height.
 Source: BCG Analysis, Filiago, Google, Facebook.

Figure 5: Current Economics to Build Rural Connectivity Often Unattractive for MNOs

Illustrative economics using data from Brazil



1. ZTE study for BTS area coverage in rural and urban areas. 2. BCG analysis based on ARPU in Brazilian market. 3. GSMA intelligence for developing markets. Note: Capex = Capital expenditures; Opex = Operating expenditures. Source: BCG Analysis.

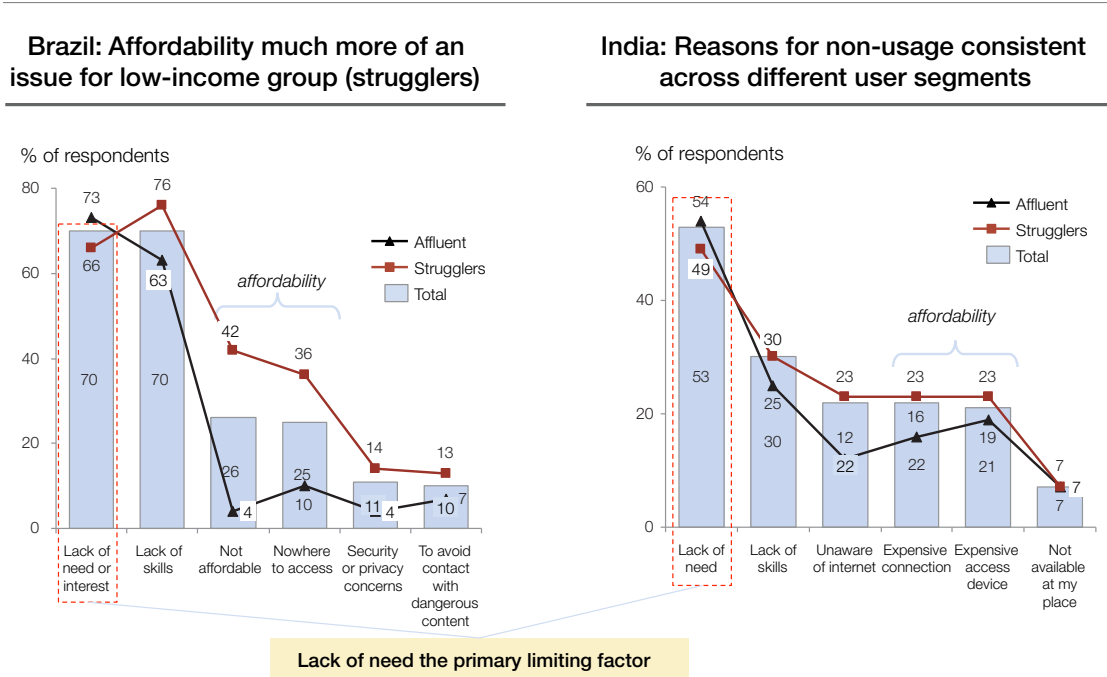
Figure 6: Approach to Building Rural Infrastructure Differs Based on the Country's Degree of Urbanization and Wealth

Wealth	Environment	
	Rural	Urban
Moderate GDP per capita (\$5,000-15,000)	<p>Potential priorities</p> <ul style="list-style-type: none"> Encourage private infrastructure investment Prove value of internet to encourage adoption <p>Example case studies</p> <ul style="list-style-type: none"> Malaysia 	<p>Potential priorities</p> <ul style="list-style-type: none"> Invest in enabling infrastructure (internet exchange points, fibre-optics) Engage SMEs in digital economy Expand digital employment <p>Example case studies</p> <ul style="list-style-type: none"> China: Balance of mobile/fixed infrastructure investment
Low GDP per capita (<\$5,000)	<p>Potential priorities</p> <ul style="list-style-type: none"> Publicly fund basic infrastructure access Reduce connectivity costs Provide remote e-government, e-health and e-education services <p>Example case studies</p> <ul style="list-style-type: none"> Oman 	<p>Potential priorities</p> <ul style="list-style-type: none"> Leapfrog infrastructure (4G) Spur local app ecosystems to drive demand Encourage enabling applications like identity, payments <p>Example case studies</p> <ul style="list-style-type: none"> Philippines

Source: BCG Analysis

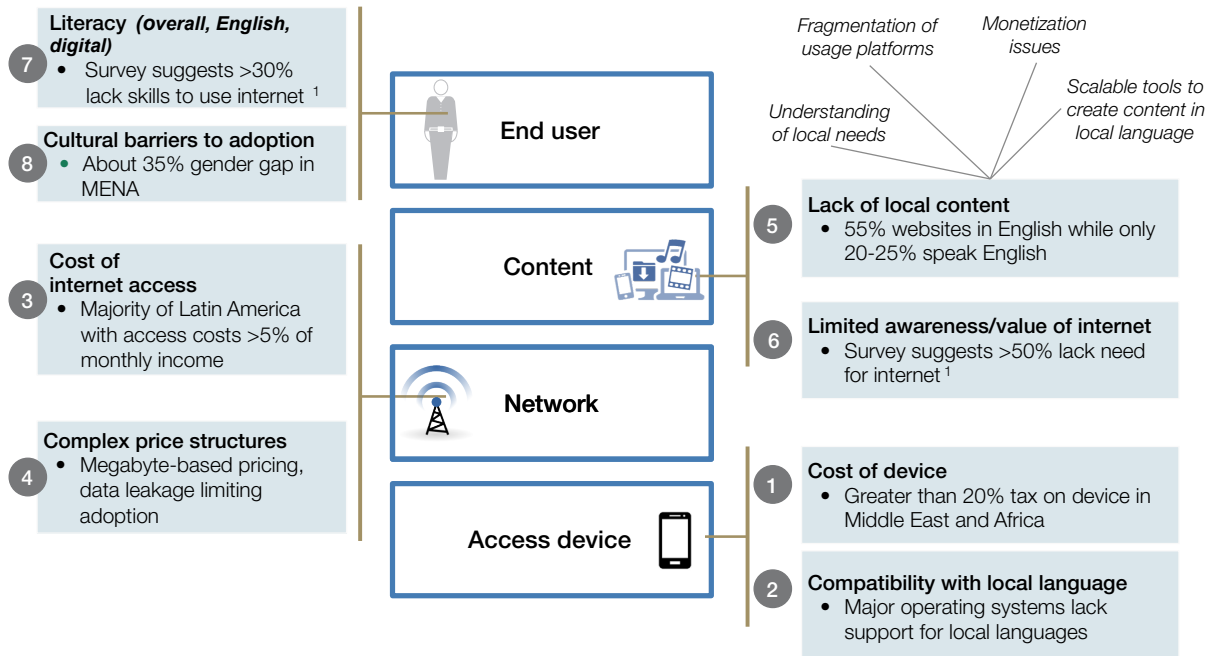
Figure 7: Lack of Need: The Primary Limiting Factor for Not Using the Internet

Skills and affordability are other big drivers, varying by income and education level



Source: BCG CCI India and Brazil studies 2014, BCG analysis

Figure 8: Multiple Challenges Limit Consumer Adoption of the Internet



1. Based on BCG CCI Study for India 2014

Note: Gender gap is defined as difference in percentage of men and women with online access (weighted by their numbers).

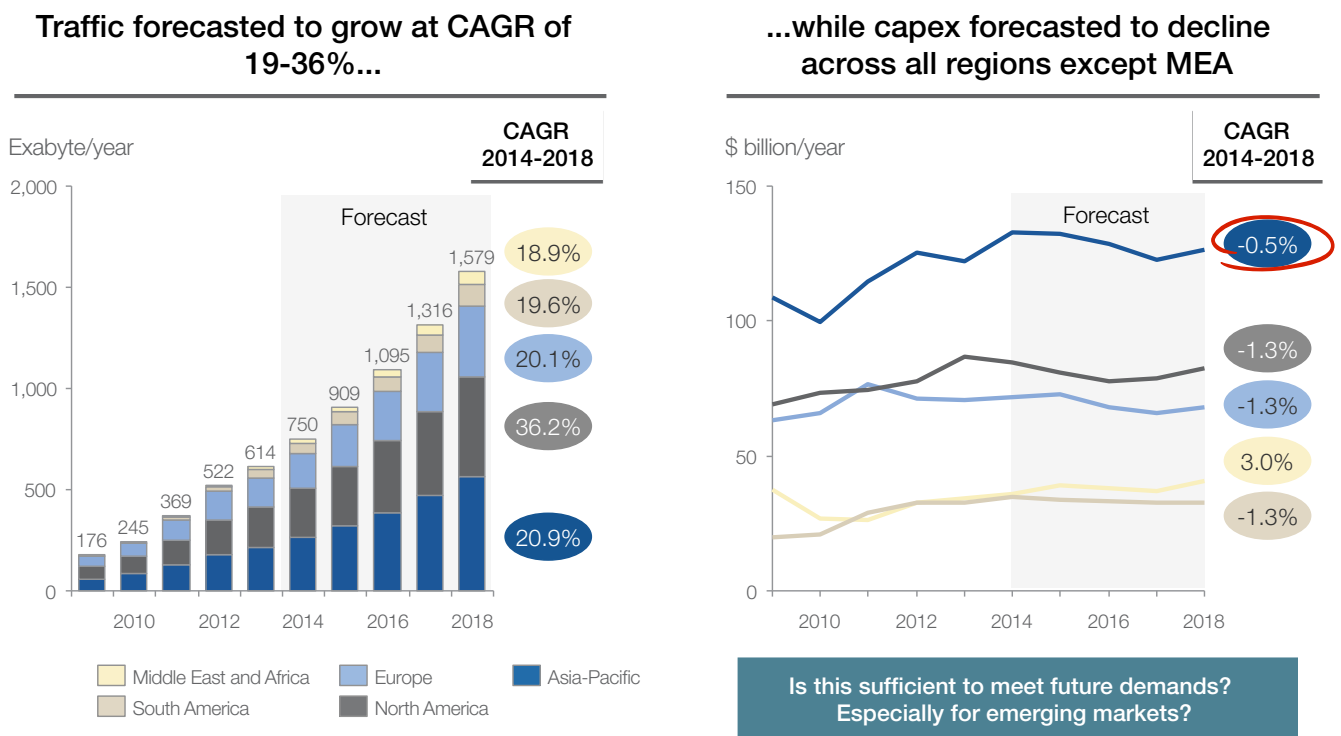
MENA = Middle East and North Africa.

Figure 9: Case Studies and Best Practices at Play to Address Impediments to Access and Usage

Dimension	Country	Best practices
1 Cost of device	Kenya	<ul style="list-style-type: none"> Taxes accounted for 25% of TCMO ¹ in 2006 – reduced to 21% by 2011 Mobile handset sales increased 4x from 2009 to 2011 – penetration from 50-70%
2 Device compatibility with local language	India	<ul style="list-style-type: none"> Handset initiatives that support multiple local languages (e.g., Android One launched in India)
3 Cost of internet access	Brazil	<ul style="list-style-type: none"> MNO collaboration on network infrastructure-sharing to lower costs (2013)
4 Complexity of pricing	India	<ul style="list-style-type: none"> Transitioned from megabyte-based pricing to value-based pricing (e.g. video for a nominal cost)
5 Lack of local content	Saudi Arabia	<ul style="list-style-type: none"> Robust set of e-government services related to health, education, taxation, etc., to drive digital engagement
6 Limited awareness/value of internet	India	<ul style="list-style-type: none"> Targeted marketing approach adopted by MNO based on segmentation and interest tagging for each segment
7 Literacy	Colombia	<ul style="list-style-type: none"> Full-blown ICT initiative along the dimensions of user engagement, fibre infrastructure, app ecosystem and access to service to build know-how
8 Cultural barriers to adoption	Iraq	<ul style="list-style-type: none"> 70% fewer women internet users compared to men ² 2x increase in women customer base for Asiacell by solving barriers to adoption (e.g. reluctance to visit/call male only shops or customer centres)

1. TCMO: Total Cost of Mobile Ownership. 2. Based on survey by Ooredoo.

Figure 10: Capex Projected to Remain Stable with Traffic Growing at over 20% CAGR across Regions



Note: Capex projections include both fixed and mobile. CAGR = Compound annual growth rate. Source: Ovum Service Provider Revenue and Capex Forecast, 2014; BCG analysis

Figure 11: Solutions to Increased Consumer and Business Traffic Needs

	Solution	Description	Demand addressed	Regulatory/Industry support needed
Spectrum	Spectrum allocation	More spectrum needed to increase capacity		<ul style="list-style-type: none"> Governments should release more (un)licensed spectrum, revise allocation (secondary markets), allow refarming, spectrum sharing
	Small cells <i>(low-cost technology)</i>	Roll-out of small cells to address coverage and capacity needs		<ul style="list-style-type: none"> Facilitate rent and backhaul cost reduction Simplify indoor small cell installation regulation <ul style="list-style-type: none"> - Closer to Wi-Fi than BTS
New business models	Innovative consumer pricing	New consumer pricing approaches to improve ARPU, i.e. pricing uploads, speed/bandwidth, latency, etc.		<ul style="list-style-type: none"> Allow alternative value based consumer pricing models that help reduce the investment gap
	IP interconnection agreements	Market-driven, transparent IP traffic agreements to avoid congestion of the network		<ul style="list-style-type: none"> <i>Allow experimentation with new IP pricing models. All parties should commit to avoiding anticompetitive actions and unreasonable discrimination against different kinds of traffic</i>
Technology solutions	Traffic compression	Compression by default can reduce traffic up to 10x among nodes		<ul style="list-style-type: none"> Stakeholders should apply compression by default and design protocols accordingly
	Network optimization	Adoption of SDN/NFV, etc., can increase network functionality and lead to capex/opex benefits for operators		<ul style="list-style-type: none"> <i>Reassess legacy regulatory requirements like PSTN investments in light of modern technologies and market structures – modernization of policies and regulations to encourage investment and innovation</i>

Capacity
 Latency
 Inc. in upload
 Italicized information – addressed last year

Note: SDN/NFV = software designed networks/network function virtualization; PSTN = public switched telephone network.

Figure 12: Key Recommendations to Address IoT Network Requirements






	Solution	Description	Demand addressed	Regulatory support needed
Spectrum	Allocate new spectrum types	<ul style="list-style-type: none"> Sub-1GHz unlicensed spectrum High frequency spectrum Experimental spectrum 		<ul style="list-style-type: none"> Drive allocation of new types of licensed and unlicensed spectrum for different IoT needs
	Low-cost alternative ways of using spectrum	<ul style="list-style-type: none"> Dynamic spectrum access <ul style="list-style-type: none"> - Unused analogue TV spectrum - ASA/LSA/PA¹/Unlicensed 		<ul style="list-style-type: none"> Allow regulatory flexibility to adopt different spectrum usage approaches <ul style="list-style-type: none"> - TV white space - Authorized shared use/access
	Advanced spectrum technologies like LTE A or 5G	<ul style="list-style-type: none"> Potential to solve for new requirements <ul style="list-style-type: none"> - Multi-spectrum operability - Capacity, security and availability 		<ul style="list-style-type: none"> Define R&D, standardization and roll-out roadmap for new spectrum tech Reduce burdens of spectrum usage for experiments to drive innovation
Standard and Protocols	Common open standards for IoT communication	<ul style="list-style-type: none"> Scaled down equivalent of internet protocols for the IoT world Standardization among multiple competing platforms 		<ul style="list-style-type: none"> Strengthen/accelerate the standardization roadmap for IoT communication protocols Ensure standards are globally relevant and interoperable

Security and Availability
 Protocols and Standards
 Spectrum needs

1. Authorized shared access/Licensed shared access/Priority access.

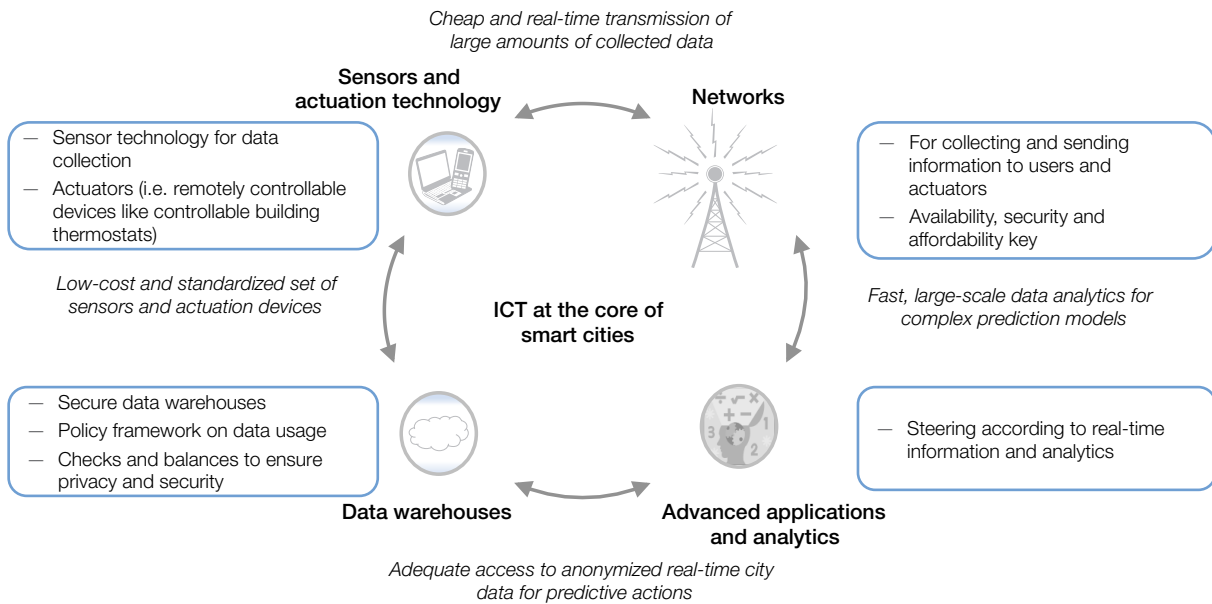
Figure 13: Smart-City Applications Can Help Cope with Scalability of Smart Cities

Examples from different verticals

		<i>Examples</i>				
		 Energy	 Transport	 Water and waste	 Social	 Buildings
ICT-based systems/apps/services	Smart meters and demand response	Intelligent transportation and smart parking	Smart water meters	E-government	Home, building and energy management systems	
	Electric vehicle infrastructure	Tolling and congestion charging	Distribution network control, leak detection, GIS	Remote social infrastructure (health, education)	Home entertainment and communication	
	Distributed generation integration	Public transport system information sharing	Storm and flood management	Safety and security	Smart consumer appliances and devices	
	Consumption visualization and behaviour change	Car and public transport sharing	Consumption visualization and behaviour change	Social city apps	Peer-to-peer room sharing portals	
Non-ICT	Renewable- and co-generation	Low emission vehicles and new public transport	New water purification methods	Green hospitals	Energy-efficient building design and refurbishment	

Note: GIS = geographic information system.

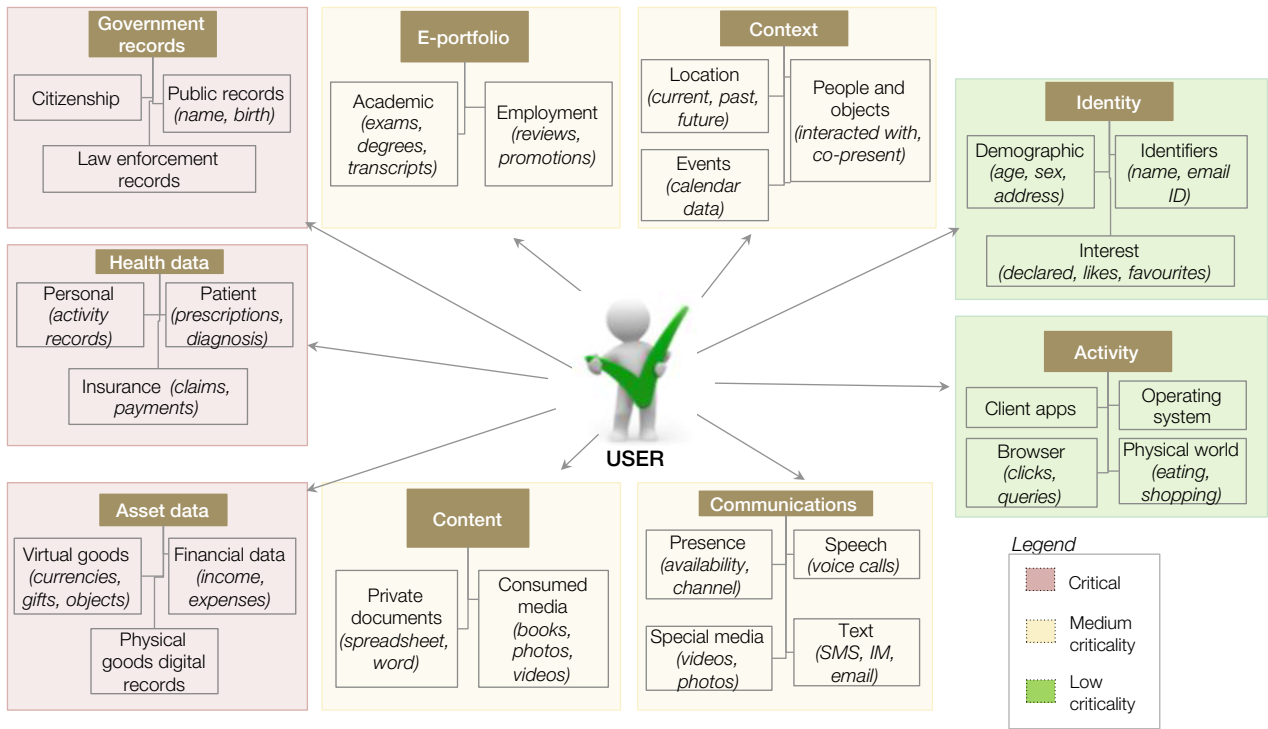
Figure 14: Many Elements of ICT Infrastructure Needed for Smart Cities



Individual building blocks often in place – need for government to play the coordinating role to bring it all together

Source: BCG analysis

Figure 15: Consumers Are Tied to Many Digital Assets



Source: Kaliya "Identity Woman" Hamlin and Personal Data Ecosystem Consortium derived from a list of personal data types appearing in: Davis, Marc, Ron Martinez and Chris Kalaboukis, "Rethinking Personal Information – Workshop Pre-read" Invention Arts and World Economic Forum, June 2010; Criticality is defined as impact to individual if data is compromised.



Endnotes

¹ Euromonitor International, June 2014.

² The Boston Consulting Group (BCG), *The Internet Economy in the G-20: The \$4.2 Trillion Growth Opportunity*, March 2012, <https://www.bcg.com/documents/file100409.pdf>.

³ Euromonitor International, June 2014.

⁴ BCG, March 2012; BCG analysis.

⁵ Cisco, *The Internet of Everything – A \$19 Trillion Opportunity*, 2014, <http://www.cisco.com/web/services/portfolio/consulting-services/documents/consulting-services-capturing-ioe-value-aag.pdf>.

⁶ International Telecommunication Union (ITU), *The Impact of Broadband on the Economy: Research to Date and Policy Issues*, 2012, http://www.itu.int/ITU-D/treg/broadband/ITU-BB-Reports_Impact-of-Broadband-on-the-Economy.pdf; Qiang, C., Rosetto, C., and Kimura, K., "Economic impacts of broadband", *Information and Communications for Development 2009: Extending Reach and Increasing Impact*, pp. 35-50.

⁷ World Economic Forum, *The Global Information Technology Report: Rewards and Risks of Big Data*, 2014, http://www3.weforum.org/docs/WEF_GlobalInformationTechnology_Report_2014.pdf.

⁸ BCG, *The 2013 BCG e-Intensity Index*, https://www.bcgperspectives.com/content/interactive/telecommunications_media_entertainment_bcg_e_intensity_index/.

⁹ World Economic Forum, *Delivering Digital Infrastructure: Advancing the Internet Economy*, April 2014, <http://www.weforum.org/reports/delivering-digital-infrastructure-advancing-internet-economy>.



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The World Economic Forum's Digital Infrastructure and Applications 2020+ initiative, in partnership with The Boston Consulting Group, is a global effort to ensure that digital infrastructure deployments are able to support the promise of the digital economy.

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Salesforce.com, JP Rangaswami, Chief Scientist (2010-2014)
Telefonica, Enrique Medina, Chief Policy Officer
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