THALES

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innovations

"Talk to any biologist and they will tell you that the most impressive and adaptive systems **are humans and animals"**

Christophe Meyer, director of research and advanced studies, secure communication and information systems at Thales

THALES

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"A company like ours clearly can lead the way in meeting the challenges of **datafication** and **helping society to live sustainably**. All our **energy and expertise** is focused on these very challenges"

Challenged almost 50 years ago to propose a definition of life itself, François Jacob posited that "life processes are characterised by a perpetual flow of energy, matter and information".

Our digital age seems to confirm these words.

"Flow of energy and matter is completely determined by proteins," continued Jacob, who shared the Nobel prize in 1965 for his research into genetics. "But information flow is another concern." As we are discovering today, information flow is indeed another concern.

"In the third century BC, the Library of Alexandria was believed to house the sum of human knowledge. Today, there is enough information in the world to give every person alive 320 times as much of it as historians think was stored in Alexandria's entire collection — an estimated 1,200 exabytes' worth." This comparison, quoted from an essay by Kenneth Neil Cukier and Oxford professor Viktor Mayer-Schoenberger, authors of *Big Data: A revolution that will transform how we live, work, and think*, brings some perspective to the staggering volume of information we need to deal with today. "If all this information were placed on CDs and they were stacked up," the authors continue, "the CDs would form five separate piles that would all reach to the moon."

Even more staggering is how recently the data revolution has occurred. An estimated 90 per cent of the world's data has been generated in the past two years, according to Stephen Gold from the leadership team at IBM's Watson Group.

Where is this all leading? Many people see datafication as the new energy source for our societies.

"Data is the new oil," claimed the British data science entrepreneur Clive Humby back in 2006. And to expand on his metaphor, data is just like crude in many important ways. It needs to be extracted, but it cannot really be used until refined. Data needs to be gathered, but it then needs to be processed and analysed for it to have much value. In both cases, the products need to be transported without causing pollution, leaks or system overloads, then distributed safely and efficiently to users.

This is exactly what a group like Thales does — gathers data, extracts the value, then guarantees that the refined products flow quickly and efficiently to the people who need them. More important than information itself, information flow is critical to life in the 21st century.

A company like ours clearly can lead the way in meeting the challenges of datafication and helping society to live sustainably. All our energy and expertise is focused on these very challenges. This latest issue of *Innovations* offers some insights into the role we are playing on the front lines of this revolution, from developing the tiniest components to imagining the most ambitious "smart city" projects, from tapping the potential of geointelligence to inventing the semiconducting materials of the future.

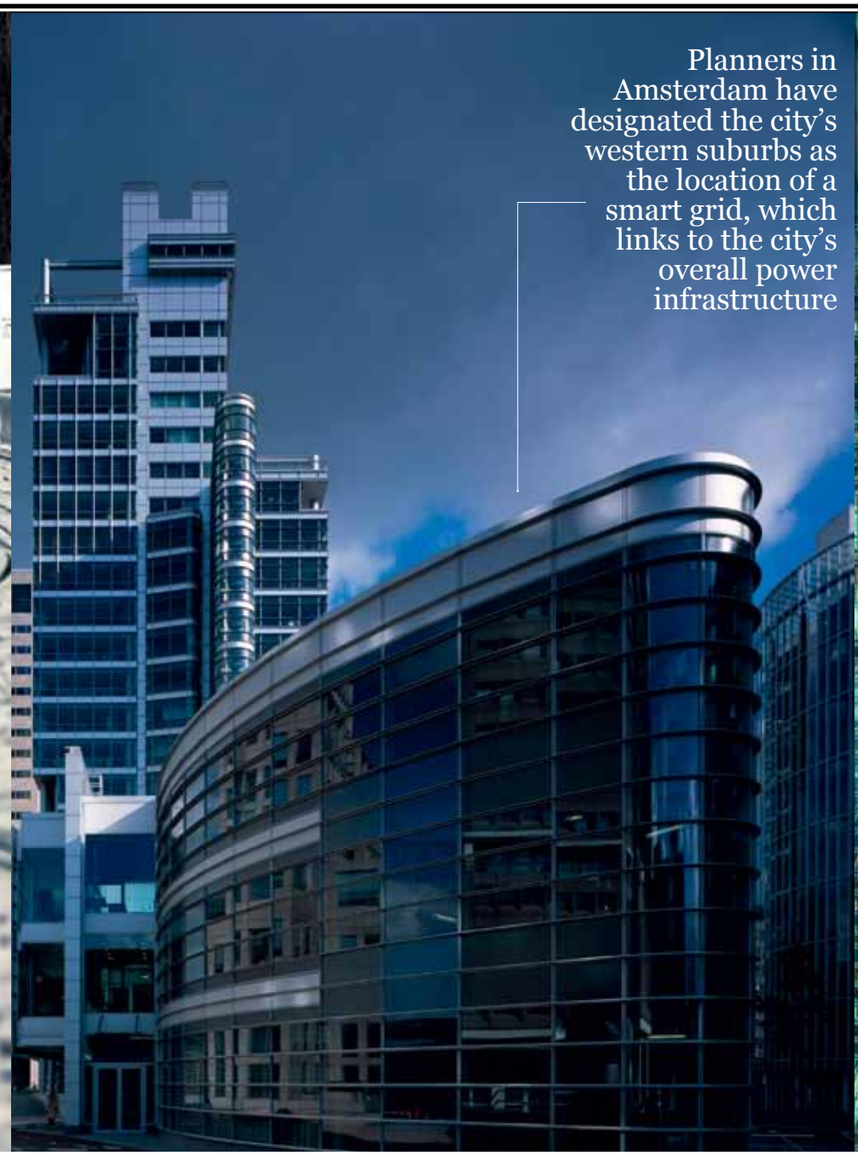
Marko Erman
Chief technical officer, Thales

Innovation by the numbers

1/4
A quarter of the world's territory is protected by air defence radars from Thales Raytheon Systems.

15,700 km
Some 15,700 km of railway lines around the world are equipped with the ETCS solution (European Train Control System) from Thales.

130,000
More than 130,000 passengers use Thales in-flight entertainment systems every day, equivalent to almost 50 million users per year.



Planners in Amsterdam have designated the city's western suburbs as the location of a smart grid, which links to the city's overall power infrastructure

In Brief

1 "Smart cities" use IT to bring citizens and services together in urban environments.

2 They connect government, education, security, health, economic life, energy, waste and other areas vital to daily life.

3 For this to succeed, collaboration is essential – no individual, agency or organisation can create a smart city entirely on its own.

Smart moves

Urban authorities around the world are collaborating with stakeholders and making the most of advances in technology to create a cleaner, smarter, more efficient environment for their residents and workers.

Christian Doherty

Urban development has come a long way since Haussmann introduced neat and elegant boulevards to the Paris landscape. Since then, various styles and theories have come and gone, and we have reached a point where we now have "megacities" outgrowing their own geography, while even medium-sized cities struggle with congestion, outdated infrastructure and environmental concerns. The challenges facing city planners and local governments now cover all the great trends of the 21st century: mobility, sustainability, security, privacy, transparency, efficiency and energy.

And that's before considering the competing factions: local authorities, businesses, community groups, transport operators, health providers and so on. The dizzying set of different inputs and the attendant technology creates both risk – that cities become more fractured and complicated – and opportunity: the developments in data, analytics and digitisation can be tied together to address the challenges and create a smarter, safer, cleaner, more pleasant city environment. If grasped, the opportunity to develop smart cities may mark a turning point in urban design for better and more sustainable living.

Understanding the basics

"A 'smart city' is one that uses information technologies in a much more intensive and applied way, not only to connect different components of urban management to one another – for example, when managing large events – but also to engage citizens more closely with their cities and the services they offer. This also renews the way individuals take part in their communities," explains Pierre Cunéo, director with the strategy, research and technology department at Thales.

The smart city concept encompasses a wide range of different players, inputs and interests – government, education, security, health, economic life, energy and waste. All of these critical aspects of urban life and development have to be considered when addressing the next set of challenges.

In response, there are now numerous examples of cities introducing smart solutions. The most groundbreaking of them tend to be found in existing cities seeking to improve and update their management systems as opposed to planned cities such as Songdo in Korea and Masdar in Abu Dhabi. Indeed, smart city theory is moving away from developing cities along the lines of a mainframe

In Strasbourg, Thales has worked to build an integrated transport network that employs more than 800 control points, delivering real-time traffic flow metrics from individual junctions and crossings, allowing controllers to prioritise public transport vehicles, improve flow and cut congestion

computer towards something more akin to a network, or web.

For instance, planners in Amsterdam have designated the city's western suburbs as the location of a smart grid, which links to the city's overall power infrastructure but manages demand and supply intuitively. The grid saves energy while developing and improving the city's energy infrastructure.

Meanwhile, in Strasbourg, Thales has worked to build an integrated transport network that employs more than 800 control points, delivering real-time traffic flow metrics from individual junctions and crossings, allowing controllers to prioritise public transport vehicles, improve flow and cut congestion.

Both these schemes are intuitive, real-time and flexible. It's less "command and control" and more "go with the flow".

All together now

For some, smart city solutions are simply individual schemes designed to improve one specific aspect of the city that then becomes connected to the whole; for others, they are part of an overarching strategy to "upsmart" the city.

An example of the latter is Singapore. One of the key features of the city's development is its intelligent and integrated city planning. The Urban Redevelopment Authority develops land use plans that will guide Singapore's development for the next 40 to 50 years. As part of that land use, traffic management, public transport, housing, security, infrastructure and links to other countries and cities are all considered holistically, each part contributing to the success of the other.

"In Singapore, particularly at the moment, we are preparing the future by brainstorming with different stakeholders," says Jean-Noël Stock, country director for Thales in Singapore. "Most of all, I believe that the city will become smarter when we start not only to address issues on a project-by-project basis, but manage to have projects that encompass security and mobility at the same time. If we want to design and build a truly smart city, we also need to take into account the environmental impact of what we do: we need to optimise the use of energy and therefore have partners providing smart grids.

"It might sound over-ambitious, but until we're able to deal jointly with several agencies – transport authority, information and environmental development agency – as well as partnering with other industries including telecoms, environment and energy, will we be able to restructure and really deliver 21st-century smart solutions?"

This is indeed an ambitious goal, but Singapore has significant advantages over other cities as it tackles its challenges: a heritage of strong, central government planning and good execution; many international companies operating there; a clear vision of what its future should look like; the resources to finance a range of hi-tech solutions; and, given its geography, a clear limit on future population size, making the task of planning and projecting the future a little clearer.

At the other end of the spectrum, Stock cites Mexico City's efforts to solve its crime and security problem within a wider urban context. Thales partnered with Mexico's telco, Telmex, to upgrade the city's security infrastructure, deploying 8,000 cameras, optical sensors, drones and other types of detectors along with existing surveillance systems and concentrating all that information into four command centres (see p 6).

"Look at the outcomes," says Stock. Car theft has been cut tenfold, the number of people being attacked or murdered has reduced between 10 and 20 per cent annually over the past three years and "companies that had decided to move out of Mexico because of security now are moving back in".

Change and collaboration

Of course, every engineer and planner has great faith in the technological solutions they design and deploy. But the most successful solutions, says Stock, move beyond simply installing new technology and integrate both the mechanical and human into making a city smarter – "Every city has got its own way of being smart," he says.

Pioneering an e-future: Vienna

Planners in Vienna are trialling a low-energy tram service that links to the city's existing network. Using smart technology, the trams monitor the number of passengers onboard at any one time and adjust the temperature and speed accordingly. The tram is just one part of Vienna's ambitious scheme to convert to an integrated electric transport system by 2025.

The aim for the city's e-mobility-on-demand system is to build onto the existing transport infrastructure an e-car network that will allow e-cars and charging stations to be used where they can replace fossil-fuel powered business journeys, and where they can provide mobility when walking, cycling and public transport are not practical.

Using big data to improve public health: Chicago

As the third-largest American city, Chicago shares many of the challenges facing large urban areas – transport inefficiencies, pressure on resources, and poor public health in neglected areas. It is in this last area where the authorities in Chicago – one of the few cities in the world to employ a specific chief technology officer – have focused their recent efforts.

The initiative has primarily involved the public health department partnering with the city's Department of Innovation and Technology, to bring in local partners to identify various data related to food establishments and their locations.

The data takes in building code violations, the food supply chain, complaints that come into local authorities (about food and sanitation), how well lit the areas behind the food establishment are, what construction is happening locally, social media input, the neighbourhood population density, complaint histories of other establishments with the same owner and more.

All these inputs then go towards producing a "risk score" for each establishment that handles and sells food. The pilot will aim to help health officials map risk across the city, and target and prioritise inspection and oversight efforts.

Lee Woodcock, director of Intelligent Mobility at urban solutions consultancy Atkins, agrees: "For cities to be smart or more integrated, it's not just about new solutions. It's about change, and specifically behavioural change. If you take driverless cars, for instance, the issue around deployment is not technology or even legislation. It's trust and privacy. When we embark on city-related programmes, we must embrace change management and excellent communications – not just think about development and deployment."

Woodcock says that city authorities – and contractors – must ask themselves whether, on smart city projects, "they really have aligned objectives, shared operations, joint risks, measures for delivery and for behaviours, creation of value and mutual benefits".

Clearly, given the multidisciplinary nature of the challenges facing cities across the world, all planners need to recognise the need for collaboration. "Collaboration is key – there is no single agency or organisation that can 'deliver' smart cities," says Woodcock. "We often think we are collaborating, but really we are coordinating. The maturity of true collaboration needs to increase if we are going to realise the potential and meet the opportunities ahead of us."

Cunéo agrees. He says that while Thales can bring its unparalleled track record of innovation and excellence in security and communications, "it must, as part of the solution, aim to work in tandem with – and complementary to – energy suppliers, police authorities, rolling stock manufacturers and waste managers, to name just a few".

But everyone involved in smart city work – from mayors to police chiefs, technologists to futurologists – accepts that cities exist first and foremost for those who live in them, and that the "smart" part is the human factor.

"Technology today, and particularly IT, can provide only so much benefit," says Stock. "Everyone wants to be smart. Everyone wants to see how much smarter they could be thanks to the use of that IT, but the best option is to have the city contribute to that intelligence.

"A robot that syncs everything for everyone is not as smart as a solution that connects citizens and allows them to contribute to the wellbeing of the city," he says. "For example, the Waze app allows users to share information about traffic jams. The system synthesises the information but citizens are more important than simply collecting data from sensors. A citizen will always be smarter than a camera."

And once you create a smarter network of citizens and technology, the possibilities for smarter cities seem endless, as Cunéo points out: "One could easily conceive of 'smart agriculture' built around geolocation, species selection, chemistry, weather models and biotechnology. One could also include security for networks that inherently have ramifications far beyond the city, and create 'smart countries' with integrated, secure operations both inside the country and at its borders."

How do you protect a metropolis with a population of over 20 million people from the growing threat of street crimes and attack? The authorities in Mexico City have turned to technology to find an answer.

Needles in a haystack: Mexico City

Pip Brooking

"Armed robberies, 'express' kidnappings, car thefts, carjackings, credit card fraud, and various forms of residential and street crime are daily concerns. The low rate of convictions of criminals contributes to the high crime rate. Criminals select victims based on an appearance of prosperity, vulnerability or a lack of awareness. Displays of wealth are magnets for thieves in Mexico City."

Mexico 2014 Crime and Safety Report: Mexico City, published by the United States Department of Defence, makes for some stark reading. While Mexico has been named as one of the world's emerging economic giants, attracting $35bn in foreign direct investment in 2013, the country is still battling its reputation. Drug warfare, violent and organised crime and corruption still feature prominently – and that's something it's keen to change, in order to capitalise on economic growth and international interest.

Mexico City – at the centre of this investment – may have escaped the worst of the drug war, but its dense population of nearly 21 million, combined with underdeveloped infrastructure and traffic-logged streets, pose a serious challenge for policing. That has been made harder still by a historic under-reporting of crime and lack of confidence in the police. And with one of the largest police officer-to-resident ratios in the world already (80,000 police officers), it is not something the Federal District authorities could attack with more human resources.

Instead, they turned to technology to tackle crime more effectively, raise public awareness of its crime fighting efforts and, in turn, improve quality of life in the city.

One vision of the city

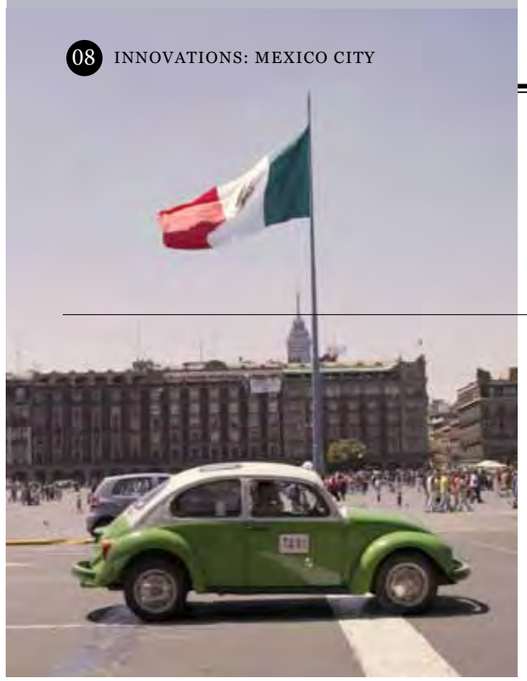
The "Ciudad Segura" (or "Safe City") programme was designed in 2009 and installed by Thales in partnership with national telecoms company Telmex. The latter provided a dedicated fibre optic network and other communications infrastructure necessary to support the programme, while Thales supplied a range of high-end technology and created the software to cope with the scale of the project, as well as overseeing the civil work associated with building one central and five regional command centres.

Before the scheme was finalised, Mexico City's then mayor Marcelo Ebrard travelled to cities around the world to see how they managed city-wide surveillance projects and what technology they used.

One of a few thousand officers who monitor Mexico City's busy Zócalo or main plaza during events that can attract several thousand people. Trying to spot one person who might be engaged in criminal activity in this crowd would be impossible without additional support.

In Brief

1. Faced with a steady rise in violence and criminal activity, authorities in Mexico City turned to technology to help solve the problem.
2. The "Ciudad Segura" or "Safe City" programme was launched in 2009.
3. A network of high-tech cameras now operates 24 hours a day, contributing to a significant reduction in "high-impact" crime in the city.



21 million

Mexico City may have escaped the worst of the drug war, but its dense population of nearly 21 million, combined with underdeveloped infrastructure and traffic-logged streets, pose a serious challenge for policing

But his ambition to transform the city into somewhere more enjoyable to live and work, for both residents and foreign visitors, placed tough demands on the project.

A network of more than 8,000 cameras now records Mexico City's streets 24 hours a day, seven days a week. It operates alongside hundreds of emergency call points (or panic buttons), as well as a fleet of drones. All of this data feeds into state-of-the-art command centres, where more than two million incidents have already been logged and response time has been reduced from over 12 minutes to 2.03 minutes since its launch. It has also seen high-impact crime, such as kidnappings, fall by 42 per cent and car theft by 33 per cent.

"We haven't found a similar project in another country that records all the time. You need a lot of space and a lot of bandwidth to do that," says José Redon, the Ciudad Segura project director at Thales. "We have seen other projects that haven't worked because of a lack of budget or technology."

The programme was fully operational by 2012, along with two mobile command centres. When the announcement was made in April 2014 that the scheme was going to be nearly doubled in size, it had already been hailed as the world's most ambitious urban security programme, for both its size and scope. At one end of the scale, license plate recognition can be used to track a single car across the city. At the other, it has been used to facilitate the emergency response to a gas explosion at a government building, as well as earthquakes, and to manage the six million-strong crowds during the pilgrimage to the Basilica of Guadalupe held each December.

Making it happen

To deliver the system, a multi-national Thales team was brought together, including experts from the company's headquarters in Paris and software specialists who had been involved in a similar project (albeit on a far smaller scale) for the Singaporean police.

The team developed two major pieces of software. The first, Computer Aided Dispatch (CAD), handles incident management from the moment something is detected via a camera or reported by a citizen, and is linked to all the emergency services.

The second is the Video Management System (VMS) from Thales, which handles the flow of data from all the cameras. By compressing the recorded images, it can deliver the data to different command centres simultaneously. It can also not only support the existing 8,000 cameras, says Redon, but offers "unlimited growth" – a good thing, considering the additional 7,000 cameras already planned.

On any shift, up to 500 policemen can each watch up to 16 cameras at a time via three monitors, in which they have CAD, VMS and a Geographical Information System (GIS) to pinpoint the exact area they are watching.

At the heart of the programme is the central Computerised Command, Control, Communications and Intelligence (C4I) centre which accommodates half the surveillance workforce – and the mayor, should any incident require his oversight. In local news reports this has been credited with giving the police "one vision of the city".

Coordinated response

The success of the scheme hasn't been just about putting the latest technology into use. It's also been integrated into the way the emergency services work and interact with each other, as well as winning the approval of the local population.

There are several different police and ambulance services in the city and Guido Sanchez, director of the city's medical emergency rescue squad (ERUM), highlights the benefits of coordination in a big city that has hundreds of incidents each day.

"The ERUM only has 16 ambulances, so we can't afford to have two or three ambulances arriving at the same place," he says. "The C4I helps us to determine if it is a real call or a false alarm and send exactly the help needed. It also means we can dispatch ambulances from the rescue unit closest to the incident."

Response times can still be in excess of 20 minutes due to traffic and the city's size, but Sanchez points out that "lives depend" on keeping the response time to a minimum.

Before the scheme was finalised, Mexico City's mayor at the time travelled to cities around the world to see how they managed city-wide surveillance projects and what technology they used

He points to another advantage: the ERUM uses volunteers over the weekends, when there are a higher number of emergencies to deal with. The success of the scheme makes them feel safer while they are doing their job.

But not everyone likes the idea of widespread surveillance. Redon says it was important for the mayor to get the necessary regulation in place before the Ciudad Segura programme began, addressing any possible future legal challenges up front. Thales also worked closely with the government to explain what the programme implied in terms of security and citizen safety.

"This was a political programme of great significance to the mayor," says Antonio Quintanilla, country director for Thales in Mexico. And although there were some complaints early on, the city's residents quickly understood the benefits, particularly when the results started to show, says Redon.

"Instead of complaining against it, they complain that there are not enough cameras in their neighbourhood. They want more cameras. They want to have one close to their house," he adds.

Thales also had to adapt the system to evolving demands from users: "Over the years, as the system has been implemented, the customer has discovered new ways to use it and is obviously hungry for more functionality as they've gained experience," says Quintanilla.

Tracking vehicles more effectively is a good example of this: "Functionality has been developed and fine-tuned within the system," he explains. "We've improved everything to do with licence plate registration and identification, and how to use that information – such as sending speeding fines directly to the driver."

Unmanned aerial vehicles are the latest addition, affording entry into high risk zones where fixed camera positions can't reach. Both Thales and the authorities in Mexico City are keen to investigate new opportunities and integrate further technology as it comes online.

International scope

"In terms of smart cities, the sky is the limit. It just depends on the budget, the imagination and the ambitions of the customer," says Quintanilla. "This type of system can be connected to all existing infrastructure – not just cameras in the streets but also in the metro system, airports, critical infrastructure, you name it. It can be expanded to as big a perimeter as you want. It's just a matter of budget and political will."

But, he continues, each project is customer-specific: "It's very difficult to propose an urban security or an urban surveillance solution off the shelf. It has to be tailor-made according to the specific requirements and conditions each and every customer is situated in," he says. And that includes the operational concept, as well as living conditions and existing infrastructure.

However, Redon calls Ciudad Segura an "unbeatable reference" for what can be achieved in urban security around the world – "We have proven it works in what is a very complex environment."

Thales Mexico has become a regional hub for expertise in protection systems in the hope it can replicate the same level of success for other Latin American markets. After all, six cities in the region remain in the UN's top ten most dangerous places when it comes to murder rates. Implementing such a system could transform the lives of those living there and offer hope for a safer future.

"This achievement with the Mexico City authorities is a clear vote of confidence in Thales and partner, Telmex, and a compelling illustration of the performance of the system already in place, based on its success record since 2011," says Dominique Gaiardo, vice president and managing director of Protection systems with Thales. "With our world-class capabilities and local skills based in Mexico, we are well placed to provide high-end security solutions and address the key issues faced by major cities in Latin America and around the globe."

Tomorrow's soldier today

7kgs Technologists at MIT in the US have set themselves the task of reducing the weight of the typical pack from 45kgs to 7kgs

In Brief

1 For as long as people have gone to war, a soldier's equipment has been his closest ally in the field.

2 Tomorrow's soldier will need more than a weapon and armour to succeed – new technology will play a vital part.

3 From comms to "liquid armour", soldiers will be equipped with everything they need to ensure they are plugged in to the decision making process.

For the military, there is little more important than ensuring the forces in the field have the best available equipment at the right time, if they are to be as safe and effective as they can be. The threats they face continue to evolve and tomorrow's soldier will need to be properly equipped in order to anticipate them. Fully networked communication technologies and advanced materials are driving the change.

Christian Doherty

Recent flashpoints in the Middle East, Africa and Eastern Europe have demonstrated that warfare as we once knew it is no longer straightforward, with conventional forces facing off in a black and white battle for territory.

Insurgents are far more likely to be part of a scattered, unconventional force, unrecognisable from the columns and battalions of the past. Many soldiers now find themselves up against a hidden enemy, using the urban environment to sow confusion and disorient their opponent.

Commanders and planners acknowledge that simply employing overwhelming firepower eventually suffers diminishing returns. Ultimately, you need ground forces to win the fight. If scale and scope won't meet the challenge, clearly something else is needed – a solution that combines smarter deployment of targeted weapons, beefed up protection for exposed forces, and greater integration and connectivity in what is a confusing and dangerous theatre of war.

And it all needs to be carried by the average soldier.

Fit for purpose

Thomas Reydellet, director of strategic advanced studies at Thales Research & Technology, says that, in the very near future, "soldiers will need a high degree of autonomy (in terms of logistics, ammunitions, chargers and batteries) for extended missions against hybrid, extremely adaptable enemies (for which a lot of ordnance is required because they are hidden, agile and fleeting). Sharing tactical information in real time will be vital to create a common operational picture between all different military assets on the battleground – UAV, Vehicles, fighters – not least to limit friendly fire and reduce uncertainty."

For the men and women tasked with deploying these new technologies, the future looks increasingly digital. Described by the US military as "an individual soldier combat system", what used to be an infantryman is now a fully equipped, connected and protected fighting unit able to engage accurately and safely with an elusive enemy, communicate with colleagues, share information instantly and discriminate between friend and foe.

And this is no mere *Iron Man* fantasy – armed forces across the globe are deploying a range of advanced technologies that wouldn't look out of place in a Hollywood blockbuster.

Reydellet says the challenge facing commanders sending soldiers into the modern battlefield is straightforward: "For the soldier of the future there are three key factors: mobility, firepower and protection," he says. "You need to enhance the protection and that's the priority. And because you need to fight in urban settings with specific constraints – as a fully connected intelligence captor but also an effector – the soldier becomes one of the most important elements in war. You need to be close in order to discriminate between enemy combatants and civilians, engage with precision and neutralise efficiently, in a very short decision loop. Reaction time is often the key to success."

Many of the most innovative aspects of the tech-soldier are already in use. Some forces have standard issue helmets with GPS antennae to send constant positioning information back to commanders; built-in cameras have been around for a while, sending real time pictures not only to base but to colleagues in the field; and modern body armour is a far cry from the heavy and unreliable kit of just ten years ago.

Equipping the soldier of the future relies on a number of different bleeding edge disciplines: nanotechnology and the latest in lightweight but strong materials, 3D printing (also known as additive manufacturing) to fine tune and manufacture the kit needed, and intuitive and integrated secure digital communication systems that seamlessly knit soldiers together into a coherent and reliable network.

Described by the US military as "an individual soldier combat system", what used to be an infantryman is now a fully equipped, connected and protected fighting unit

Adapt or die

While a soldier's primary task may be to engage the enemy, there are countless other aspects that need attention. Interacting with locals and demonstrating awareness of local issues are essential for the modern soldier. Indeed, if the US experience in Iraq demonstrated one thing, it was the damage that can result when a military force is cut off from the population it is sent in to protect.

Reydellet points out that, because the enemy moves quickly, using the geographic specificities of the urban landscape, soldiers have to be equally mobile and able to adapt to their environment. In urban warfare, soldiers should be able to manage three dimensions because threats are coming in all directions, from underground to the air, day and night.

"In the new battleground environment, the technology solutions that we design have to be modular, so they can be adapted and offer flexibility to the soldier. That means he can switch quickly between modes – from talking to locals in an open way to hardly engaging with the enemy. If the soldier senses a change in atmosphere or threat, he must be able to adapt and engage with that, so all of our technology centres on being flexible and modular. Sharing intelligence with the capacity to understand a moving situation while maintaining communication links under the stress of attack, demands specific modern technologies."

Lighter touch

Naturally, there are obstacles to overcome in order to turn these technologies into a coherent package that can genuinely protect and enhance the soldier's performance, not least is the issue of weight. Many of the tech already exists – sensors and GPS aren't new – but packing it all into a wearable, durable and lightweight suit that can be worn without impairing performance is the real test.

"The weight factor in particular will continue to be an obstacle to the mobility of an ever-more network-centric soldier in the combat environment," says Reydellet. "Soldiers will need the capability to deliver effects with precision at all times and to impose their rhythm of the operation on the enemy."

When it comes to solving the weight conundrum, most of the focus has been on using lighter materials. Technologists at MIT in the US, for instance, have set themselves the task of reducing the weight of the typical pack from 45kgs to 7kgs.

"There are two ways to do that," explains Reydellet. "You can develop lighter materials – most of them based on nanomaterials – and/or combine functionalities into one, so that technology can do more than one job at the same time."

Multifunctional kit offers a promising solution. For example, a rifle can double as a radio, thanks to what is a relatively straightforward modification.

"It means you get more capability per kilo," says Reydellet. "Some medical studies suggest that soldiers can carry no more than 35 per cent of their own bodyweight. If you go to 45 per cent, for instance, it has a huge effect and slows the person down enormously. Reducing the weight will make a huge difference."

The other game changer in assisting soldiers, alongside lightweight materials and increased functionality, is the exoskeleton. While it is still early days, extensive research is currently taking place in various countries to develop battlefield exoskeletons that augment the soldiers' strength and increase their stamina and weight bearing capacity.

That's not the only element of the exoskeleton that has intrigued military planners. Researchers at the US Defense Advance Research Projects Agency have been working on a lightweight exosuit that "seeks to employ a system (or web) of closed-loop controlled actuation, transmission and functional structures that protect injury prone areas, focusing on the soft tissues that connect and interface with the skeletal system."

In other words, strengthening soldiers in the areas most at risk of stress injuries in combat.

Information overload

One of the perennial problems facing those producing new and innovative technological solutions is the limit of the human cognitive system. As with advances in business analytics – where previously unheard of amounts of information can be harvested and analysed – innovations in battle systems offer the possibility of providing soldiers and their commanders with a wealth of information and connectivity.

But while the data analyst in an office may have a month to absorb, review and study the data, the soldier in a combat situation has none of that luxury. Military planners must decide what information is important or superfluous when equipping soldiers with the next generation of communication and recognition tools.

Liquid armour is based on the use of "shear-thickening" fluids – these increase their viscosity with impact, becoming thicker and almost solid

From liquid to solid

Protecting life and limb with a liquid may seem counter-intuitive, but research suggests that liquid armour – flexible, light and above all incredibly strong – may offer a significant advancement in battlefield protection. Early results suggest certain liquid-based armours can offer lightweight protection by turning to a solid on impact, effectively becoming armour in an instant. Liquid armour is based on the use of "shear-thickening" fluids – these increase their viscosity with impact, becoming thicker and almost solid.

The armour, which is being pioneered by the US Army Research Lab, doesn't act as a shield – it is instead soaked into a protective vest to strengthen it by locking together when it is struck by a projectile like a bullet or shrapnel.

The liquid distributes the force of the impact over a wider area than traditional body armour, reducing localised impact and shifting it away from the point of contact.

Kevlar has become the standard material for battlefield protections, but despite its success as a bulletproof shield, it has drawbacks. As a solid armour it is inflexible, impeding soldiers' movement; and although much work has gone into making it as light as possible, it is still heavy. Liquid armour may offer a viable alternative.

Given the data-gathering capabilities of drones, for example, at what point does a soldier become overwhelmed by coordinates and orders being sent from central command?

Soldiers must adapt – in the future they will receive more data despite not seeing the enemy. A number of studies, particularly in the USA, have attempted to measure and evaluate the point at which information overload occurs for those under stress. The US Army's Augmented Cognition programme focuses on ways to help troops decide what information to include and what to keep.

One way of monitoring overload is a portable system that uses body-mounted electrocardiogram and electroencephalogram sensors to monitor cognitive activity in the brain and blood flow in the rest of the body. The data is then broadcast by system-equipped soldiers wirelessly back to commanders, allowing them to dial up or down the level and scope of information being fed to the soldier in the field.

The next generation of helmets will also provide soldiers with a 360° view, says Reydellet: "And, based on the research we've done, the new helmets will have several cameras that allow the soldier to zoom and focus by using vocal command."

Reydellet points out that it is now common practice for a soldier to have a camera mounted on his weapon enabling him to send images and information to colleagues. Augmented reality technology could also be used to enhance situational analysis.

"In turn, that helps the commander, who can make better decisions faster and remotely, sending them instantly along the chain of command. The soldier is one member of this strong network. It's important for him to share the data in real time, to maximise the understanding of the situation. As a result, the effectiveness of each soldier is improved."

Battalion commanders have long bemoaned their inability to strategise and react in real time in the fractured and confused battleground. Equipping the soldier on the ground with a range of "reporting" tools can have a real impact.

Ultimately, Reydellet explains, the work being done in universities and R&D labs around the world is designed to achieve one thing on the battlefield: "It's about shortening the decision loop – reducing the time needed to decide, act and control the tempo of the manoeuvre. If you can see, move and fire a few seconds ahead of your enemy, then you have a critical advantage. The tech can deliver all kinds of things and enhance the combat performance of course, but if it slows you down, then you're at a disadvantage. The work we're doing is about using the new technology in the best possible way to protect and serve the soldiers in the field."

Creativity in action

If you're trying to design the right solution, you need to make certain you're addressing the right problem. Design thinking goes to the source to make sure the results work for everyone.

James Gavin

Traditionally, innovation focuses on solutions, rather than problems. But for Didier Boulet, director of Thales' Design Centre, the innovation process really starts at the source.

"You have to look for the right problems to solve before you can even start thinking about solutions," he says.

Boulet has pioneered a new approach to the innovative process within Thales, under the banner of "design thinking." The idea was sparked in the 1980s, when Rolf Faste, an American designer and professor of mechanical engineering began teaching students at Stanford University a new way to think about creative design practice.

A pioneer of human-centred design, Faste propagated the concept of design thinking as a formal method for a creative and more successful resolution of problems or issues.

Colleagues soon joined Professor Faste in building a new methodology for realising concepts and ideas through design. David Kelley, a former Stanford professor who founded both the Stanford Design School (d.School) and the global design consultancy Ideo, popularised design thinking as a method of creative action. His aim was to encourage designers to conceive of themselves as design thinkers, with a methodology that enables them to come up with viable, test-driven solutions.

A new approach

Design thinking sounds deceptively simple: it is a way of thinking about the problem, but it also has practical business applications, making innovations more desirable to clients. The business world has been quick to adopt this concept.

Thales, inspired by a team of visionary executives including chief technical officer Marko Erman who has been an enthusiastic supporter of the approach, has been working since

In Brief

1 In order to come up with the right solution, you have to make sure you're looking at the right problem.

2 "Design thinking" aims to address this by introducing creativity in the problem solving process.

3 "Success" will be based on the quality of the design research and the insights generated as a result of design thinking.

Room to think

The Design Centre concept is intended to engender greater freedom of thought among those using the facilities. As Barry Connor, the head of the Thales Glasgow Design Centre explains, the space is intended to be modular, allowing people to modify the space as they see fit.

"There are no fixed walls here. People use beanbags to sit on and large white walls to sketch on. We're trying to create an unconstrained space to ensure unconstrained thinking. I firmly believe that space encourages a certain type of behaviour that can facilitate creative thinking."

A new start

Thales's Design Centre was set up in 2012 by a team of inspired and ambitious individuals, encouraged by chief technical officer Marko Erman's enthusiasm for design thinking: Jean-Loup Picard, former senior vice president of strategy at Thales; Alain Oumeddour, the general manager of Thales University at that time; Patricia Viviani, vice president, Human Resources; and Jean-François Pernotte, former vice president of strategic partnerships and development at Thales.

2009 in partnership with the Stanford d.School and Paris-est d.School. Under Boulet's lead, design thinking has radically reshaped the way the company approaches the subject. Customer-driven innovation now forms part of the company's human-centered approach to problem solving.

Since 2012, Boulet has been working on the Design Centre, which operates within Thales University and specialises in the implementation of design thinking.

"People come into the Design Centre to develop new concepts, products, services and strategies. The scope is all about innovation – more specifically design-driven and user-driven innovations," says Boulet.

Meeting the right needs

Design thinking has reshaped the entire relationship between client and company. In the past, technology was developed and a suitable application found in the marketplace. Now, the customer is brought on board far earlier in the process.

"The customer is the end-user – if the product does not fit their requirements, then it is of no value," says Boulet. Understanding what people actually need right from the start ensures that the right products are designed and that they are fit for purpose. By taking the customer along the design "journey", they are unlikely to be surprised or disappointed by the final product.

The key is to begin not with problem solving, but with problem finding: "Every project starts with user research. You immerse yourself in the problem, you filter it, you try to connect with different people and trends. It's in the collision between the design team experiences, all the different inspiration sources, that real insights can be forged into unique, new points of view," says Boulet.

Empathy is at the heart of the process. According to Barry Connor, the head of the Thales Glasgow Design Centre – the first such facility outside France – the aim is to encourage divergent thinking: "It's all about understanding the problem and empathising with the end-user of the product we're going to build. That can be done in a number of ways, such as user interviews, trials and getting feedback from marketing and sales. That allows us to get more insights and understand the user's environment," says Connor.

The empathy stage enables some of the potential unknowns to be revealed and explained, says Connor: "It might be that customers don't know what they want – or might think they know what they want, but are mistaken. The empathy stage exposes the product to other potential uses, for which it might not have been designed."

This is followed by the problem solving stage, which is about generating ideas – "ideation", in the language of design thinking. Creativity is a key element in design thinking, but should not be overemphasised. It represents about 20 per cent of the overall process, estimates Boulet: "People sometimes exaggerate the importance of this part of the process. However, the ultimate success mostly rests on the quality of the design research you've done and the quality of the generated insights.

10

The design thinking project is not lacking in ambition; Thales is aiming to transform itself over the next 10 years

"The other key success factor lies in the prototyping, experimentation and the numerous permutations that you come up with," he says, mirroring the maxim that genius is 99 per cent perspiration and one per cent inspiration.

"It is only when you create prototypes and experiment that you can test the ideas against the potential uses. That's when it all starts to make sense."

Gauging the results

If design thinking is a means of taking a more systematic approach to the creative process, how can its impact be measured?

"The ultimate measurement is how many products hit the market and the performance of those projects," says Boulet. "You need to go through the full product cycle, from problem identification to investment in a new product and show that this couldn't have happened without the design thinking process. The Design Centre initiative is still young – it has been up and running since January 2013 – but we can already see its impact on creative new product categories (ie urban security) and the unique co-design opportunities it generates with our customers."

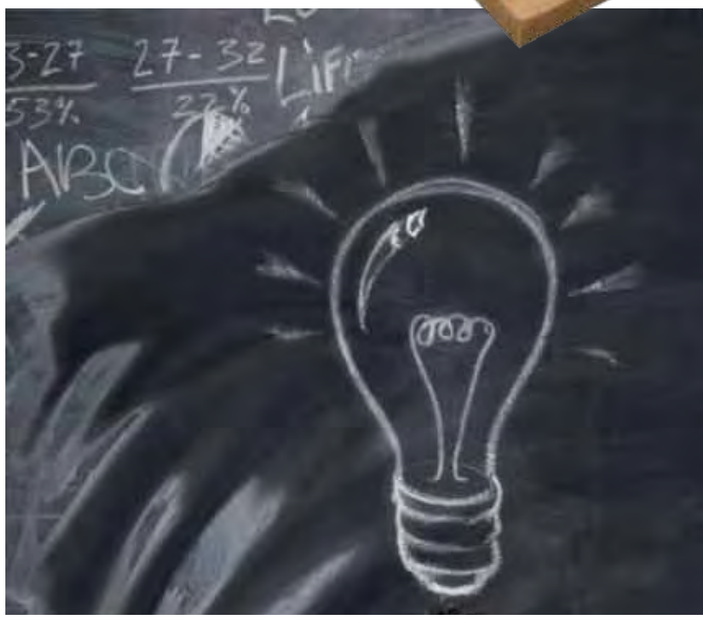
20% of the design thinking process is creativity

The dissemination of design thinking has moved well beyond the Paris Design Centre – it was never intended to be anchored in a unique location. Rather, it is intended to become a wider network. In cities like Reading, Bordeaux and Singapore, innovation teams are developing solid skills in design thinking and will most certainly become full-fledged Design Centres in the near future.

The design thinking project is not lacking in ambition; Thales is aiming to transform itself over the next 10 years. The company will be more entrepreneurial and intra-preneurial, says Boulet, with internal incubators acting as channels for these new business initiatives.

The Thales Design Centres have the potential to become the perfect platforms for this burst of business innovation.

"This is definitely how we should position ourselves in the future, to become incubation platforms inside Thales for young business initiatives," says Boulet.



i-Lab: a laboratory for ideas

Air Liquide, a leading producer and supplier of industrial and medical gases and related products, has created its own design centre in the form of an "i-Lab" – a laboratory for new ideas, to help accelerate the pace of innovation and explore new markets. The i-Lab is both a think tank and a venue for experimentation (a so-called "Corporate Garage") in new ideas that will benefit the group. The Paris-based i-Lab gets support from the group's R&D sites, its work focused on both short-term and long-term issues.

i-Lab's Think Tank is tasked with identifying and mapping new growth opportunities for the company. A multidisciplinary team analyses trends, such as industry globalisation and resource constraints, evolving consumption and demographics, urbanisation and new technologies, to better understand their impact on consumer habits.

"The first goal is to accelerate innovation through prototyping," says i-Lab director Grégory Olocco. "In the short-term, it is about thinking in a framework of three-to five years, taking in all the megatrends that might have an impact on the business. For the long-term, we're looking at horizons stretching 10 to 15 years from now."

The objective of the i-Lab Corporate Garage is to test ideas on end-users and to do so quickly. An open innovation team tries to identify potential partners, whether SMEs or academics, in order to catalyse their development. There is also a data workshop, with a small team working on big data and the "internet of things'.

The i-Lab, located in the middle of Paris, is an open space with none of the usual office architecture you might expect. Its central local encourages interaction with outside parties, acting as a hub where people can meet and exchange ideas.

Design thinking is central to the i-Lab concept, says Olocco: "In design thinking, you are always thinking about use and desirability. The i-Lab is completely new and could have a real impact on the business. The point is to generate one per cent more growth to Air Liquide within the next seven years."

This still presents some major challenges: "First, we have to put in place all the tools to bring an idea successfully to market. We think we can realise that. The aim is to have 15 to 20 ideas in our portfolio within a couple of years."

The second challenge is about geographic expansion: "Once we have consolidated the base in Paris, we want to have some satellites, such as labs opening in the United States, to catch the future trends," says Olocco.

Under an electron microscope, the butterfly's wings reveal tiny comb-like structures, about the same size as the wavelength of light itself

How can a butterfly's wings help drive down the cost of transmitting information across the Internet? Or a burdock burr lead to a revolutionary new fastener? As scientists and engineers around the world have known for some time: the natural world is still the best source for inspiration.

Biomimetics: taking cues from nature

Dr Stuart Clark

In Brief

1 Biomimetics seek to emulate nature in the search for innovation.

2 This approach looks for new solutions by examining and trying to understand the natural world's adaptive systems.

3 Solutions derived from biomimetics could apply to everything from electronics to medicine, communications and robotics.

The iridescent wings of the butterfly

Morpho Rhetenor have puzzled scientists for years. How do they achieve such an intense blue colour? Master painters such as Giotto had to crush the precious stone lapis-lazuli to obtain the pigment. But the butterflies can't crush stones to cover themselves. So how do they do it?

Under an electron microscope, scientists in the Thin Film Photonics Group at the University of Exeter discovered that the butterfly's wings reveal tiny comb-like structures, about the same size as the wavelength of light itself. This allows them to interact with light very strongly indeed and gives them their iridescent blue colouring. A similar iridescence was found on some marine worms and has been traced to a series of microscopic holes in the creature's body hair.

Now, a similar miniature mesh has been created artificially by Alfredo de Rossi of Thales Research & Technology Physics group, to control light in a very specific and potentially very useful way: "We are not the first to use light to control light, but we are attempting to do it in a smarter way," he explains.

The mesh confines light to a tiny volume, producing an extremely high density of light energy. The concentration generates an electrical field so strong that it can then be used to control other beams of light.

"In a transistor, you have three terminals. The current on one terminal is used to control the flow of current across the other two," de Rossi explains. "We have found an approach to do this with light. We don't use electricity except to power up the equipment. All signals are carried on light."

Removing much of the need for electricity gives this technology the power to transform communications, which is currently expanding at an unsustainable pace. "Communication technology is consuming more energy due to the dramatic rise in communication traffic. According to many who study power consumption statistics in the telecoms domain, if this carries on, we will soon have to use all the electrical power that we produce just powering the Internet. Clearly this is impossible," says de Rossi. The new systems that he and colleagues are pursuing use just milliwatts of power, offering enormous potential for the future of our increasingly interconnected world.

The eyes have it

This "biomimetic" approach to solving a pressing problem, by emulating aspects and systems from nature, seems to be inspiring a raft of new projects around the world and producing remarkable results.

Researcher Jean-François Goudou and his team at Thales are two years into a project aimed at recreating human vision. It may appear that cameras, with their lens and detectors, already offer an acceptable imitation but this is not so, says Goudou. The eye is far more complicated.

"The retina is not only a photon collector, it also processes the data. It does not provide an image to the brain but transmits information about the spatial and temporal features of what you are seeing," says Goudou.

The retina's processing includes de-noising, contour recognition and orientation, as well as

> "Talk to any biologist and they will tell you that the most impressive and adaptive systems are humans and animals"

movement recognition. This is much more useful to a data-processing device such as the brain (or a computer) than an image which must first be "scanned" for its details before it can be processed.

Another difference is that the pixels of a camera see the same field of view at the same resolution, whereas the eye has a very high resolution area in the centre, but less detail on the periphery.

Goudou believes that a successful biomimetic system may be another few years away but, when it comes, it will make computer vision a much more efficient thing. It has obvious applications in robotics, which need to understand their surroundings quickly to be as responsive as possible.

"This would allow a robot's eyes to move very quickly to objects of interest in their field of view," says Goudou. "The robots would also receive motion information about things in their environment."

This would be a step towards the ultimate biomimetic goal of producing artificial animals. Consider the exploration of other worlds: at the moment, rovers trundle across distant planets, sending images of their surroundings back to "drivers" on Earth, who help them navigate the alien landscape.

This is a long-winded process and the use of wheels severely restricts where the rovers can go. Even the most modern rover, such as NASA's Mars Curiosity, is terrible at coping with unexpected situations. What are the alternatives?

"Talk to any biologist and they will tell you that the most impressive and adaptive systems are humans and animals. To survive, animals are capable of displaying astonishing adaptive capabilities," says Christophe Meyer, senior expert, director of research and advanced studies, secure communication and information systems at Thales.

What if you could design your rover as an artificial animal – something referred to as an "animat" – that can walk or crawl across any surface, recognising hazards and avoiding them? These could also be used on Earth in situations that are too dangerous for humans.

The heart of biomimetics

Biomimetics transforms nature's solutions into technology. Although its origins can be traced to Leonardo da Vinci's drawings of bird-like wings designed to allow humans to fly, it was transformed into an academic field during the 1950s by American scientist Otto Schmitt.

He coined the term as part of his doctorate, in which he designed an electrical circuit known as a "Schmitt trigger", which uses feedback to convert an analogue electrical input signal into digital output. Schmitt was inspired by the way a neural impulse moves through squid nerves.

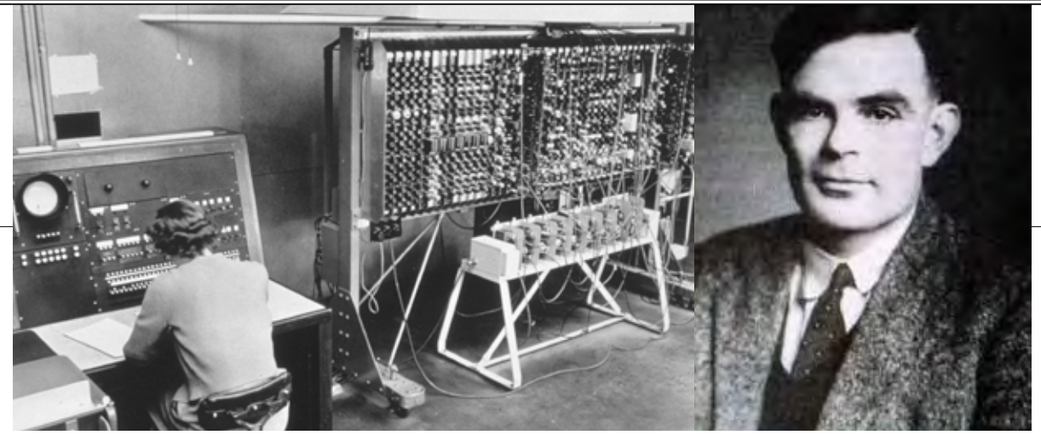
The Schmitt trigger is not the only biomimetic success story. Perhaps the best known is that of Swiss electrical engineer George de Mestral, whose dog became covered in burdock burrs during a hunting trip in the Alps in 1941.

He examined a burr under a microscope to discover that its grip is simply the product of tiny hooks. With this as his inspiration, de Mestral invented a unique fabric hook and loop fastener – better known as Velcro.

Walk this way

Meyer's interest in biomimetics began early. His father worked with the pioneering MIT researcher Rodney Brooks, who set about developing adaptive robots. Meyer remembers one particular robot that was engineered to learn how to walk: "This robot built its own programme, allowing it to learn how to cover the largest area in the smallest amount of time," says Meyer.

The software was designed to learn how best to achieve its objective, rather than just slavishly following a set of commands – when one of the robots had a leg removed to simulate an accident, it relearned how to move. It may not have been as efficient, but it learned how to make the best of what it now had and was able to continue performing its mission.



Alan Turing, considered the father of modern computer science, once asked: can machines think? Today, biomimetics seeks to mimic rather than demonstrate actual intellect.

As well as the hardware biomimicry – for example, legs rather than wheels – there must also be biomimicry in the software. This leads to a new approach in the field of artificial intelligence.

"In the old days, it was all about beating the Turing test," says Meyer. This was a concept introduced by Alan Turing in 1950 in a paper entitled *Computing Machinery and Intelligence*. He posed the question, "Can machines think?" and proposed a test by which a person holds two conversations via computer screen and keyboard with participants that cannot be seen. One participant is a computer, one is a human. The computer passes the Turing test if the human asking the questions cannot determine which of the participants is human.

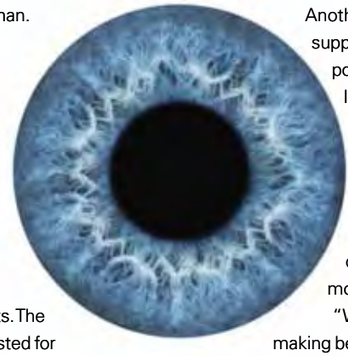
Modern artificial intelligence does away with this lofty goal and simply concentrates on giving the machine enough smarts to achieve a goal. It doesn't tell the machine how to do so, instead it lets the machine work out the details for itself based on what it can sense of its environment. In other words, it makes it up as it goes along.

Meyer is in charge of Thales's adaptive systems and biomimetics simulation project, which uses biomimetic software to simulate the behaviour of human beings in virtual environments. The SE-Star software allows building designs to be tested for their efficiency, safely and user friendliness before they are built.

The project began five years ago when Meyer realised that human irrationality and behaviour in strange situations has been studied sufficiently well that it could be simulated on a computer.

"We can now use the system to test critical infrastructure design before building the real thing. Then we populate this virtual environment with virtual people who behave realistically and see what happens," he says. "For example, we can put a fire or smoke anywhere we want in the environment and see how people behave." They can then change the placement of the exits and run the simulation again to see if more people can get out quickly.

The same software tools can also be used for other applications. The first is to train people who use computer screens to monitor the movement of people, such as CCTV operators of crowd management systems.



Currently, operators are trained by sitting with colleagues and watching daily operations but, to build expertise, they need to learn how to handle difficult situations. Simulations of real human behaviour offer a clear advantage.

"We call this embedded training because you use your operational system but instead of being connected to reality, you are connected to a biomimetic simulation," says Meyer. It is rather like pilots in flight simulators who practise emergency procedures, even though most will never encounter such a situation in real life.

Another application in development is decision support. Simulation software can be used to test possible solutions before they are implemented. It works by taking a snapshot of a real-world situation – say the number of people in an unexpectedly busy airport – and transferring this to the simulation, where possible scenarios can be tested quickly.

For example, additional X-ray machines could be opened or closed, staff could be moved from one operation to another.

"We do not speak about automatic decision making because the system cannot say what will happen, only what could happen," says Meyer. Nevertheless, it could help operators make good real-time decisions.

"Taking inspiration from the microscopic world, artificial immune systems are now developed in my team by Fabien Flacher to provide new adaptive cyber security functions, able to detect complex intrusions in critical information systems as well as to dynamically follow the evolution of these systems," adds Meyer.

Biomimetics is a broad, sweeping discipline – from the smallest component to the largest system, answers can be found in nature. All engineers and technologists need to do is look for them. After all, nature has had four billion years of evolution to solve all sorts of problems.

"This is just Darwinism speeded up," says Meyer.

As the old saying goes, imitation is the sincerest form of flattery – and Mother Nature should feel very flattered indeed.

> "It can be used for observation and surveillance with radar or cameras embarked on the platform, to control borders, industrial sites or pollution"

The sky's not the limit

John Coutts

Not so long ago, many people believed dirigibles were the future of transport. These lighter-than-air aircraft were going to fill the skies, floating passengers long distances in luxurious comfort. The appearance and fast paced commercial evolution of airplanes soon overshadowed the potential of these delicate airships, but that wasn't the end of their story. Today, a new dirigible looks set to make big waves and this time its sights are set a bit higher – 20km higher, to be precise.

The Stratobus is a concept for a new stratospheric, stationary, completely autonomous data capture and transmission platform – described as "midway between a satellite and a UAV" – led by Thales Alenia Space with Zodiac Marine and CEA-Liten.

According to Jean-Philippe Chessel, the project manager at Thales Alenia Space, it is quite a large platform (70-100 metres long and 20-30 metres in diameter) but can be put into the stratosphere in under four hours without the need for a launcher. Instead, it is floated into position and moves via two self-adjusting electric motors.

"Once in position, it uses a number of innovative systems to capture the power it requires – including internal reflectors for sunlight amplification and rotation capabilities, according to the sun's position – and to recharge its regenerative fuel cells, in order to function in darkness," says Chessel. "It has a design life span of more than five years and would be brought back to Earth once a year for maintenance if necessary."

The ship's ability to carry a 200kg payload, could apply to everything from observation and mapping to telecommunications in both civil and defence market: "It can be used for observation and surveillance with radar or cameras embarked on the platform, to control borders, industrial sites or pollution," says Jean-Pierre Prost, the technical manager of Thales Alenia Space. He adds that it can also be used to provide low-cost telecoms in certain territories in a more efficient manner than other efforts because it's stationary. And as it sits lower in the atmosphere than satellites, it can provide an intermediary link between them and other aircraft, as well as capturing higher resolution visuals within a regional overage.

Cloud Broker

Hostile terrain. Heavy vehicles. Long distances. And dozens, perhaps hundreds, of personnel to provision and keep safe. It all adds up to a logistical nightmare. But for the armed forces and civilian aid agencies, tough logistical challenges like these come with the territory.

Successful operations in harsh environments depend on access to high-quality geospatial information. Mission leaders need to know, for example, what the conditions of roads and tracks are likely to be, not only for the next 24 hours but for many days ahead.

Getting answers to questions like these in the field is not easy. Rainfall in one region can quickly translate into downstream floods in another, making river crossings impossible and washing away roads.

Data from geographic information systems, satellite imagery, meteorological and hydrological data must all be integrated to make accurate predictions. But getting hold of that information in the field can be difficult, often impossible, because it requires access to remote data sets. And even if you can, you're unlikely to have the processing power needed to perform complex logistical computations.

Cloud Broker – currently in the demonstration phase – could change all of that.

"The idea is to provide a one-stop shop for highly complex logistical calculations, delivered as a cloud service," says Dr Henry. "We take the requirement from the end-user application and make the results available in the fastest possible way with the least complexity. We have the geospatial knowledge, networks, maps and information products to make this a reality."

Rainfall in one region can quickly translate into downstream floods in another, making river crossings impossible and washing away roads

In Brief

1 Geospatial technology – the marriage of maps, data and communications – is transforming public security.

2 Among other things, this technology is being used to improve the way the military plans its missions.

3 Geospatial information could help the armed forces and civilian organisations (such as those bringing aid) overcome logistical challenges.

What do tweets, tablets and radar signals have in common? They're among the ingredients being used to bring the next generation of electronic maps to life – maps that are helping to tackle some of the world's toughest security challenges.

True north

John Coutts

Quebec's spring thaw heralds the end of winter. It also brings the danger of flooding. Organising an effective public safety response means knowing where and when floods are likely to strike and that involves charting rising river levels over a huge area.

"This used to mean going out with a laptop, a camera and a GPS device, and all the data entry was manual," recalls Martin Rivest, technological innovation lead with Thales in Canada. "Now all that's needed is a tablet and the app we've developed: OnFieldView. This makes it possible to capture data from sensors and share it with a command centre instantly."

OnFieldView underlines the way that geospatial technology – the marriage of maps, data and communications – is transforming public security. Not only in flood management, but also in areas such as smart cities, defence, law enforcement and transport.

"Geospatial technology touches on everything from the sensors on-board satellites to image processing, data production and the geospatial applications used in civilian and military applications," says Dr Jean-Baptiste Henry, head of the Geospatial Centre of Expertise SIX/PRS at Thales.

Reach for the sky

The armed forces used to be among the most sophisticated users of geospatial technology. Mission planning systems – powerful computer systems that allow users to plan, execute and replay assignments – depend on the integration of maps and data.

"Mission planning starts on the ground," says Matthew Tucknott, software specialist (GIS) with air operations systems and services, Land & Air Systems UK at Thales. "If you don't want to be seen, you can plan a route that takes advantage of the cover provided by hills or mountains. You can adjust your route to the mission requirements."

Once planned, mission data is copied to portable storage media (a "data brick") and this is uploaded to the aircraft for display in the cockpit. Careful preparation minimises aircrew workload, cuts energy consumption and, most important of all, reduces risk.

The same technology makes it possible to play back the mission and evaluate the intelligence collected. This is linked to a map base, so suspicious activity is easy to spot.

"With the Sea King, for example, you can replay the route, along with

interesting information that has been gathered," explains Tucknott. Thales in the UK produces mission planning systems to support aircraft such as Sea King Mk7 and Chinook helicopters. It also supports the Typhoon fighter and the Voyager air-to-air refuelling tanker – the RAF's largest aircraft.

Data of interest includes radar plots and the position of friendly forces acquired through Link 16, the tactical data exchange network. The system also collects IFF data – identification, friend or foe – which reveals the presence of other aircraft. Ship tracking data from the AIS (Automatic Identification System) is also captured. These digital traces help to build up a picture known as a "pattern of life".

"Replaying the mission allows you to have a look at what has occurred over time so it's used for pattern recognition," explains Tucknott. "When unexpected things happen, such as a set of radar returns going across a border, they stick out like a sore thumb. That contributes to situational awareness."

The underlying map data is subject to a painstaking evaluation before it can be used. Electronic maps used in aircraft cockpits are produced in-house by Thales.

"Those systems are flight assured," says Tucknott. "The provenance of the software is rigorously assessed."

For the mapping used on ground systems, increased use is being made of commercial off-the-shelf packages. Strict selection criteria apply here as well: all mapping is vetted by a speciality engineering team before it can be used.

Three billion sensors

The ability to visualise exactly what is happening, and where, is the key to building situational awareness. This principle applies not only to military operations, but also to organising civilian emergency services and managing crowds at major events.

But while military systems acquire intelligence via sophisticated sensors such as infrared cameras and radar systems, crowd management is a different matter.

With more than three billion mobile subscribers worldwide, the answer could be to use people to create a sensor network based on data from smartphones and wearable technologies. Applying social media analytics to user-generated content, such as tweets, blogs and Facebook posts, makes it possible to monitor crowd sentiment. It's also possible to work out where people are, even if the data isn't geotagged with a specific GPS location.

"We have tools that allow us to deduct position by parsing text," explains Rivest. "If you map that information, it helps you to understand your tactical situation or operational context."

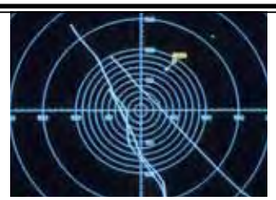
Big data based insights of this sort provide a valuable early warning, allowing public safety agencies to manage security proactively, rather than just reacting once things have escalated. This approach could have important implications for policing large-scale public events.

The way ahead

Where next for geospatial technology? Thales recently offered a glimpse into the future with Battlespace Vista, demonstrated at the 2014 Eurosatory defence and security trade show in Paris. Battles will increasingly be won or lost on the basis of data. In the digital era, information superiority and the ability to share intelligence with the right people will prove decisive.

"We have to fight off the same map," says Henry. "Battlespace Vista provides the same information for everyone, including tactical entities, intelligence, blue force tracking, red force tracking – everything on the same map. It's really bringing the same reference data to all levels of command."

This principle is equally relevant in the civilian arena. "The geospatial awareness of all our users is growing," notes Henry. "We have more and more data to process, and it doesn't matter whether it's for the general public, decision makers or the armed forces: it's really about finding the right strategy to make this data understandable and actionable."



"Geospatial technology touches on everything from the sensors on-board satellites to image processing, data production and the geospatial applications used in civilian and military applications"

Dr Jean-Baptiste Henry, head of the Geospatial Centre of Expertise SIX/PRS at Thales

Smarter collaboration

With geospatial techniques developing rapidly, sharing expertise is essential. To assist in this process, Thales created the Geospatial Core Working Group. The initiative is sponsored by the company's Technical Directorate and the group first met in 2013 at Palaiseau, home of Thales Research and Technology.

One of the points that emerged from the seminar was the idea of rationalising procurement expenditure, particularly for software, which represents a potentially significant cost. Could this be reduced?

"There are lot of commonalities in the technologies and software being used," says Henry. "Different areas of the business have many different contracts with the same software vendor. One idea that came up was to have one Thales speaking to different vendors, to have better access to the technology. It would allow us to offer better prices when it comes to deployment and selling the technology to our clients."

The 2014 meeting in Palaiseau made it clear that greater collaboration across the organisation could also help to reshape the way Thales develops or uses geospatial capabilities within complex systems to share information and experiences.

In the military arena, for example, exploiting the commonalities between solutions provided for different national defence markets could yield significant benefits.

"Every system is different but various capacities could be applied beneficially across our network of geospatial specialists," says Henry.

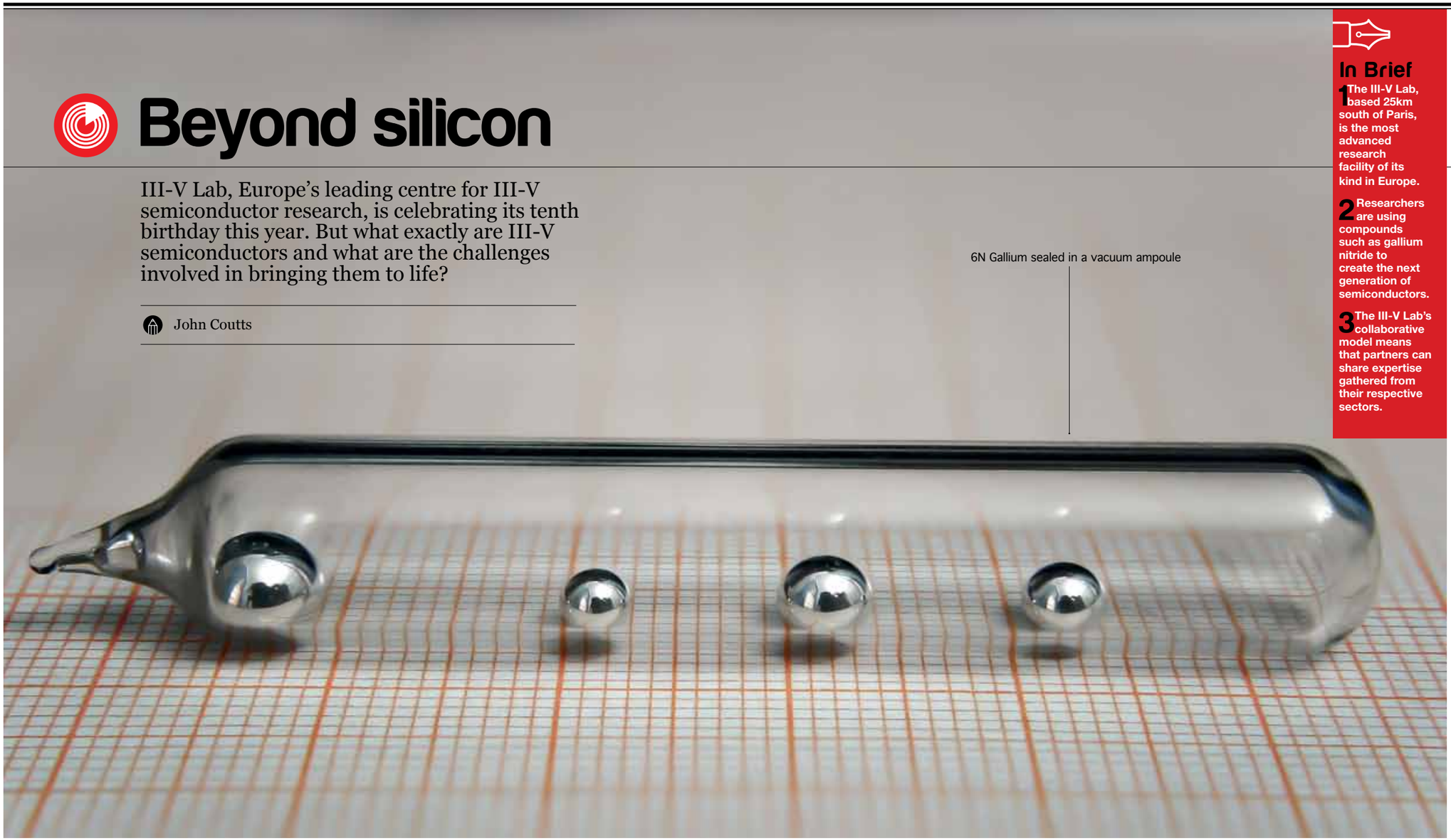
"Greater involvement in open source projects and standards implementation look to be on the cards in the future.

"We have very different requirements from very different clients," he emphasises. "Bringing in new capabilities that end users may not have thought about would be a good way to answer all these different requirements and beyond. And we should not reinvent the wheel each time by taking better advantage of our experiences across the whole company."

Beyond silicon

III-V Lab, Europe's leading centre for III-V semiconductor research, is celebrating its tenth birthday this year. But what exactly are III-V semiconductors and what are the challenges involved in bringing them to life?

John Coutts



6N Gallium sealed in a vacuum ampoule

In Brief

1 The III-V Lab, based 25km south of Paris, is the most advanced research facility of its kind in Europe.

2 Researchers are using compounds such as gallium nitride to create the next generation of semiconductors.

3 The III-V Lab's collaborative model means that partners can share expertise gathered from their respective sectors.

Imagine something the thickness of a human hair. Now try to imagine something 10,000 times thinner. For scientists at III-V Lab, manipulating materials at this scale is all in a day's work. What's more remarkable are the materials they're working with: instead of silicon, an electronics industry staple for more than 40 years, researchers are using compounds such as gallium nitride to create the next generation of semiconductors – chips with extraordinary properties.

Welcome to III-V Lab, the most advanced research facility of its kind in Europe. The lab has staff of some 120 people, the majority of them scientists, technicians and PhD candidates, and it currently operates from two sites – Palaiseau and Marcoussis – about 25km south of Paris. III-V Lab also has full access to the CEA Leti platform in Grenoble, where another 25 scientists and engineers are contributing to the lab's research programmes.

The work being carried out at III-V Lab is at the cutting edge of semiconductor technology and the lab's name provides a clue: "III-V" refers to groups III and V of Mendeleev's periodic table. These groups contain elements, such as gallium, indium and arsenic, which have unique properties, especially when combined. The role of III-V Lab is to create components that exploit those properties.

"To have a good semiconductor, you either use elements in column IV of the periodic table, such as silicon and germanium, or you make compounds using elements in columns III and V," explains François Luc, president of III-V Lab. "Compounds such as gallium arsenide, gallium nitride and indium phosphide have properties that silicon doesn't have."

Smarter semiconductors

Most people associate semiconductors with silicon chips found in computers and other electronic devices – components capable of high-speed number crunching. But the semiconductors III-V Lab is working on are not made from silicon and they do more than simply perform calculations.

Gallium arsenide and gallium nitride semiconductors are capable of generating infrared and laser light, emitting radio energy and detecting light and radio waves.

Semiconductors with these properties play an increasingly vital role in defence, aerospace and telecommunications.

"III-V components are critical for some of our systems," says Bertrand Demotes-Mainard, vice president of hardware technologies at Thales. "Applications include radar, thermal imaging and communications. It's important that we have an independent source of supply."

The radar used by France's Rafale omni-role combat aircraft is a case in point. Gallium arsenide (GaAs) is at the heart of the aircraft's AESA (active electronically scanned array) radar system.

The solid-state GaAs components used in the system – which both transmit and receive the radio signals needed to pinpoint distant objects – were developed in house and manufactured by United Monolithic Semiconductors (UMS), a Thales joint venture. Rafale's radar system is powerful, compact and uses a minimum amount of energy.

Semiconductors containing GaAs, developed by III-V Lab, are also a vital ingredient in thermal imaging cameras. These cameras not only allow users to see in the dark, but – thanks to infrared technology – provide visibility through smoke and fog. GaAs components are used both to generate infrared light and to detect it, something that is achieved using quantum well infrared photodetectors (QWIPs).

Innovation seldom stands still for long, though, and the lab is spearheading the development of gallium nitride (GaN) semiconductor technology. This offers performance improvements over GaAs and holds the key to the next generation of high-bandwidth communications tech.

120

III-V Lab, the most advanced research facility of its kind in Europe, has staff of some 120 people, the majority of them scientists, technicians and PhD candidates, and it currently operates from two sites – Palaiseau and Marcoussis

“To have a good semiconductor, you either use elements in column IV of the periodic table, such as silicon and germanium, or you make compounds using elements in columns III and V”

“Power saving and higher frequencies are a big driver and gallium nitride is the new frontier,” says Luc. “We expect almost an order of magnitude increase compared to gallium arsenide – you need to reduce size, weight and power.”

Making it happen

It takes significant expertise and state-of-the-art equipment to stay ahead of the game. The facilities at III-V Lab are comprehensive and include more than 2,000 square metres of clean rooms filled with some of the most advanced semiconductor manufacturing technology available.

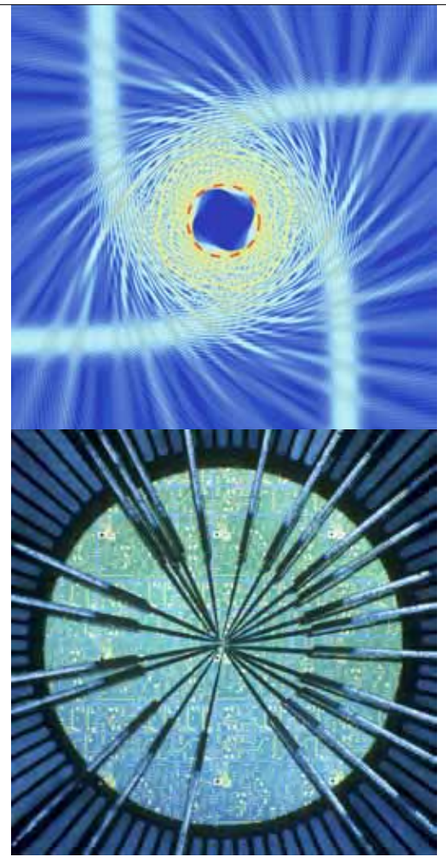
“We start from the basic material, so we are able to grow III-V compounds atomic layer by atomic layer,” says Luc. “To achieve this, we have ten epitaxial reactors, each representing an initial investment of up to €2 million.”

Sophisticated lithographic processes are used to trace the intricate patterns that provide the all-important connections on each component.

“We have an electron beam lithography machine,” says Luc. “Accuracy is in the range of 10 nanometres – that’s about 20 to 30 atoms. This is very significant infrastructure.”

Creating components is a slow and delicate process. The most sensitive machinery is seismically isolated on a concrete block because even the slightest vibration could unravel weeks of work. Airflows and staff access are also strictly controlled – “Nobody gets into the room when we’re carrying out electron beam lithographic processes,” stresses Luc.

The ability to design and build components on site is a differentiator. This is important for two reasons. One is that it makes it possible to carry out experimental work and to build advanced prototypes in-house. This can help to consolidate a competitive advantage.



“Alcatel demonstrated a communication capability of one terabit per second over 3,500km on a single fibre – this was achieved with our components,” says Luc. “Such a demonstration highlights the technical advances we are making. It can shape the standards as well as influence the market.”

Another advantage with having an in-house chip-making capability is being able to carry out small-scale manufacturing, producing dozens or hundreds of components, rather than the thousands normally handled by large chip makers.

“We produce wafers that we sell to Sofradir for use in infrared cameras, something in the range of one hundred per year,” says Luc. “Most foundries would not take such an order because the quantities are not big enough. This is part of our business and it underlines the way we are integrated as part of the strategic supply chain of Thales group.”

Bridging the technology gap

The ability to nurture good ideas and turn them into working products is vital. At III-V Lab, the focus is on bringing new technologies to a level of maturity at which they can be transferred to partners for industrialisation and production.

“Our work programmes always aim for a final application,” says Luc. “The devices we are developing are new system cores that will take our parent companies one step further than ‘off- the- shelf’ electrical or electro-optical components.” The lab is also active in creating and protecting intellectual property for commercial exploitation through licensing and royalties.

Turning a good idea into a successful commercial product can be a long and complex process. One way ideas and projects are assessed is in terms of their technology readiness level (TRL) – a series of developmental milestones that show how near a technology is to being market-ready.

A new and unproved technology, for example, would be categorised as TRL 1. This might be an observation made in a university lab, such as a previously unnoticed but promising phenomenon. At the other end of the scale, TRL 9 represents a finished product based on that original idea.

“TRL3 is usually where we start working with the universities,” says Luc. “It’s the point at which the science is well understood and you can start targeting a given application. We wouldn’t normally engage before that stage.”

Once an idea has been selected for development, the job of creating a real-world solution gets underway: “We work together with our businesses and agree how we should develop the technology and start testing it against targeted applications,” says Luc. “When we reach a point where it can be used by the businesses of our parent companies, we hand over to them. Generally, this would be between TRL 5 and 6.”

The radar used by France’s Rafale omni-role combat aircraft is a case in point. Gallium arsenide (GaAs) is at the heart of the aircraft’s AESA (active electronically scanned array) radar system

Picking winners is no easy task, though. “Basic academic research is not very expensive, so at the early stages you do not have a big funding problem,” explains Luc. “And at the other end of the scale, you have a viable technology that makes money. The risk lies between these points: nobody can be sure that a new technology will work 100 per cent of the time, so you are taking a bet – and you also start to incur significant costs.”

One of the riskiest points is the handover from applied research to technological development, known in the industry as the “valley of death”. While it is inevitable that some ideas will fall by the wayside, the stewardship provided by III-V Lab ensures that the best ideas don’t perish through lack of funding. But sponsorship of this sort requires dedication and deep pockets.

“That’s one of the reasons this is not a 100 per cent Thales venture,” stresses Luc. The lab is a collaborative endeavour. The founding partners, Thales and Alcatel-Lucent, each fund 40 per cent. CEA-Leti, a French government agency active in energy and electronics, joined the lab in 2011.

“Our research requires very significant investments, both in terms of equipment and in terms of scale. It’s a matter of critical mass – none of the partners could afford to maintain a team like this on their own,” says Luc.

Gaining insight

As well as helping to spread the cost of developing new technologies, the lab’s collaborative model helps the partners to share expertise gathered from their respective sectors.

“Silicon and III-V materials will be combined in the near future,” says Demotes-Mainard. “One of the reasons we were interested in having CEA-Leti join the lab is that it offers access to silicon technology.”

Collaboration also promotes the cross-fertilisation of ideas between markets. That’s important, because the boundary between professional and consumer technologies is becoming increasingly fuzzy.

“When we created the lab ten years ago, the key markets for III-V were telecoms, aerospace and defence, which was fine for Thales and Alcatel-Lucent,” says Demotes-Mainard. “Now, many other markets are interested in III-V, such as automotive and power electronics. CEA-Leti is a way for us to have a window on these markets.”

Integrated circuits that use light to communicate, rather than electricity, could be the next leap forward. For more than half a century, microprocessor chips have conformed to Moore’s law – the observation that performance doubles every 18-24 months. But there’s evidence that this growth is reaching saturation point as the limits of miniaturisation are reached.

Instead of trying to do “more Moore”, there’s increasing interest within the industry of doing “more than Moore”. That means creating a new generation of components that combine both digital and analogue processing.

“There’s a vision for communications convergence and that means implementing new functions on silicon,” says Luc. “III-V materials can enable optical communications from core-to-core, from processor-to-processor, board-to-board, from computer-to-computer and data centre-to-data centre. III-V on silicon is an interesting way of doing that.”

International cooperation: the ESSOR project

In 2009, six European nations – Finland, France, Italy, Poland, Spain and Sweden – launched the European Secure Software defined Radio (ESSOR) project, which aims to establish a baseline standard for development and production of military SDR in Europe.

An ESSOR reference architecture has been defined by the European partners, compatible with the US SCA standard, and a coalition high-data-rate waveform developed. Through ESSOR, the Thales CONTACT programme will draw on a foundation of communication architecture standards: SDR waveforms developed within this framework will meet new requirements as armed forces make the transition to the digitised battlespace and increase their reliance on C4I, video transmissions and other value-added services.

A century of communications

From telegraph and Morse code to tactical internet, military communications technology has changed radically over the past century. And now digital communications, in the form of software defined radio, is shaking things up yet again.

Chris Insall

Modern military engagement – where international, highly mobile forces often operate under joint or allied command – demands a "Common Operational Picture", so that decisions can be made based on all available information and then transmitted as quickly as possible.

This complex "big picture" view of diverse forces working closely together depends on a state-of-the-art, coordinated, connected, sturdy and secure communications platform, one that meets these new cooperative operational requirements.

"We're not designing solely for voice communication anymore," says Gilbert Multedo, vice president, CTO and design authority responsible for radio communications products at Thales. "We're designing for multimedia voice, data and video communications. We're creating radios that support the networking of platforms – from combat management systems to intelligence and command systems."

Software defined radio (SDR) has played a major part in this evolution. SDR introduces standard software architecture supported by modern digital hardware with strong computation power, as well as a wide frequency band RF architecture including very linear power amplifier and cositing filters. This allows for the integration of several SDRs in one vehicle. As a consequence, an advanced SDR system will support a vast range of radio waveforms enabling a dazzling array of powerful applications to explore the complete radio spectrum.

For the armed forces, there is nothing new about SDR – alongside the consumer digital radio revolution, it was identified over a decade ago as technology that offered lightweight, powerful and versatile communications, packaged within an enhanced security environment that only a digital radio system could offer. The difference today is that SDR is being used as the basis for new, more interconnected communications systems by the armed forces around the world. In France, this is best exemplified by the CONTACT (Communications Numeriques Tactiques et de Theatre) programme. Launched in 2012 by the Direction Générale de l'Armement (DGA) – responsible for defence procurement in France – CONTACT will replace many of the armed forces' existing tactical radio systems (both personal and in vehicles) with new SDR-based technology. Thales is acting as system architect and integrator for the programme.

In Brief

1 **In order for the armed forces to be effective and efficient, it is essential they have the best possible communications equipment.**

2 **Thales has been developing military radio communications for a century.**

3 **Software defined radio is breaking new ground, offering lightweight, powerful, secure and versatile communications for soldiers in the field.**

The Thales connection

CONTACT takes full advantage of SDR's potential, while remaining compatible with Thales's PR4G radios (currently used in France and widely deployed in 43 other countries), thereby ensuring a smooth transition. The new system offers greater bandwidth, security, stability and interoperability to armed forces operating in the field.

To achieve this, significant technological challenges had to be overcome, the first of which was miniaturisation – in the field, smaller is better.

"Thales has a long tradition of radio miniaturisation, with the capability to develop modules, not only for digital communications and security, but also for radio frequency," says Multedo.

The second challenge was to allow for and include access to multimedia services: CONTACT was designed to integrate a wider range of richer operational media such as digital voice conference and Voice-over-IP (VoIP), hierarchical and geographical Blue Force Tracking, short messages, image and video transmission, plus web-based applications.

The third major change is integrating lines of communication: the new system provides greater connectivity between headquarters and active units, right down to the individual soldier,

"The US has turned in the direction of SDR and it's coming to Europe, via the NATO countries. We're also talking about SDR with countries outside of Europe and the US"

as well as improving links between these units: "With SDR, you are able to create not only hierarchical but also transverse communications," says Didier Portier, military advisor to Thales and former officer in the French forces. "Even if you are not in the same physical network, you can share a picture or your location with everyone, thanks to the transverse communication capacity of SDR."

And for Multedo, full integration is key: "With SDR, you will achieve an integrated tactical communications infrastructure. For example, we're designing new SDRs that are dual-channel and can network different waveforms: VHF, UHF and, in the future, satellite communications."

Finally, CONTACT represents a move towards greater compatibility from application and IP level up to radio level, increasing connectivity for joint operations. As Hervé Derrey, vice president of radio communications products with Thales, points out, SDR technology offers interoperability between land and joint forces, which is unprecedented in military history. With ESSOR (see box) and CONTACT, Thales is turning this dream into a reality.

Working in the field

This increased capacity for interconnected communications is opening doors for the technology with military forces around the world.

"The US has turned in the direction of SDR and it's coming to Europe, via the NATO countries," says Derrey. "We're also talking about SDR with countries outside of Europe and the US, such as India and several countries in the Middle East. This technology is becoming the norm."

What's driving this trend towards stronger connections and communications? In most cases, it's down to customer demand. There are growing numbers of users that need to communicate very fast across multiple channels. The difference today is that this demand is being met by involving users in virtually every stage of the development process.

According to Philippe Lardilleux, strategy and marketing director, a specialised Thales toolset allows for ideas and concepts to be developed with greater ease: "We try to improve the way we discuss and serve our customers with tools like Software Lab, Radio Lab, Communications Lab. Customers approach us with their operational requirements and we can then convert them into a system architecture and migration path solutions."

"Most of the products have been designed in close cooperation with our customers," adds Derrey. "We expose them to our products at different stages of development to produce solutions that are fit-for-purpose."

The secure radio revolution

Part of that purpose is greater security in an increasingly insecure digital environment, as systems become networked they can potentially become more vulnerable. Survey results published by Unisys and Ponemon Institute in the United States in July 2014 revealed that "nearly 70 per cent of critical infrastructure managers surveyed reported at least one security breach that led to the loss of confidential information or disruption of operations in the past 12 months".

"In addition, 78 per cent said a successful attack on their organisation's [industrial control systems] or [supervisory control and data acquisition] systems is at least somewhat likely within the next 24 months," the survey continued. "Yet only one in six respondents described their organisation's IT security programme or activities as 'mature'."

Defence applications use the same hardware and software technologies as the civilian world and are increasingly connected to it. Without careful attention, a cyber-attack on civilian infrastructure could also target military forces.

The security challenges posed by the new cooperative tactical communications requirements are considerable: while the scope of communications is significantly increased by the number of transverse links available to users, the tools applied in this arena will be typical digital communications and VoIP, which can be highly vulnerable.

"Thales has a long tradition of radio miniaturisation, with the capability to develop modules, not only for digital communications and security, but also for radio frequency"

"It's said that cyberspace is 'the fifth domain of warfare'," points out Pierre Jeanne, vice president of security at Thales. "Digital communications is a major leap forward for security. All available state-of-the-art countermeasures have been applied in the new generation CONTACT system to protect it against cyber-attacks."

The level of crypto security has advanced considerably in recent Thales systems. But can military radio communications ever be "too secure" – to the point where it limits, rather than enhances, the technology?

Not according to Jeanne: "Foreign agencies are spending more time and money intercepting communications and maintaining the superiority of their defence. It's the job of our engineers and technicians to anticipate risk and to stay a step ahead of future developments. In our opinion, security can never be too strong."

For Lardilleux, this comes down to the most basic principles: "Communication is sovereignty," he says. "If you have sound communications, you will keep sovereignty."

Thales: a history of innovation

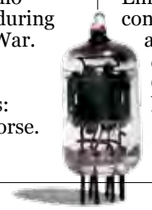
After a century of experience and more than 800,000 military radio sets in the field, Thales continues to drive innovation in defence communications around the world. This includes radio solutions delivered in more than 50 countries, across the broadest range of platforms, including armoured vehicles, dismounted infantry, helicopters, aircraft and navies.

"There have been major milestones – from digital to frequency-hopping and now SDR," says Derrey. "Thales remains at the forefront of innovation."

As Derrey explains, Thales's particular success in the field over the years, up to and including CONTACT, is attributable to fundamental customer values: "Our long history is well recognised and our customers never question this, as they have a high quality radio delivering high performance – they know they will get results from Thales. They return to us because of the excellence of our engineers and the performance of their radio technologies."

Radio communications: a timeline

1914-1918
The origins of military radio
Extensive radio deployment during First World War. Spark transmitters or generators: telegraph, morse.



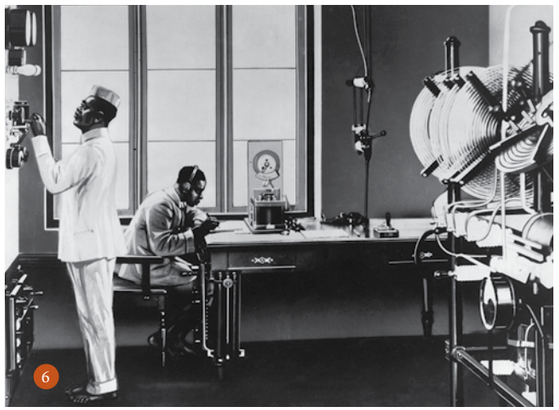
1918-1945
Development of Secure Voice
Emitters and triode tubes: continuous wave, stability and increased reliability of communications. Complete catalogue of long-wave transmitters (15-35 kHz).

1945-1965
The development of portability
Transistors: miniaturisation and reduced equipment weight.

1965-1985
Faster radio resource implementation
Fixed frequency synthesizer: faster implementation.

1985-to-present
Enhanced communications security
Escape frequencies, spread spectrum, location, command and control data. Frequency hopping PR4G radio, secure transmission. SDR with wideband capabilities.

Thales and the First World War



The second part of our trip down memory lane provides an opportunity, as we mark the **100th anniversary of the start of First World War**, to remember the pioneers and talented engineers who by force of circumstance, played a key role in the development of new technologies and helped to build the Thales Group.

The Model B, the world's first metal cine-camera capable of withstanding the harsh conditions on board the aircraft of the Royal Flying Corps. (Source: Imperial War Museum)

1 The Badin airspeed indicator

In 1911, Raoul Edouard Badin invented an airspeed indicator, which soon became known simply as the "Badin". The device represented a considerable step forward in terms of flight safety by allowing pilots to fly in a controlled manner in zero visibility conditions. The Badin airspeed indicator became mandatory on board civil aircraft from 1923. The firm he set up also developed other equipment, including the variometer, and was taken over by Crouzet, then became part of Sextant Avionique, and the Thales Group, from 1989.

2 Vinten and the on-board cine-camera

Vinten, the company founded by William Vinten in London in 1910, started out manufacturing Kinemacolor projectors. Early in the First World War, the company's operations were taken over by the government and Vinten moved to the Sopwith aircraft factory at Kingston upon Thames. Vinten continued his research into cine-cameras and developed the Model B, the world's first metal cine-camera capable of withstanding the harsh conditions on board the aircraft of the Royal Flying Corps.

3 Brandt: from ornamental ironwork to mortars

Edgar William Brandt, born in Paris in 1880 and originally an ornamental ironworker, introduced a 60mm trench mortar in 1915, known as the "pneumatic mortar". Three thousand examples of the model "B" of this weapon were produced from 1916, together with three million shells. At the end of the war, Brandt made the bronze slab for the Tomb of the Unknown Soldier under the Arc de Triomphe in Paris, as well as the Armistice monument at Rethondes.

4 CGR transmitters

Jules Carpentier, whose factory produced large numbers of periscopes for use by the navy and infantry (see *Innovations* 2), was also one of the founders of the firm CGR (Compagnie Générale Radiotélégraphique), which specialised in military radio communications equipment. In August 1914, at short notice, the company supplied an 80kW rotary spark gap transmitter (combined with an antenna 1,000 metres in length!) which was installed at Bordeaux. During the war, CGR joined with Delahaye to produce communications vehicles for the army. CGR also manufactured devices designed in the laboratories of the radio pioneer General Ferrié. These included a receiver for listening to enemy communications, and a Type G resonance box used in direction finding. At the end of the war, CGR changed its name to CSF (Compagnie Générale de Télégraphie sans Fil).

5 Thomson and field telephones

Once the war was under way, the use of field telephones became an increasingly pressing need. Thomson's factory in Rue des Favorites in Paris received an order for several thousand portable field telephones for allied infantry and artillery units. At the same time, the French Ministry of War commissioned the firm to install switchboards in its offices around the country.

> The use of field telephones became an increasingly pressing need. Thomson's factory... in Paris received an order for several thousand portable field telephones

6 Germany: Telefunken

The German companies that would later contribute to building the Thales Group were also making significant advances in the field of telecommunications, building an impressive radio station at Kamina (now in the Democratic Republic of Congo) and developing powerful onboard radio sets for submarines. Many years later, in 1996, these activities and the electron tubes business operating under the AEG-Telefunken brand became part of the Group, making Thales the world's leading manufacturer of travelling wave tubes (TWTs) for space applications.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