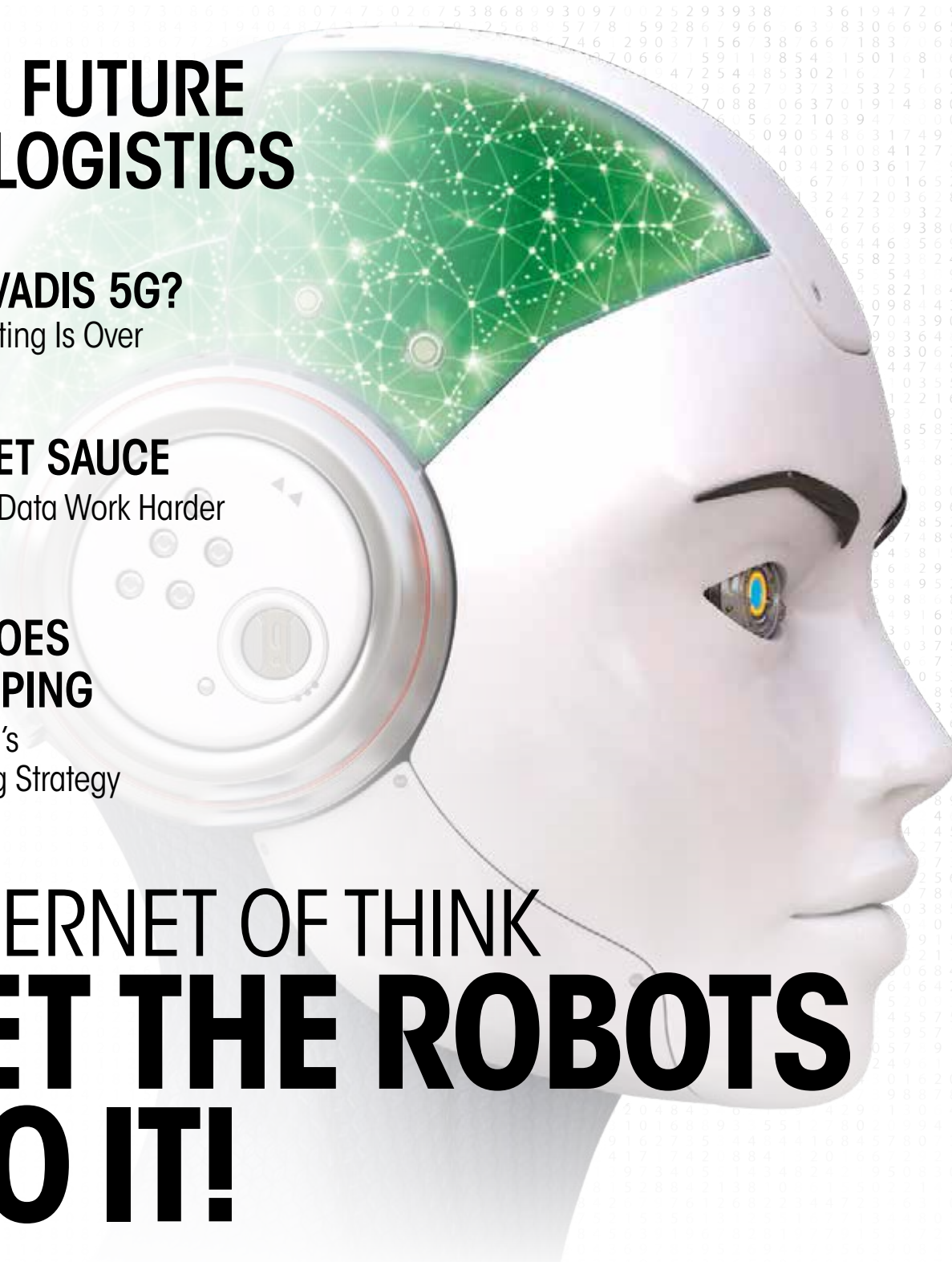# SMART
INDUSTRY

The IoT Business Magazine

THE FUTURE OF LOGISTICS

QUO VADIS 5G?
The Waiting Is Over

SECRET SAUCE
Making Data Work Harder

IOT GOES SHOPPING
Amazon's
Amazing Strategy

INTERNET OF THINK
LET THE ROBOTS DO IT!

WILD WILD WEB

Tim Cole
is the editor of Smart Industry – the IoT Business Magazine. His latest book, *Wild Wild West – What the History of the American Wild West Teaches Us About the Future of the Digital Society*, has just been published in German by Vahlen/Beck.

When we think about the short, exciting history of the Internet, it helps first to think back to the events that shaped what we like to call the American Wild West. Then and now, a new world was formed and, in the beginning, the only law was that of strength and willpower – that is, if there were any laws at all. Over time, the land was settled, cultivated, and, finally, civilized.

Will we one day look back on the early decades of the Internet in a similar way? And what will the future bring?

After all, we know what came after the Wild West: First, the farmers ploughed the land and fenced it (in 1867, Lucien B Smith from Ohio received a patent for his invention of barbed wire, arguably more important for winning the West than the six-shooter). Then came the traders, the shop owners, the saloons, the sheriffs, the judges, the surveyors, the registrars, the railroads, the highways. Eventually, the wild land and people were calmed, and with that came prosperity, progress, and diversity.

In the Age of the Internet, all of that still lies ahead of us. We are at a point today like the settlers on the banks of the Big Muddy River waiting to cross over into the promised land. That means all the hard work of turning the wilderness into a lush garden still lies ahead of us. First, we will need to clean up, create order out of chaos, pass laws and make sure they are enforced, prune the excesses, lock up the bad guys, put the robber barons on a leash, and make the land fruitful and life worth living.

All this won't be easy and, in fact, the prospects aren't that good. The other side appears too powerful: the Googles, Apples, Facebooks, and Amazons. The rules and regulations set up to protect citizens and consumers appear too puny or simply don't exist. No matter what politicians will tell you, the Internet is still largely a legal vacuum. Günther Oettinger, at the time Europe's digital commissar, was right when he told me in an interview for this magazine (see SI 2016) that we need a European Civil Code that, for instance, says clearly who really owns our data.

Oettinger is worried about the future of business if, for example, nobody knows who the CAD files belong to that a manufacturer sends online to enable a customer to 3D-print a needed spare part so production can start again faster than waiting for the part to arrive by truck. And who owns the data my car increasingly produces and sends to the car manufacturer every time I visit the garage? Car makers will tell you it's them because you signed over the rights to your data when you accepted the terms and conditions – but did anyone tell you?

All of this reminds me of the "Gilded Age," a term Mark Twain coined to describe the era of the US robber barons – Rockefeller, Carnegie, Morgan, and Vanderbilt, just to name a few. This was in the years between the 19th and 20th centuries, when the West had been won and gigantic corporate empires were built: powerful monopolies that exploited millions of people unchecked.

Eventually, resistance mounted; workers went on strike and burned factories down. The National Guard was called in to quell the riots at the behest of the robber barons and their friends, the most powerful politicians of their age.

Will we see similar resistance and unrest aimed at the overwhelming power of the tech giants? Will people take to the streets to demand their rights? Actually, this is already happening as we speak.

Our SI columnist and futurist Gerd Leonhard has called for a kind of digital machine tax, the proceeds of which should go to those who are forced out of their jobs by robots and artificial intelligence. I would go further. Why not divert part of the obscene profits raked up by companies like Apple, which recently became the first company in history to be valued at a staggering one trillion dollars, into a worldwide relief fund to provide direct assistance to those suffering from the consequences of digitization and automation? A relief fund would at least lessen the worst effects of advances in technology, and Google and the others should pay for it! After all, they are the biggest beneficiaries; in fact, the only beneficiaries, at least for now.

Personally, I don't want to live in the Wild West and, if you're honest, gentle reader, you don't want to either. After all, we can always watch it on TV.

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As an automation platform, robotic process automation (RPA) has the ability to help manage all of the capabilities that Internet of Things now makes possible. The management of notifications, flagged events and more, as well as routing more data, are among the capabilities it could provide links or repositories for.

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Behind the Scenes
SMART PEOPLE

All over the world, brilliant individuals are hard at work creating the technologies and solutions that will one day **make the Internet of Things come alive.** We visited a few of them and listened to their fascinating stories.

Hanno Schoklitsch of Kaiserwetter
A Bottom Line Look at Climate Control

Hanno Schoklitsch is a man on a mission. "Bringing together supply and demand is one of the biggest challenges in the energy industry," says the CEO and founder of Kaiserwetter Energy Asset Management, a young company on a sharp upward trajectory. Kaiserwetter has expanded from its roots in Hamburg, Germany, to include branch offices in Madrid, New York, and recently in China. It employs more than 300 specialists – climate experts, engineers, analysts, and programmers. The startup has set its goals on using real-time, IoT-based data, energy investment portfolio managers that can maximize profits and minimize risk.

"Climate control and reducing," the greenhouse effect are very noble goals in themselves," Schoklitsch says, but his sights are set on something else: the bottom line. "Climate control should be about investment, and

> ## Climate control should be about investment, and investors are mainly looking for security
>
> **Hanno Schocklitsch**

investors are looking for security," he believes. He aims to give them all the information they need to make informed investment decisions and be sure their energy plants – everything from classical fossil-fuel and nuclear power plants to wind turbines, solar farms, hydroelectric power stations, and biogas production – are squeezing as much profit as possible out of the money invested in them. That will allow operators to increase efficiency and thus reduce their environmental footprints.

Simply bemoaning the rise in CO_2 levels and hugging trees, he believes, won't help us meet the objectives of the Paris Climate Agreement, especially since the current US administration has taken the United States out of the picture as far as battling global warming is concerned. Luckily, he says, individual states are still in the game, especially California, itself the seventh-largest nation economy in the world.

The first thing energy executives need, says Schocklitsich, is data. With that in mind, he has turned his small company into a data aggregator. "We're providing the ability to aggregate and correlate data from all over the world, things like technical, meteorological, and financial data, and benchmark which equipment is working properly or not to make risk assessments on a local, regional, or international basis so investors can make performance-based decisions," he told Forbes, a business magazine.

Many companies around the world rely on enterprise resource planning, or ERP systems, for insights into the workings of their companies. Schocklitsch teamed up early with Germany's most valuable company, SAP, becoming a premium partner and basing its core product, named "Aristoteles," on the SAP Cloud Platform, using SAP Leonardo IoT, analytics, and machine learning capabilities. Using smart data analytics to unlock private capital investments in renewable energies, Aristoteles won the worldwide SAP Innovation Award for 2018 at the company's annual bash, SAPPHIRE, in Orlando, Florida. Schocklitsch was born in a tiny town high up in the Austrian Alps and studied engineering in Graz. He spent a few years in real estate before founding Kaiserwetter Energy Asset Management in 2012. His plans at Kaiserwetter call for adding capabilities like predictive data simulation analytics, energy storage optimization, blockchain, AI, and demand-side power generation into Aristoteles'

already impressive list. All this comes with one overarching objective in mind: "By increasing investments in renewable energies, we can improve the lives of millions of people worldwide," Schoklitsch maintains.

Andreas Jamm of Boldly Go Industries
Going Where None Have Gone Before

At the age of 8, Andreas Jamm was experimenting with electronics and writing his first IT program as a way of earning his first pocket money. Even as a child, he was an inventor with an entrepreneurial spirit. The young inventor went on to become a bold entrepreneur, who today consults renowned industrial players on their future platform business models and innovative smart services offerings. To get to this point, however, Jamm and his company had to reinvent themselves. Over more than ten years, Jamm successfully led a traditional SAP consultancy specialized in porta-, intra-, and extranet solutions. However, he anticipated early on that the digital future also required a different approach: the understanding of new interdependent technologies in complex application scenarios to solve the new emerging customer challenges that the digital era brought about.

Jamm notes that "we are observing that the market is demanding, especially in the context of IoT and industry 4.0, a new type of consultancy with new inspiration, impulses, and methodical approaches to guide customers collaboratively to new, data-based digital business models and smart solutions." He adds that "this realization was also the early motivation for us to initiate our own transformation as a modern and innovative consultancy. In retrospect, this early, first-mover step was a very important one for us!"

"The journey into the unknown wasn't always easy, even uncomfortable at times, but this is exactly where you learn the most. And it is from this, our very own transformation experience, that we can share and consult

> ## The market demands a new type of consulting, new inspiration and new impulses in the context of IoT
>
> **Andreas Jamm**

companies in the same process with realistic integrity and not just a new marketing tab on a web page! We felt the struggle and the challenge but we also seized the opportunity as we see our bold customers are ready to do," Jamm recalls.

Jamm made his company's transformation his very own priority. He transformed the skill and solution portfolio, built up a new team, experimented with unconventional new organizational forms and changed his success paradigm for a consultancy in a new digital area – moving from plan–build–run to innovate–design–transform. Everything was viewed upside down, to gain insight and take ideas and people out of their habitual comfort zones. This included the brand, a central communication tool for the future mission of the unconventional consultancy. Nothing seemed to fit better than an allusion to the classic but timeless intro of the beloved sci-fi story Star Trek with its slogan, "Boldly go where no man has gone before." The commitment by Captain Kirk and his crew is embraced no less by Jamm and his excited team. Thus, the brand Boldly Go Industries was born. "Boldly Go Industries expresses our mission to explore new bold steps towards the digital future together with our customers," explains Jamm. To be able to face this complex new world, Jamm built up an interdisciplinary team of experts in the areas of strategy, design, technology, and data science.

Jamm believes in his vision that "through this breadth of expertise, we can cover the entire digitization value chain from the methodical generation of innovative ideas and a user-centered digital design up to the technological full-stack implementation, such as, for example, a smart automated service, all in one."

A highly successful and popular example, proving the validity of BGO's self-reinvention, is the customer Endress+Hauser Flowtech AG, a producer of industrial measuring devices. Boldly Go developed a platform-based app for a smart diagnostics and predictive maintenance scenario. Especially in the field of process industry, the overall plant efficiency and availability becomes an increasingly critical economic success factor, Jamm says.

As it is common in large plants to have a wide variety and large number of manufacturer equipment installed, each and every one of these process components needs to fulfill maximum reliability and application intelligence requirements. This will allow, through various features, the monitoring of the actual real-time health of things, and, at some point, processes, as well as autonomously carrying through the required service transactions at a minimum risk point in time. The solution not only allows, on the basis of a digital twin, a transparent view on the current real-time asset health data but enhances this information with intelligent microservices to generate new insights. This Boldly Go project with Flowtech, generally viewed as an IoT lighthouse initiative, was presented among others to chancellor Angela Merkel at the Digital Summit 2017. But Jamm and his crew didn't stop there – they have now anticipated the next level and implemented their vision in a first real tech machine-to-service use case. "Technological feasibility, as of today, allows us to imagine and test entirely new approaches on value creation networks and partnerships in digitized and IoT-enabled industrial ecosystems," Jamm explains. Currently, he and his crew are beta-testing smart

contracts and real-time service payments based on blockchain technology along an automated, end-to-end process from incident diagnostic to automatic maintenance.

Boldly Go Industries' transformation doesn't stop at its own business model. Jamm continues to develop his consultancy toward a digital product-based future for tomorrow's industrial challenges.

In collaboration with other excited stakeholders within the process industry, Jamm is working on building an IoT-based platform solution (PaaS) for connected data-based added services within dedicated use cases. A strong network of industrial partners and customers is already on board to join the pioneer and explore new IoT galaxies together. On that note: boldly go where no man has gone before …

Brian Bosire and Victor Shikoli
A New Way to Bring Water to Africa

Two thirds of the world's population will be living in water-stressed conditions by 2025 according to the UN, most of them in Sub-Saharan Africa. Over 300 million out of the 1.2 billion Africans still lack clean and reliable water sources.

Brian Bosire and Victor Shikoli were both born and raised in western Kenya and moved to the city of Nairobi more than eight years ago. Life in Kenya is different in many ways from Europe or America, where running water hardly ever receives a second thought. Where Bosire and Shikoli

grew up, people receive a water bill regularly, once a month; however, their taps usually remain dry about two or three days a week.

Bosire, an engineer, and Shikoli, a student at Mt. Kenya University, decided to do something about the problem. In 2015, they founded a technology company they named Hydrologistics Africa, whose goal is to connect utilities companies and consumers via an online platform that would increase efficiency in water use.

Together, they developed a device they called HydroIQ that uses GPD and the Internet to automatically monitor water use, water quality, and water leakages. Plugged into existing water supply systems, in homes or businesses and along a water distribution network, HydroIQ uses sensors and sends data in real time to an online platform, thereby turning traditional water systems into smart water grids. The results are improved water efficiencies, sanitation, and hygiene; the device replaces manual water-reading technologies.

The online platform allows registered users to monitor and receive water bills and make payments via mobile money, eliminating the need for the costly and erroneous physical meter reading in the traditional model. This creates a completely new business model; one that allows the water industry to digitize its processes, reduce upfront investments, and lower the cost and time of adoption, thus enabling it to deliver the higher value to its consumers.

The device ensures aggregation of real-time data on water consumption and distribution, which through data analytics provides insights for informed decision-making. "Our ambition is to become the world's first virtual water network operator," says Bosire.

In recognition of their achievements, Bosire and Shikoli were recently awarded the "Africa Startup of the Year 2018" award by Bonjour Idée, which is supported by 70 major business groups, incubators, Chambers of Commerce, media, competitiveness clusters, and influential blogs.

> **"** Our ambition is to become the first virtual water network operator.

Brian Bosire of HydroIQ

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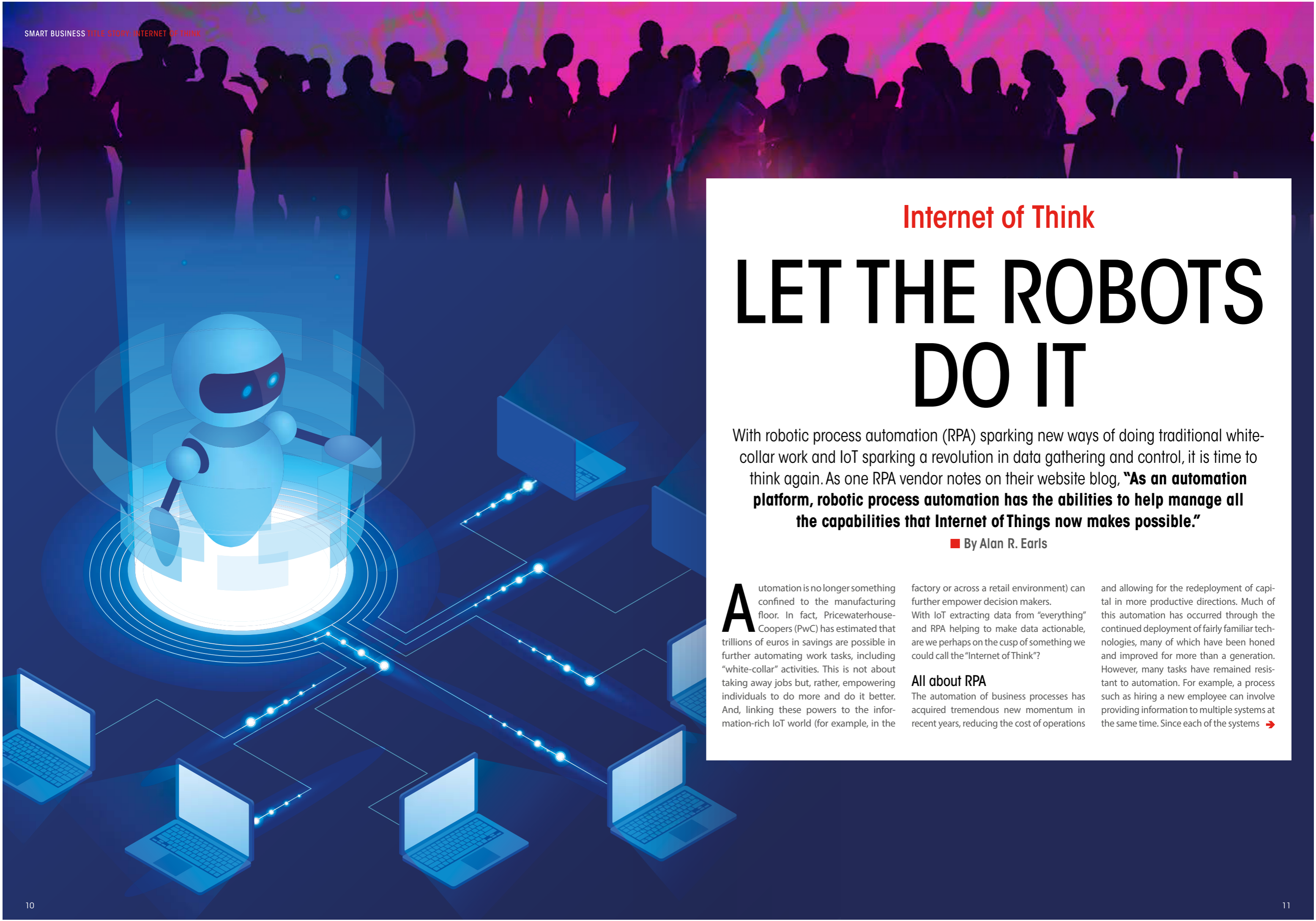
Internet of Think

LET THE ROBOTS DO IT

With robotic process automation (RPA) sparking new ways of doing traditional white-collar work and IoT sparking a revolution in data gathering and control, it is time to think again. As one RPA vendor notes on their website blog, **"As an automation platform, robotic process automation has the abilities to help manage all the capabilities that Internet of Things now makes possible."**

■ By Alan R. Earls

Automation is no longer something confined to the manufacturing floor. In fact, Pricewaterhouse-Coopers (PwC) has estimated that trillions of euros in savings are possible in further automating work tasks, including "white-collar" activities. This is not about taking away jobs but, rather, empowering individuals to do more and do it better. And, linking these powers to the information-rich IoT world (for example, in the factory or across a retail environment) can further empower decision makers.

With IoT extracting data from "everything" and RPA helping to make data actionable, are we perhaps on the cusp of something we could call the "Internet of Think"?

All about RPA

The automation of business processes has acquired tremendous new momentum in recent years, reducing the cost of operations and allowing for the redeployment of capital in more productive directions. Much of this automation has occurred through the continued deployment of fairly familiar technologies, many of which have been honed and improved for more than a generation. However, many tasks have remained resistant to automation. For example, a process such as hiring a new employee can involve providing information to multiple systems at the same time. Since each of the systems ➡

are separate, rekeying data is still often required, with all the risks of errors as well as the direct costs that implies. But even these hard-to-manage manual systems are built on rules, even if the rules themselves are well hidden in the habits of employees and not formally documented. Enter robotic process automation (RPA). And don't be confused by the word robotic, which is something of a misnomer. Rather than parking a hulking automaton at a desk in your accounts payable office, RPA vendors instead aim to have you adopt their software tools, which can automate those manual, rules-based tasks. The result of applying these tools is the creation of a virtual robot of sorts – bots in the parlance of the industry – that can thereafter continue to perform a specific process automatically. Often, the bots work hand in hand with existing business process automation systems. The bot creation process varies from vendor to vendor. Many RPA companies now offer forms of artificial intelligence or "machine learning." Armed with this capability, RPA can quickly grasp the nature of the task and of the data and emulate tasks previously performed by humans. In the example of the employee onboarding mentioned above, an RPA system might be able to quickly record the steps involved and embed the logic in its own activities which would then share the

Many everyday tasks have remained resistant to automation. Rekeying data is still often required, with all the risks of errors as well as the direct costs that implies.

❝❝

Today, bots routinely work hand in hand with business process automation systems.

data, as appropriate, between different systems – quickly and minus the clerical errors for which humans are well known.

Machine learning in RPA can speed up the process by making educated guesses about the meaning of specific fields in paper or electronic documents. Bots can also simply "watch" humans perform tasks and come to conclusions about what is going on. For example, a bot watching a human look at accounts receivable documents might notice that values above a certain level in invoices of a certain age caused the human to take a specific action – perhaps flagging the account for a call by a human being. Of course, just like a human assistant, bots may need help or correction from time to time until they reach or exceed human accuracy in performing a task. At that point, the payoff begins because the human can now spend time on more important tasks than simply entering data and making routine decisions.

There are, of course, multiple flavors of RPA. One, often called robotic desktop automation, is a kind of grown-up screen scraper, reading a display screen much as a human would and taking steps based on the information it finds.

More sophisticated enterprise RPA (ERPA) aims at broader solutions. Based on premises or in the cloud,

ERPA tools can detect and create logical paths to model a wider range of processes, harvesting necessary data and making use of other tools and systems, much as a human would. ERPA doesn't necessarily lock people out of processes but often provides helpful capabilities such as security and even audit trails so, again, ERPA can be kept on a short leash – its actions verified and audited as needed. RPA offerings can also include varying degrees of advanced analytics and machine learning so that they can adapt and change to meet new circumstances; a crucial difference compared to many traditional IT solutions, which often need to be reworked to meet new circumstances by the time they are actually implemented.

To be sure RPA is not a magic bullet and can't solve all business challenges. It is also more complex and requires a bigger commitment of time and talent than, say, a typical packaged software implementation. Interactions between bots also need to be anticipated and understood. Perhaps that is why so many RPA adopters have hailed from the upper ranks of businesses where resources and technical sophistication are greatest.

But the benefits can also accrue to smaller organizations (see John Gikopoulos interview) and there is an indication that RPA may soon become a feature of Microsoft Dynamics ERP, which has always focused on the enterprise management needs of mid-size companies.

While IT may have the skills to help implement RPA, they may not be needed or wanted in the adoption process because RPA functions so closely with activities of the business and relies on the business for its mission definition and training. On the other hand, automation occasioned by RPA may have implications that are broader than simply speeding a few tasks and freeing up human talent, so communicating with IT is probably a good idea.

For the faint of heart, of course, integrators and consultants, usually with relationships to an RPA vendor, can help smooth the way. ➜

Volvo: From RFID to IoT

Yvan Jacquet
"If you change the tag, you have to change something else."

At Volvo in Ghent, a long relationship with RFID has helped create the foundation for IoT and now, with more available data, the company is looking at ways to share and leverage the data using big data analytics. According to Yvan Jacquet, data communications and RFID concept project manager, Volvo Cars in Ghent, the company started implementing RFID in 1995, long before talk of the Smart Factory. The primary idea was simply to identify the car within manufacturing and report its location. From an IT perspective, it was really focused on the production activity. All the data were located between the RFID and the programmable logic controller (PLC) level. "There wasn't really much integration," Jacquet says. Historically, he notes, the best RFID was generally seen as the one providing the highest amount of memory because the trend was to have all the data located on the device and have the device mounted on the car. The focus was on the production function, not on logistics. That, he says, was the status
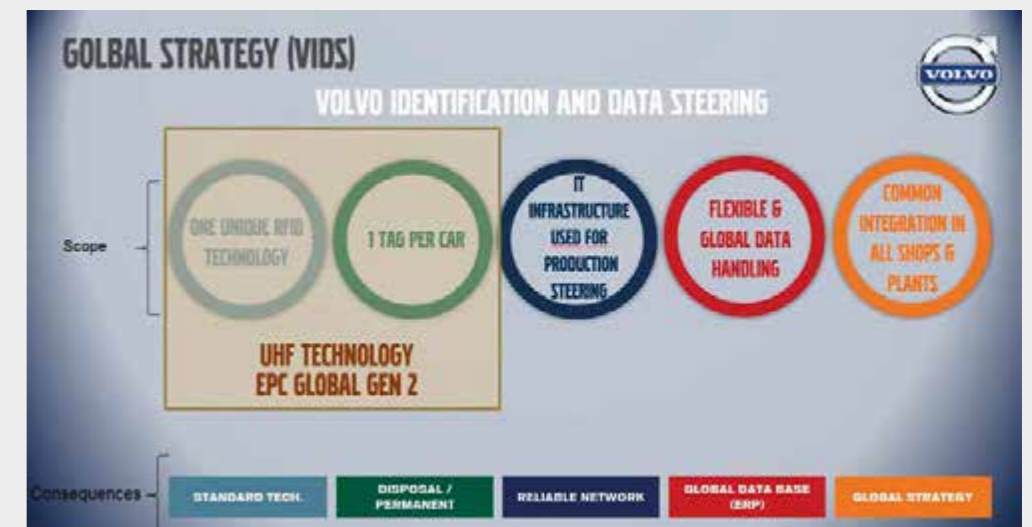
quo for almost 15 years. But the status quo wasn't an entirely happy place. "We quickly discovered that when one of the vendors of the RFID tags changed the product or it got to the end of its life, it would be a tremendous amount of work to change because everything relied on the way it worked. "If you changed the tag, you have to change something else. It was tremendous work to switch from one product to another and actually that was the root of the changes that were decided in 2004," says Jacquet. "That was when one of the main RFID vendors Volvo was using decided to quit production of the product. We were facing a difficult situation; how could the team change 200 readers in the whole factory all in one shot? Instead, we started to analyze why we had so many different RFID solutions in the company – we found more than ten and maintaining them all was tricky," Jacquet says. From that point, he says, the company decided to change completely

and standardize around one single system that fits all over the welding shop, the paint shop, and final assembly.

That solution turned out to be RAIN RFID from Confidex and Impinj. Working with those two companies Volvo consolidated multiple tracking methods into a single approach applicable across the manufacturing operation and potentially beyond. One immediate challenge was improving RFID performance in challenging environments, where machinery and physical space constraints reduced the predictability of radio signals.

Particularly to support growing levels of vehicle customization, Volvo wanted to uniquely and accurately identify vehicles throughout the production cycle. Its original adoption of RFID was a start but more recently, Volvo turned to a simplified RAIN RFID solution from Confidex and Impinj to enable asset tracking from the paint shop to the point of final assembly.

Jacquet says that with the enhanced system, it is possible to store quality reports for every activity, right down to individual spot welds. "Now the amount of data that we store is more than a thousand times greater than when we started," he says.

Although Volvo didn't start with a vision of the Smart Factory, by taking smaller steps it has ended up there, he says. Much of the system beyond the tags themselves was developed internally at the Ghent site and has since been adopted by other operations. More data has turned out to be a good thing across manufacturing and is now helping to inform purchasing, logistics, and other areas, potentially including RPA.

The road ahead
Volvo consolidated multiple tracking methods into a single approach applicable across the manufacturing operation and potentially beyond.

Steering toward automation
The system ties into production-steering systems and provides the highly flexible and global data handling that facilities in different countries require.

Finally, for those worried about entrusting their business to robots, RPA advocates insist people are never really out of the loop and built-in safeguards can spot anomalous behavior and show how it occurred. In fact, most of the RPA vendors focus on what might almost be considered a cyborg approach to the subject. Humans will be central but with RPA they will have superpowers. RPA might help bunch, organize, and categorize alerts in a way that makes them more actionable. Sometimes, RPA might be given the power to automate some tasks but a chain of alerts and tools will provide visibility and allow the human to spot problems early and intervene quickly and effectively.

The IoT side

And what about IoT? Ask someone who is deep in the IoT market. "When I went to the Gartner conference last year, there were analysts there who saw RPA and IoT as a natural synergy," says Abhijit Kakhandiki, vice president of products at Automation Anywhere, an RPA vendor.

RPA is about getting work done, not just integrating systems and building connections -- and a big component is the bot on a machine where the work gets done, he adds.

A similar arc is described by Simon van der Jagt, CEO of Nowi. The company was founded in 2015 by van der Jagt and Omar Link. Nowi is a team of 12 people currently with some €2 million invested in product development and with four patents filed. The company is located in Delft, the Neth-

> **IoT has taken on a number of forms including Industrial Internet of Things (IIoT), Internet of Medical Things (IoMT), and the Internet of Everything (IoE).**
>
> **Pete Smith,**
> TE Connectivity Ltd

Abhijit Kakhandiki, vice president of products at Automation Anywhere

erlands, and is building upon decades of academic research on energy harvesting and power management for low-power devices. This knowledge is now being used to solve what they call the power bottleneck in the Internet of Things – namely the fact that IoT is being held back by the need to deliver power to all those sensors and other IoT gadgets.

"For IoT to succeed we first need to solve the bottleneck of power in wireless sensors," he adds. Nowi is tackling that challenge by enabling sensor solutions with an "unlimited energy source." The Nowi Power Module allows sensors to power themselves with what is already available; for example, ambient light, vibrations, or even RF signals such as GSM and Wi-Fi. "There is energy all around us that we can use to power small connected devices," he explains.

And, he hopes, with Nowi technology it will be possible to dramatically multiply the scale and cost-effectiveness of the Internet of Things. Then, the data floodgates will open and RPA will need to be ready. "I think that RPA has a lot of different names across industries but it seems to boil down to the same thing. It's about making things smarter," says van der Jagt.

With RPA, by making things smarter, the process ends up being more efficient, healthy, and productive. "This process of making something smarter differs by application but the underlying principles are always the same," says van der Jagt – and it's comparable to human experiences. If a hu-

man wants to be smart, he first needs to have senses, needs to be able to smell, touch, hear, taste, etc. This is essentially (IoT) data coming in to the system, he notes.

Algorithms in the cloud or on premises make sense of the data. "Then we act, say turning traffic lights from red to green, altering a logistics route, or adjusting the temperature output of an air-conditioning unit. "In RPA we have this process of sense, think, and act," van der Jagt explains.
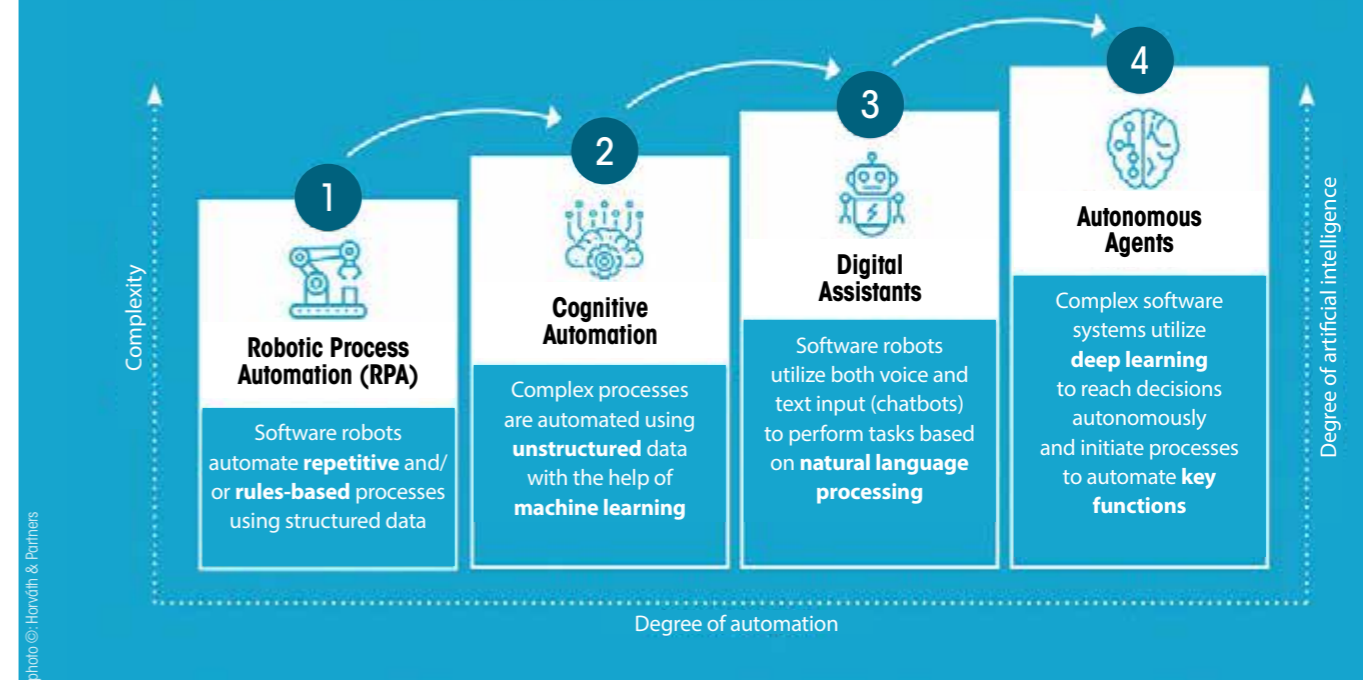
Humans can gather data and make decisions but they suffer from interruptions and fatigue. And that's the problem: without sensors constantly bringing in data, the RPA process quickly comes to a stop. "It is impossible for a smart process to function without having its eyes and ears in the physical world," says van der Jagt. Some of those eyes and ears are made by TE Connectivity Ltd., a Swiss company that designs and manufactures connectivity and sensor products. "IoT has taken on a number of forms including an Industrial Internet of Things (IIoT), Internet of Medical Things (IoMT), and the Internet of Everything (IoE)," notes Pete Smith, manager of sensor product knowledge and training at the company. Smith explains that the sensors division at TE focuses particularly on harsh environments and is often involved in IoT implementations.

Many IoT activities are in factories, "which are often shown as gleaming showcases, with people in lab coats" – the factory of the future. However, Smith notes, many real-world customers want to apply factory-of-the-

Under pressure
Wireless pressure sensor and transducers such as M5600 and U5600 from TE are used for many industrial and commercial applications.

4-Step Model of Intelligent Process Automation
From simple batch processing to self-teaching intelligent systems

Complexity

1 Robotic Process Automation (RPA)
Software robots automate **repetitive** and/ or **rules-based** processes using structured data

2 Cognitive Automation
Complex processes are automated using **unstructured** data with the help of **machine learning**

3 Digital Assistants
Software robots utilize both voice and text input (chatbots) to perform tasks based on **natural language processing**

4 Autonomous Agents
Complex software systems utilize **deep learning** to reach decisions autonomously and initiate processes to automate **key functions**

Degree of artificial intelligence

Degree of automation

future thinking to existing facilities that look nothing like that. In fact, he notes, many of his company's sensors are found in steel mills, sewage treatment facilities, and offshore oil plants. Sean Gough, director of product management at the company says the route from IoT sensors to RPA in all those facilities usually starts with local intelligence, where initial analysis can help reduce the deluge of data to something more manageable. "People are working to get to the right level of local analytics so that they are transmitting and analyzing the right level of data at each layer," he says.

Certainly, getting data to where it is needed is a challenge. Hard-wiring sensors used to be standard practice, but particularly where customers want to retrofit, "the only practical method is often to use radio," says Gough. He says the company is now combining sensors and radio in a single device.

According to Smith, customers want the ability to integrate as much as possible. In response, the company is making sensors that are digital and adding microprocessors, primarily for self-test, so they can know whether the sensors are operating properly, he explains. But the desire to process more at the edge is likely to increase.

How much value can you get from automation? "A lot of our customers are on a discovery mission to understand how this will help them," Smith says. "We think there is no limit," he adds.

Making the case

Both RPA and IoT have those who claim they can demonstrate strong ROI. Of course, the specifics vary. Some projects produce stellar results and others are not so impressive. However, according to a Tata Consulting Services blog, RPA is demonstrating ROI "in about 25 percent of the time required for a business process workflow solution and 16 percent of the time taken for enterprise application integration to demonstrate significant value."

A recent article posted by ISG Research, "Is IT a Catalyst or Adversary of Your RPA Initiative?," revealed the results of a survey of 549 European business leaders regarding their adoption of RPA technology and services. One finding was that in EMEA, the CIO is usually responsible or accountable for the RPA buying decision (81 percent) but 57 percent of organizations surveyed said they were stymied in their RPA endeavors by "Lack of IT support" and "Governance/compliance" issues.

The road to RPA
The evolution of robotic process automation can be seen as a series of steps towards ever-increasing levels of automation and artificial intelligence.

The article's authors, Keri Smith and Aparna Gajanan, observe "if you consider automation a team sport, both the business side and the IT organization must play together to advance the ball."

They also observed that though CIOs often have responsibility for RPA buying, implementation is often handled by others, including CFOs and shared services leaders. Furthermore, despite a widespread belief that RPA is "intuitive" and doesn't require IT involvement, in fact "RPA is not a plug-and-play capability; it requires people with technical and business skills to plan, develop, deploy and manage it." Earlier this year, ISG also weighed in on the broader outlook for advanced business use of RPA in Europe, which they expect will double by 2020, as companies seek to improve customer experience and streamline their finance operations.

ISG and Automation Anywhere, an RPA software provider, recently surveyed European business leaders and found that that fewer than 10% of companies will not have begun working on RPA by 2020, while those at an advanced stage will have doubled.

While Europe has been slower to adopt technologies like automation than other markets, according ➡

to ISG, RPA is actually moving into the mainstream, with 92 percent of respondents saying they anticipate using RPA by 2020, and 54 percent saying they will reach the advanced stage of adoption by then, up from 27 percent currently.

Budgets are also up, they said – on average by nine percent in the last year, well ahead of the average increase for general IT spending. Third parties, such as consultants and service providers, make up more than half of this spending.

Over the next 24 months, respondents to ISG say RPA is expected to have the greatest impact on customer service and order-processing functions (43 percent), closely followed by finance, treasury, and audit (42 percent), procurement, logistics, and supply chain (40 percent), and sales and marketing (38 percent). The results did not address manufacturing impacts.

Among Europe's largest markets studied by ISG, 60 percent of German companies expect to be in the advanced stage of deployment by 2020 (versus 32 percent today), following by 50 percent in France (up from 22 percent) and 46 percent in the UK (up from 23 percent).

However, barriers to adoption remain. Security is a key concern, with 42 percent of businesses citing this as an obstacle to expanding their RPA use. James Dening, vice president Europe at RPA vendor Automation Anywhere, adds: "European enterprises are at an exciting juncture with respect to RPA. If implemented properly, over the next few years RPA technologies will

Shane Nolan,
VP Technology, Consumer & Business Services at Industrial Development Authority (IDA), Ireland

help deliver significant value for businesses across a range of European enterprises and industries, ensuring growth in productivity, efficiency, and output, and helping these firms and industries stay competitive at a local, regional, and global level."

Impact on employment

According to a recently published article in the US-based Wall Street Journal, Finnish engineering company Wärtsilä Corporation is well along on the RPA path, making plans to deploy more software robots to bring up the efficiency of its finance unit. In part, the investments are in anticipation of the challenges involved with taking on acquired companies in the future. And those financial people currently represent some 750 out of the company's total headcount of more than 18,000. Improvements in efficiency could have important benefits, according to the article. Since first adopting the "robots" in 2015, more than 100 routine tasks have been reassigned from human workers to robot workers.

Certainly, this has all the hallmarks of the all-too-familiar headlines that predict robots will be eliminating most human jobs. But the story is as familiar as the development of the plow in past millennia or the development of industry more recently: fewer people will be able to produce more.

> **RPA and IoT are tending to drive up employee engagement by changing the nature of some work.**
>
> **Guy Kirkwood,** chief evangelist at UI Path for Europe, UK

And that has always led to broad economic growth that creates new kinds of jobs – and usually better kinds of jobs. So, expect short-term disruption and long-term gain.

Although there are "horror stories" about people being made redundant through automation, Guy Kirkwood, chief evangelist at UI Path for Europe, based in the UK, says he is not seeing that among customers. Instead, RPA and IoT are actually tending to drive up employee engagement by changing the nature of some work. And, he adds, there is a direct link between employee engagement and customer experience. "So, I expect these technologies to come together over time; I expect the number of people in the back office corporate functions to diminish over time, not through mass redundancy, but through new opportunities," he says. And, he adds, the number of people doing customer service will rise. "How you deal with customers and how open and approachable and efficient you are will be more important," he says. And, he notes, "automation" in the form of IoT can have an even more direct link, especially on things like telecom, utilities, or insurance. "IoT is taking off because those companies needed more data; but then the question is what you do with the data and then how you manipulate it," he adds.

Internet of "Think," as discussed in this article, is about better integration of factory and other corporate functions. All new technologies can have an impact on job opportunities. Most likely, these effects will be gradual and diffuse – and therefore societies will adapt. When change is faster or more disruptive, for example, in a single enterprise or business sector, there may be opportunities for countervailing efforts – training, job creation, or more. However, mostly this is likely to be an opportunity to empower individuals to do more and for society as a whole to benefit with higher productivity.

Much like the way ubiquitous word-processing technology largely eliminated the typing pools of (mostly) women performing a manual task

for others, so too RPA may displace some. But, just as with the casualties among professional typists, many of whom up-skilled, using keyboard knowledge as an entry point to other business positions with greater opportunity, so too will those freed from drudge work by RPA find new and often better opportunities.

Shane Nolan, SVP Technology, Consumer & Business Services at Industrial Development Authority (IDA) Ireland, says his agency is looking at the potential impact of RPA, IoT, and other emerging technologies on Ireland as both a threat and an opportunity.

A first concern, of course, is the potential impact on employment. "We have done some modeling on this and on the one hand you could suggest that AI and RPA will drive jobless economic growth in nations where the capacity for job growth is limited," says Nolan. In Ireland, particularly, so-called shared service centers handling back office or middle office activities are a major source of employment. Companies are usually attracted by lower price points, and the functions are mostly financial, though other functions are becoming standardized and are being provided from a shared service location. At present, some 1,300 multinationals are present in Ireland with 700 of those coming from the US employing about 40,000 people in total. Nolan estimates that about 40 percent of service center activities such as accounts payable and receivables "could be automated tomorrow." In response, he explains, IDA has developed a strategy and a roadmap for shared services and automation.

"We want people to be both concerned and enthused about the potential," he says. The concern is not just felt in Ireland; it gets to the heart of broader concerns about the future of work. Nolan says the IDA believes it is something where government needs to play a role. "Undoubtedly people will be displaced, so we want to put in place training infrastructure to work with the new technology," he says. Initial training, for instance, has already been conducted with Blue Prism, an RPA vendor that has ranked high ➜

Cathy Tornbohm,
Gartner's vice president for BPO Research, London

Gartner Puts RPA in Perspective

For starters, notes Cathy Tornbohm, Gartner's London-based vice president for BPO Research, RPA can't "think" – it's not smart. "The vision of adding IoT to everything is interesting and RPA could help you manage that. But it depends where you are starting from," she says. In general, companies are mainly using RPA tools to move data in and out of legacy systems, client servers, or websites. Sometimes, she notes, when each of us conducts business through a website, particularly with organizations that matured before the Internet, when we input data we assume it is going directly into a computer; however, in many cases there is still an intermediate step involving a human. And that's part of RPA's appeal.

"I have looked at both RPA and IoT since they came out and, essentially, one of the challenges of IoT is that there is a lot you need to get in and out in the form of thousands of data points," Tornbohm says. That's where an RPA tool can be helpful. Much like an Excel macro, the RPA moves data from A to B. However, there are other capable tools, some with AI, that can filter and move data very reliably, she says. "But if you don't have something like that, which can handle complex moves, why not an RPA tool?" Indeed, why not?

Well, according to Tornbohm, there are reasons to consider other options. For example, if you have several data points that need to be perfectly moved to a legacy system or BI system and there is no native integration route then RPA is

a good option. It is useful when there is something to stop you from using an API or BPM tool or an integration-as-a-service tool. Those are all forms of automation that provide many ways to get the same results, without an RPA. "In a sense RPA is like BPM lite," Tornbohm says.

It is when you can't use an API that RPA becomes the integration option of choice, according to Tornbohm. However, the decision to deploy RPA will always come from encountering roadblocks involved with moving data.

"To offer another example, let's say my IoT data told me the traffic lights were out in my neighborhood or all the road salt boxes are empty," says Tornbohm. Often, there is still a person taking all that data spewing from the IoT source and then laboriously feeding it into a legacy system so that the proper orders are generated to install the new lamps or fill the boxes. "Again, if that kind of thing is a roadblock you face and you find an RPA system will do it more efficiently – and without introducing any keying errors – that's fine," says Tornbohm. On the other hand, she notes, "maybe you should invest in newer systems instead of trying to maintain your old legacy system, because that might save time and money." And, an RPA system might not be that much of an improvement. "It might take Fred or Susan five hours to move the data; the RPA system might do it in two and in the meantime you are still operating all those old systems," she adds.

An API approach in contrast is much more of a plug-and-play situation. "An API is built to deal with change but with an RPA, when processes or systems change it has to be updated," she says.

photo © Universal Robots

in Gartner's Magic Quadrant evaluation. Automation Anywhere and UI Path, also RPA vendors, are on the list. "We have developed a full suite of courses with employee federation and the Hackett Group ranging from certificates to college master's degrees."

Separately, Nolan says IDA is looking for opportunities to embrace other new technologies. "We have a big biopharma industry, especially biotech, that is very next generation and is full of sensors and we also have companies working on autonomous vehicles here," he explains.

Nolan predicts that IoT will create a phenomenal volume of data, beyond what humans can deal with practically, so RPA will be a requirement.

The new wave of technology

Sandwiched between the "executive" level of RPA and the other tendrils of IoT are other technologies that also help complete the picture, including "traditional" robots implemented in hardware.

"Looking at the big picture, we are seeing robots becoming more versatile and able to do more than one thing," says Howie Choset, Professor of Robotics at Carnegie Mellon University School (CMU) of Computer Science in the US. Choset believes one driver will be that high-volume, highly cus-

Robots everywhere
Collaborative robots created by Universal Robots, a market leader in cobotics, hard at work in an automated factory in Odense, Denmark.

tomized products will be in great demand in the years ahead and robots can help deliver them. Second, robots are becoming more flexible and easier to install and repurpose, which will be important for low volume, high customization.

"We're also seeing cost reduction in robots and there is a trend toward more collaborative robots (cobots), which are robots working alongside and perhaps directly with people, so they are sharing a common task," he says.

Among the companies embracing the trend, the largest is Universal Robots, a Danish manufacturer of smaller flexible industrial collaborative robot arms just purchased by Teradyne, a maker of automatic test equipment, he says. "These kinds of robots are smaller and

> **"** A key part of digital transformation is having the ability to make data accessible for analysis and to gather insight.
>
> **Andy Chang,**
> director of product marketing at KUKA

safer to work around and a little bit easier to program, but Universal is not alone," he says. ABB is another, along with KUKA. Choset says many companies have been slow to embrace robots, cobots, and even RPA. One reason, he notes, is that integration, as with IoT in general, can be challenging. Unlike consumer software or apps for mobile devices, manufacturers "haven't figured out how to scale; robotic installations are still very customized," says Choset.

"When the industry accomplishes that [better integration], the real discovery of what we can do with automation as well as with data collection will happen," he says, "and that's particularly true once robotics is more accessible to SMB-level companies."

In part, he notes, it is a matter of having the right standards in place. "It isn't like you just turn on your robot and off you go; there are many things that haven't been codified," Choset says. However, he notes, when the market decides it is needed it will happen.

"I think Europeans are making very nice investments in manufacturing robots," Choset says. "I wish our investments in the US were as big. I think the Europeans are doing a very good job of being progressive, especially public–private partnerships and I think my European colleagues are doing great work," he adds.

Like Choset, Andy Chang, director of product marketing at KUKA, sees room for more robust standards and protocols. "A key part of digital transformation is having the ability to make data accessible for analysis and to gather insight. Today's new technologies must be developed using standard protocols and open interfaces to allow existing robotic technologies to be part of new IoT or Industry 4.0 practices," Chang says.

For its part, KUKA has been heavily investing in cloud, web, and mobile technologies to augment existing mechatronic systems. "A product we currently offer is KUKA Connect – a software platform that leverages cloud computing technologies and big data – to provide users access and analytics of their KUKA robots at

any time and on any device," Chang says. KUKA Connect, and other similar cloud-based technologies, will allow manufacturers to implement robot-centric IoT and Industry 4.0 solutions to their operations, enabling them to create their factory of the future. In addition, "we're also looking at how we can integrate existing IT technologies from backend ERP systems with relevant technologies, such as Salesforce, to better combine business needs and customer demands," says Chang.

These developments, he believes, will fundamentally change individual companies, as well as transform market dynamics across a whole range of industries in countries all around the world – in both the developed as well as the emerging markets. "At the end of this transformation process, successful industrial companies will become true digital enterprises, with physical products at the core, augmented by digital interfaces and data-based, innovative services," he says. Insights gained through the convergence of IT and operational tech (OT) will fuel better internal business decisions, higher quality products, and faster delivery times, he believes. KUKA is also thinking about the role of AI.

But, while there is promise in all those new technologies, including AI, at least one executive warns against taking buzzwords at face value. That is the case with Jean-Philippe Baert, COO of Arago, a German AI company based in Frankfurt am Main. He notes that his company was established in 1995 by CEO Chris Boos to focus on artificial intelligence. Today, it applies that technology to process automation and, in particular, through HIRO™ its general problem-solving artificial intelligence technology.

Baert says the company has been able to achieve over 87 percent automation of processes with its customers, which now number more than 30 globally. "Anything could be run by AI to help companies be more flexible and grow faster," he says.

Baert explains that his company is based on AI that goes beyond most other AI; it can learn and solve new issues that were unknown until now.

And while there isn't a direct link to IoT, Baert says IoT provides the ability to collect and analyze more data. "The combination of applying AI to the data analytics and the environment of the IoT edge may make possible new capabilities," he says. For example, in the case of optimizing electricity consumption of a building or a city, you can have a perfect algorithm, but it will probably never be as well optimized as what HIRO can do by using data to be precise, rapid, and accurate, he explains.

Baert says that understanding, learning, and solving is what is handled by HIRO. This process is abetted by a semantically organized map that makes the logic relevant to, say, a city, an oil company, a hospital, or a travel agency. When it comes time to solve a problem, the HIRO engine goes into action. "This can be important in IoT because IoT will monitor all the flows and all the information; HIRO through its reasoning approach will be able to learn through those changes and ar-

On its own
The KMR iiwa by KUMA, a German market leader, transports material or finished products around the factory.

photo © KUKA

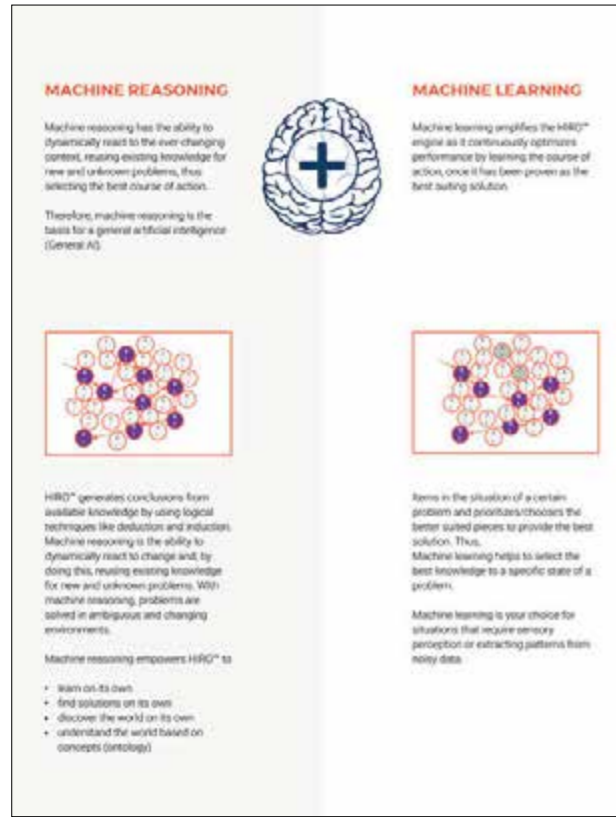rive at solutions that could not have been done before.

"Tomorrow you will have super tankers or ferries that can operate without a crew; not just as a matter of navigating with GPS but for anything that occurred or could occur, the intelligence will be able to solve the problem or prevent the problem," says Baert.

RPA takes to the air

Lufthansa's maintenance subsidiary Arago is helping to provide dramatic process optimization on the flow of activities and tasks that people have to perform at Luft Technik, the maintenance division for the airline. Aircraft regularly undergo light, medium, or high maintenance programs. All those maintenance operations can take a lot of time for the repetition of many, many manual tasks and each must be performed precisely, in accordance with regulations. "What we've done is not to change the task, because they are mandatory and compulsory, but instead we have optimized the flow of the process and the environment and the access to resources and have provided a better sequence of engagement depending on the environment," says Baert. The impact for the airline company has been huge. It is a theoretical number, but we can decrease from ten to five days per year that the plane has to be on the ground for maintenance. "It is only through reasoning by AI that we can do that," he adds. Needless to say, those business impacts become fodder for RPA and high-level management consideration.

Another view on the IoT–RPA link comes from Automation Anywhere's Kakhandiki. "We find with RPA there is a very current trend; there has been an explosion of data through digitization and analysis and for the first time, data is accessible and visible," he says. "It is coming not just from digitization of processes but from IoT and sensor data," he adds.

"In our view, as IoT becomes bigger and bigger there is a natural play between IoT and RPA," Kakhandiki says. When you create a bot on his company's platform you can log any data ➡

MACHINE REASONING

Machine reasoning has the ability to dynamically react to the ever changing context, reusing existing knowledge for new and unknown problems, thus selecting the best course of action.

Therefore, machine reasoning is the basis for a general artificial intelligence (General AI).

HIRO™ generates conclusions from available knowledge by using logical techniques like deduction and induction. Machine reasoning is the ability to dynamically react to change and, by doing this, reusing existing knowledge for new and unknown problems. With machine reasoning, problems are solved in ambiguous and changing environments.

Machine reasoning empowers HIRO™ to

- learn on its own
- find solutions on its own
- discover the world on its own
- understand the world based on concepts (ontology)

MACHINE LEARNING

Machine learning amplifies the HIRO™ engine as it continuously optimizes performance by learning the source of action, once it has been proven as the best suiting solution.

Items in the situation of a certain problem and prioritizes/chooses the better suited pieces to provide the best solution. Thus, Machine learning helps to select the best knowledge to a specific state of a problem.

Machine learning is your choice for situations that require sensory perception or extracting patterns from noisy data.

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or any business event. The data can be from a system or sensor in IoT. And, as data streams expand, "bots can deal with exponential volume increases," he says.

And it's not just theoretical. Kakhandiki says his company has set up a bot store to help people enhance their RPA ecosystem. For example, he says, "we have bots in our store that can interface with GE Predix, General Electric's software platform for the collection and analysis of data from industrial machines." Another pre-created bot can work with the C3 IoT, a platform as a service (PaaS) for the rapid design, development, and deployment of the large-scale big data and predictive analytics.

"You can take that data and now suddenly it is available to your RPA where you can further make use of it," says Kakhandiki.

Making the dream come true

"RPA and cognitive automation are rapidly being deployed throughout the world, across industries," says Dening at Automation Anywhere,

one of the largest RPA vendors. The lure, he notes, is that AI-trained algorithms that are part of RPA initiatives work 24 hours a day without complaint, require little oversight, and can quickly and easily scale. "Because the barriers to implementation are so minimal, there's little reason for most enterprises to delay piloting RPA on a limited basis," Dening notes. In most cases, company leaders will see tangible and measurable results within a few weeks rather than months, he explains. Today, most large companies are now engaging with RPA to some extent – the business drivers are primarily about reducing cost and increasing operational efficiency, "with the expectation to move or be seen to be moving to a more digitally oriented business," Dening says.

While Dening says he has not yet encountered any examples of companies integrating RPA and IoT or making plans to build it into their automation and digitalization strategy, that doesn't mean it's not going to happen. "They're not inherent bedfellows, and there is much lower hanging fruit for RPA in finance, HR, operations and the like," he says. However, as enterprises get connected, Dening says he expects more RPA/IoT use cases to crop up in the next couple of years. However, the caveat is that "given that we know IoT is going to be a 'lots-of-things' technology, the tools to manage large estates will be built into IoT platforms from day one, needing less retrofitting of tech that deals with scale, which is often what RPA is used for," Dening adds.

"What is really driving the growth of RPA is the adoption rate of automation across organizations around the world and across all industries," says Guy Kirkwood, chief evangelist at UI Path, based in the UK, which claims 45 percent of its revenue from North America, 34 percent from Europe, and 24 percent from Asia-Pacific, with 18 locations across 14 countries.

"All the vendors in RPA are growing fast, but we're the fastest; we have a thousand people in the business and revenues just topped $100 million, up from just $1 million 24 months ago,"

he says. That, he claims, is one of the fastest ever recorded in the software industry, which allows them "to play in Google's playbook." Underscoring his comments are the venture investments his company has received, including from the venture arm of Alphabet (Google).

Kirkwood says, jokingly, that the old mantra used to be that no one ever got fired for buying IBM, but in his view that thinking is no longer holding up with the new waves of innovation. "We're seeing the rise of an RPA ecosystem driving adoption and the convergence of multiple technologies," he says. He also credits his own company for seeding that ecosystem. "All the RPA vendors charge for training, including us when we joined the industry, but now we give it away," he says.

UI Path launched its free academy last year and since then over 200,000 people have gone through the RPA training program. That's an especially significant number because it includes not only developers and techies but many non-traditional business roles as well, yielding a broad field of UI Path developers active in 70 countries.

Digital transformation

For Kirkwood, the rise of RPA and IoT is essentially about the broader growth of digital and its transformative power. "Every organization is undergoing transformation; RPA is a really good first step on the journey because it is relatively quick and relatively cheap and the ROI is really good," he says.
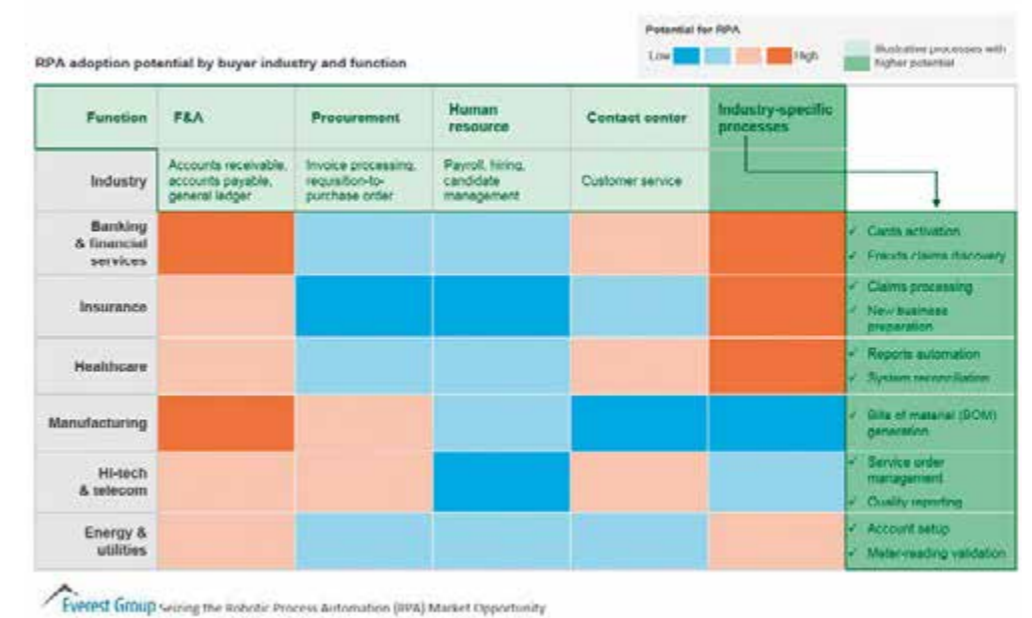
For example, working with the UK's Department for Work and Pensions (DWP), which is responsible for welfare, pensions, and child maintenance policies and ranks as the country's biggest public service department, UI Path was able to go from concept to process in 12 weeks. "They expected it to be six to nine months and now on the pilot alone they are saving 6 million pounds annually," Kirkwood says.

For UI Path and others, the "ecosystem" is helping to spread RPA. "Consultants use RPA to demonstrate digital transformation and they use that as the starting point because returns

are so quick," he says. Large independent software vendors such as Microsoft and Oracle are also anxious to put RPA into their platforms because of its inherent value but also because it opens doors to new buyers. "We are dealing with operators at different levels and also cutting across so many industries so they see it as a route to new markets," Kirkwood explains. Last year UI Path did a deal with Oracle whereby UI Path is built into their cloud business. For anyone buying Oracle cloud, the software robots are already there, waiting to be switched on. And, Kirkwood notes, his company is discussing building UI Path into Microsoft Dynamics – the mid-market ERP offering.

Looking ahead

What does the future hold for more fully integrating information flows across businesses – from IoT and robots to business functions such as planning, billing, inventory management, and marketing? Where is RPA starting to have an impact?

The answers are not yet clear. However, notes Chang, both automation and overall business processes will need to improve and transform to accommodate the increased demand from consumers. In today's market, "the

customer is the most disruptive force and the most influential driver behind product design, development, and delivery," he says. To remain competitive in their respective markets, manufacturers will be required to implement an integrated system that includes a customer-facing platform, he says.

"At the end of the day, RPA is about processes – analyzing them, understanding them, and then automating them," says Harel Tayeb, CEO of RPA vendor Kryon. He says RPA's interac-

RPA adoption potential by buyer industry and function

Function	F&A	Procurement	Human resource	Contact center	Industry-specific processes
Industry	Accounts receivable, accounts payable, general ledger	Invoice processing, requisition-to-purchase order	Payroll, hiring, candidate management	Customer service	
Banking & financial services					Cards activation / Frauds / claims discovery
Insurance					Claims processing / New business preparation
Healthcare					Reports automation / System reconciliation
Manufacturing					Bills of material (BOM) generation
Hi-tech & telecom					Service order management / Quality reporting
Energy & utilities					Account setup / Meter-reading validation

Potential for RPA: Low — High. Illustrative processes with higher potential.

Everest Group *Seizing the Robotic Process Automation (RPA) Market Opportunity*

High potential

Areas and industries where RPA can make the biggest difference according to analyst firm Everest Group.

tion with IoT is fascinating because, as the everyday objects with which we interact become "smart," the types of processes and the quantity grow exponentially. "Think of what you can do with the programs on only a desktop computer compared to a world in which our houses can be programmed, our cars, our lives," he says. "It opens up an entirely new range of opportunities for RPA, which is exciting on a consumer level as well as a developer level," Tayeb adds.

Interview

"FOR LACK OF A BETTER TERM, THIS IS THE NEW INDUSTRIAL REVOLUTION."

Looking at IoT, RPA, AI, and the future of business with Infosys
Global Head of AI and Automation, John Gikopoulos*

How would you characterize the outlook for RPA, IoT, and digital integration?

Throughout our journey, I will talk about RPA, IoT, and AI as one logical chain. All of this may not be clear to most enterprises. If you really looked at most of the practical solutions you have out there, this is a logical sequence of events starting from the opportunity side. For lack of a better term, this is the new industrial revolution.

First, having the ability to literally have every part of the supply chain, every part of an automated production line, every tool and component talk to us is unprecedented. Right now, technology will allow us to do that.

Second, in terms of process automation, the ability to eliminate the human touch from repetitive tasks creates huge advantages in cost optimization and efficiency and also reduces the need for rework. It creates a much more effective work space in manufacturing or retail industries where we see huge numbers of repetitive tasks.

Thirdly, with respect to AI, within that area, the most important element – and I'm not talking about a cognitive revolution or machines taking over the world – this is right now. What we have is the ability to use machine learning and deep learning to understand the link between cause and effect and rectify those things on any industrial process in a fraction of the time it would once have taken. This is something that has real practical value. The possibilities are endless

*John Gikopoulos
had a lengthy career at McKinsey before he moved to Infosys, a global business consulting, information technology, and outsourcing services company that does approximately one quarter of its business in Europe

in reducing cost, reducing rework, improving the customer experience, cutting time to market, and making sure the whole enterprise is more effective in the end. This creates a huge value for organizations that are willing to embark on this transformation.

What are the primary challenges in taking this direction?

I think what a lot of companies forget is that, first, this needs to be end-to-end transformation. Companies need to have an end-to-end perspective. The only certain way to destroy shareholder value is to misunderstand that because otherwise, at some point in the process, the legacy process will create problems. So, it is a really big challenge; you have to understand how to reap the benefits, you need that end-to-end perspective.

Second, it is expensive. If you look at any business case, there are few situations where you could actually say the investment will pay for itself in one to six months. This needs to be a strategic decision. It can't be a trial and error type situation and there needs to be senior stakeholders – a C-level commitment to make sure it works.

The third part is that there needs to be an operational or organizational change management program supporting the journey. There has been a lot of talk about the fear that IoT and automation brings to employment. In my experience, when you try to find actual examples, automation is not the problem that people

claim. It is not evident that people are uninterested, they're not so much afraid as simply interested in creating the next level of efficiency. Still, it is important to understand that there will be challenges within these processes with people, so any type of effort needs to be accompanied by serious HR mechanisms that help create additional value for people that are involved in more automated processes.

This is where the true multiplier exists in companies that embrace IoT and RPA. If you think of where most of the value is, in the studies I have run, depending on the industry, end-to-end, digital optimization can bring in benefits of 30 to 40 percent or even 60 percent. Beyond that, if you can redeploy people to higher value activity, the benefits can double or triple. But it is extremely important to make sure the change is supported by organizational change programs.

Should we be worried about cybersecurity?

Many companies tend to overlook this, especially when testing solutions. If you look at the most common solutions, they are mostly in the cloud. Now, this would automatically create risks that, for the average industrial players, are unfathomable. The fact that your machine tools and supply chain elements can talk to you means they could also talk to anyone else; so, this is something that companies need to take very seriously. It is not something that can be overlooked.

What about competition?

The final part is the fact that in today's world, the barriers to entry for new products and new parts of the market and new industries, they're just crumbling. And this creates a time impetus like we haven't seen in the last 30 years in most industrial applications.

For example, I'm currently discussing these technologies with a Dutch supermarket chain that wants to embrace IoT and smart pricing. They would like to be able to have the prices change throughout the day and through the lifetime of the product. For this particular chain to just buy the sensors is a 400-million-euro commitment; it is huge. The problem is that one of their key new competitors is basically an online player who managed to raise in a second or third round of funding some 150 million euros. They will probably have no need for further investment because their entire supply chain is digital to begin with. So, these guys with zero "brick and mortar" investment and no brand value have managed to infiltrate key markets where my client makes most of their money and they have effectively destroyed a huge amount of value for that company. This is where new technology makes it important to make fast decisions. On the other hand, you can also imagine the level of threat that this technology enables.

What is the future for these technologies over the next few years?

I think although there are a lot of industry-specific trends, in general, like with every other type of transformation and shift, you will see front-runners and stalwarts, but the trends are the same. Having said that, I do see three megatrends emerging.

First, for these new players, the players that have no legacy, they will be entering the market much quicker and much more aggressively than any of us have been used to for the last 20 or 30 years. I think this is something we've already seen in digital-heavy industries like retail, travel, and logistics. For example, what we've

seen with Booking.com is something that ten years ago would have been just a figment of the imagination – travel agents would have laughed. Now, it is a reality and the reality has been supported to a large extent by RPA and digital and AI-enabled technology – though not so much IoT in this case.

Second is the race that established players will have to run to make sure that they catch up and they can keep their customer base away from the grasp of the big four or five, by which I mean companies like Amazon, Google, and Microsoft. Right now, we see that gap widening even in industries that feel themselves to be relatively safe due to regulations such as banking and insurance. It wouldn't take much for those big players to decide to dip into those industries and take over the entire client relationship that they now control to a large extent anyway by managing these interfaces. What I tell my banking and insurance clients is that if you ever lose the interface with the customers, once that happens, you've lost the customer, you become just another vendor or provider and someone else will make the profit off of the customer that you think is yours.

The third trend is that we will see an acceleration in terms of end-to-end digital solution options like IoT and RPA. The reason I say that is I think when you compare Europe versus the Americas, it might be a slightly different pace, but it is not really that different. Some people have said the US and North America are more advanced in some areas but I think at the end of the day, the pace is similar, though the culture of decision-making is a little different. You will see that the moment you start to have the first big players go into these solutions, the others will follow quickly. It's a game of seeing who does it first and watching to see whether the investment they make pays for itself. So, the thinking is let someone else be the front-runner and take the risk, but I think everyone understands that if they don't get on the bandwagon, the game is over.

Regarding your warning about the need to have a strategic point of view, RPA and IoT are often pursued by business units or departments. Is that a problem?

I think at the heart lies the fact that I do see all of these technologies being part of the same journey. You need common denominators within that effort or it can be a failure; you won't get 100 percent of the benefit. Let me elaborate. A first key question for whatever I'm investing in is, what is the business value? Unless that discussion takes place takes place at a C-level, you'll never have a full answer. You will never have gotten it really right. It will be a country or business unit answer, not a company-wide answer.

Second, let's not forget that a lot of people think of the world we live in a world where everyone is friends. But it is not. Most organizations have been controlling huge units, which equals strength. People aren't that forward-looking when it comes to foregoing that strength, so what you see is that all these technologies are able to create huge amounts of value, but they aren't based on huge armies of people. Who will be the first CIO or CEO who hands over their army of people and resources to undertake a solution that might or might not create value? It won't happen in a day or two. It will take time, especially if they have revenue and profit from their current operation. That is why the world we live in is so prone to disruption. If I have no legacy, on the other hand, I can make that decision. A five-year-old company will decide to have an end-to-end digital solution if they have nothing to lose.

At the end of the day, what we believe and what I believe is that we at Infosys need to play a role of translator. It is a word you'll hear often from us; we need to translate between the business and technical and the HR requirements to make sure all the different organizations align themselves in view of the value that can be introduced by digital to various parts of their organization.

> "Eliminating the human touch from repetitive tasks creates huge advantages in cost optimization and efficiency.

Azure Sphere

In the next decade, nearly every child's toy, every household appliance, and every industrial device will be connected to the Internet. These connected devices will also become more intelligent, with the ability to predict, talk, listen and more. This connectivity provides an opportunity for the companies who manufacture these devices to transform their business – with new product offerings, new customer experiences and an opportunity to reimagine everything.

Azure Sphere brings together the best of Microsoft's expertise in cloud, software, and silicon—resulting in a unique approach to security that starts in the silicon and extends to the cloud. Together, Azure Sphere MCUs, The Azure Sphere OS, and our Azure Sphere Security Service provide a foundation of security and connectivity that lets you create intelligent products and experiences that customers love—and get them to market quickly—at a price point that enables IoT at scale.

Find peace of mind

Protect your products and customers with our turnkey, end-to-end security solution that protects, detects and responds to threats–so you don't have to.

Get to market faster

Lower overhead and increase team efficiency with tools that deliver productivity and optimize development and maintenance of your devices and experiences.

Create the future

Transform products, update engagement strategies, and drive new revenue with chips that are powerful enough to create next generation experiences.

Meet the newest class of microcontrollers, plus the OS and cloud technology that secure them
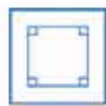
Azure Sphere MCUs

The Azure Sphere OS

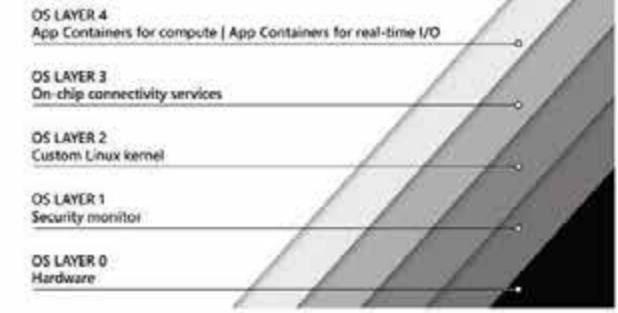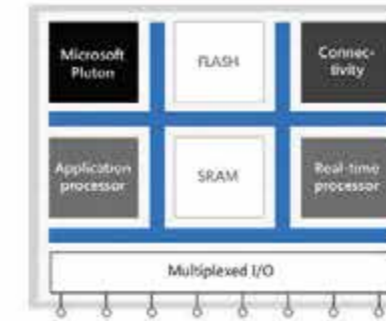**The Azure Sphere Security Service**

Azure Sphere can help you securely connect your products at a price point that enables IoT at scale. Our three-part solution brings together the best of Microsoft's expertise in cloud, software, and hardware—resulting in a unique approach to security that starts in the silicon and extends to the cloud.

An entirely new class of MCU with built-in Microsoft security technology, connectivity, and the headroom to support dynamic new experiences.

A highly-secured OS from Microsoft creates a trustworthy, defense in depth platform for new IoT experiences.

The Azure Sphere Security Service guards every Azure Sphere device. It renews security, identifies emerging threats, and brokers trust between device, cloud, and other endpoints.

Protecting devices with certificate-based authentication

Guaranteeing device authenticity and running only your genuine software

Getting insight into device and application failure and visibility into emerging threats

Deploys app updates to your Azure Sphere powered devices
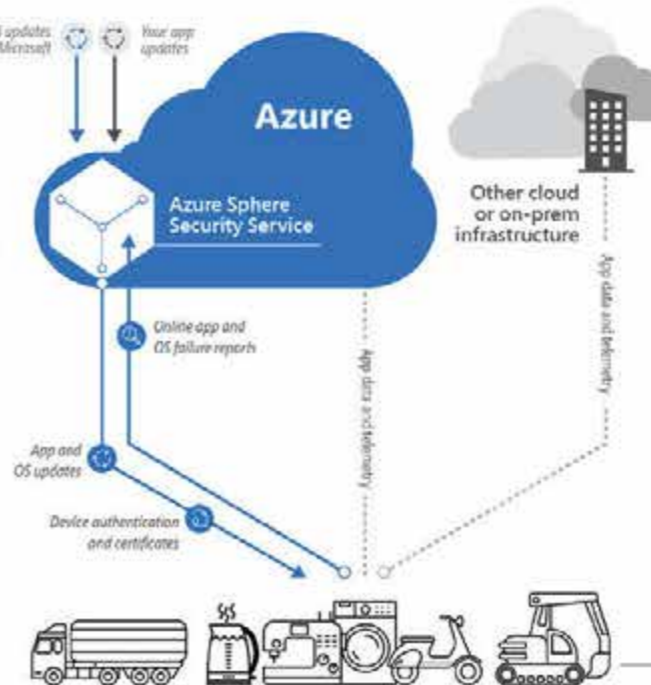
Azure Sphere gives you choice. You can connect data from any cloud, proprietary or public, or even to your on-prem infrastructure to the Azure Sphere Security Service.

Informing your app with data

Storing telemetry and insights

Providing customer information

Housing commerce and other transactions

Get more done with the Microsoft tools you already know.

Modernize your MCU development experience with Visual Studio

Install the Visual Studio Tools for Azure Sphere to get started writing applications. These tools include application templates, development tools and the Azure Sphere software development kit (SDK).

- Simplify and accelerate development
- Streamline debugging
- Modernize your development experience

Connect your Azure Sphere devices quickly and easily to Azure IoT

A simple Visual Studio wizard guides you through the process of connecting your device to Azure IoT Hub and adds the code you need directly into your application.

- Easily connect your devices to Azure
- Send telemetry from your device to the cloud
- Enable device-to-cloud and cloud-to-device messaging

Learn more: www.microsoft.com/azure-sphere

Omnipresent Amazon
SHOPPING UNLIMITED

Amazon's consumer platforms Alexa,
Dash Replenishment Service, and Fire TV are all destined to
become part of the devices the commerce behemoth sells.
The company is deploying the same strategy with all three and
is using other tactics to get companies young and old aboard.
The goal: being available everywhere.

◼ **By Marcel Weiss**

Imagine you have just founded an exciting new consumer-focused startup in the sprawling IoT space. You have a fancy new hipstery coffee machine in the works that, thanks to its "smarts," can be remotely triggered to start making coffee via its smartphone app, can automatically make different kinds of coffee and so on and so forth. Maybe you go to the popular crowdfunding platform Kickstarter to get your presales in and, in general terms, see what the demand for your first product of your new company looks like before you go into production for the first time.

After you have successfully fulfilled your crowdfunding campaign, the crucial part starts. You have a product that works but you don't really have a brand yet. You have some early adopting fans, but you don't have a large customer base. You have a product, but you don't have a market yet. The route to market is hard for new hardware startups in the consumer space. What now? Where do you turn to?

Immediate access

This is where Amazon's Launchpad comes in. Amazon gave this section in the US the subhead "New Products from Today's Brightest Startups." You get the gist. With Launchpad, Amazon gives startups a place to present and sell their products. Launchpad promises distribution to companies that have none yet. From the start,

Amazon positioned Launchpad as an international product. With Launchpad, startups immediately got access to ten of the markets Amazon operates in. Bringing startups aboard early on is attractive to Amazon. It binds young, potentially successful companies to Amazon. Distribution can be like a drug, and Launchpad is a gateway drug.

Amazon made Echo broadly available in the US in June 2015. Germany and the UK followed in 2016. And just recently, this June, Echo launched in France. Amazon meanwhile also released different versions of Echo and they certainly will bring even more form factors to market. The real story though is not about Amazon's own devices, but the software/cloud platform behind them: Alexa. To understand Amazon's long-term goal for electronics and the future of retail, Alexa is a central piece of the puzzle. Amazon sells inexpensive devices that merely connect to the cloud where everything comes together on the platform level.

All the Echos Amazon is selling are dumb terminals for the cloud. They are cheap entry points to the world of Amazon. So why are they inexpensive?

To maximize the user base for the platform beneath. They are, to borrow a phrase first coined by industry analyst Ben Thompson, the best customer of the Alexa voice platform. But they are not the only one. Amazon's Echo devices are the first avalanche. They provide an active user base for companies which want to jump on

❞ **Echo and Alexa provide an active user base for companies that want to jump on board fast.**

board fast. The more interesting step, thus, was when Amazon opened up Alexa to be integrated into every device possible.

One visible consequence: since 2017, Alexa has been the secret star at CES two years in a row. Without Amazon itself even being present at the yearly trade show. Smart home companies like Invoxia or Vivint, smart lightbulb manufacturers like Philips, GE, and many, many others, speaker companies like Sonos or Lenovo, and so on, were expectable candidates for integrating Alexa into their products.

But Alexa also found its way into cars via the Garmin Speak and directly integrated into new Ford and BMW cars. Thanks to cooperations with Microsoft and manufacturers, Alexa is also finding its way onto laptops. The first Android devices with Alexa preinstalled have also long since hit the market. This list is not exhaustive. This is just to prove a point. By now, it should be obvious that Amazon's goal is to have the Alexa platform as broadly available as possible. Alexa is being built to be an operating system for everything voice. Wherever voice may go, Amazon will be there as one of the big platform vendors.

On March 31, 2015, Amazon unveiled the Dash Button. Many at the time thought of this as a premature April fool's joke. But the people at Amazon are anything but fools, and by now the number of available FMCG brands for Dash Buttons are into the hundreds.

Coffee machines revisited

Besides the Dash Wand, an Alexa-powered barcode scanner, the Dash family also counts the Dash Replenishment Service (DRS) amongst it. DRS is an integrated refillment service; an automated Dash button, ➡

photo:© BMW

if you will. Remember our hipstery smart coffee machine? With DRS, the coffee machine knows when the coffee will be used up and automatically reorders fresh beans. Amazon can count Siemens, Bosch, and Samsung amongst some of the manufacturers integrating DRS into their home appliances. As with Alexa, DRS implements an Amazon functionality right into the devices.

In April 2014, Amazon launched the first iteration of Fire TV. Fire TV is a small box that via HDMI connects your average TV to the Internet. Like Roku or Apple TV, Fire TV nowadays represents the smarts in "Smart TV." Amazon sells three different form factors of these TV devices, but again, the more interesting aspect from a strategy perspective is the integration part. Toshiba and Element are the first to sell a "Fire TV Edition" of their products on Amazon. They won't be the last.

Amazon everywhere

Do you see the pattern? As with the Echo and Alexa and with the Dash Button and DRS, Amazon sells Fire TV devices and integrated "Fire TV Editions." Stand-alone devices and integrated functionalities, all connecting to a cloud platform controlled by Amazon. Amazon wants to inject itself into as many devices as possible. And the online retailer now has at least three consumer-facing platforms it is pushing for integration in devices. In this light, initiatives like the Amazon Alexa Fund, which invests in companies building devices with Alexa, have to be seen as ecosystem amplifiers. It doesn't end with "conventional" connected devices either. With Amazon Key, Amazon is building a platform for smart door locks that every startup in

In the driver's seat
Alexa has found its way into cars via Garmin Speak and is now being directly integrated into the latest Ford and BMW models.

"

Customers to be able to use Alexa wherever they are.

that space can hook into in the near future. And why shouldn't they: convenient home delivery of online orders is a good use case for smart locks making those locks desirable.

With Amazon being the biggest online retailer in western markets, this leads to a question: how much can Amazon leverage the distribution strength it has accrued? With Launchpad, Amazon is trying to bring start-ups early onto its commerce platform. With DRS or even a wild combination of Fire TV and advertising-based Prime channels – which are planned – device manufacturers may get a cut from the revenues generated through their devices. To fledgling consumer-facing IoT startups, Amazon presents distribution, possible investment, differentiation, and a possible recurring revenue stream. This is quite a unique proposition.

Amazon may well be on the way to becoming the major player for B2C IoT.

There is some consolation for those wanting to compete with Amazon. The latest announcements regarding DRS implementations date back to 2016. Not everything Amazon tries out immediately becomes a jugger-

naut; just remember the Fire Phone, which tanked almost immediately back in 2015.

In its recent earnings report, Amazon said that it wants "customers to be able to use Alexa wherever they are." Some believe they may try their hand again at a phone, as Benjamin Schachter, technology analyst at Macquarie, wrote in a recent note to investors. Maybe. But it is more likely that Amazon will coerce starving Android manufacturers into pre-installing Alexa. Amazon can use its e-commerce power to promote those products that have Alexa, DRS, or Fire TV integrated over those products in the same categories that do not. An integrated Amazon service may for certain product categories become an implicit prerequisite for getting promoted to Prime customers, as well.

It is obvious that at some point in the future this will become a regulatory issue. Abuse of market power seems inevitable at this point. Until then, Amazon will almost surely find its way into more and more connected devices and the boundaries between retail and products will blur further and further.

This is inevitable with connected devices: connectivity also allows for embedded e-commerce. For the first time, the seller of a product is given the power and the incentive to become a service provider for the product. You don't just earn by selling the devices, but also through their usage. Amazon is simply the first and most aggressive company yet to start taking advantage of this.

Making a dash for it
Amazon's Dash Replenishment Service (DRS) service is currently being integrated by Siemens, Bosch, and Samsung into their home appliances.

Twyst
SMART BAG

This tiny company is changing brick-and-mortar retail by ending checkout lines and capturing customers' in-store behavior.

■ **By Mark McCoy**

Imagine walking into your favorite store, getting a special offer just for you, choosing your items, and then walking out. No line, no checkout. Just a wireless, effortless, and secure transaction that automatically charges you for the items in your bag when you leave a store. That's the not-so-distant future of shopping, and it's being implemented right now by innovators like Kevin Schaff, founder and CEO of IoT start-up Twyst.

Here's how it works. Upon entering, you're greeted with a push notification on your smartphone asking if you'd like to try the Twyst Smart Bag. The bag is equipped with Bluetooth and by simply touching your phone to the bag, you'll receive a prompt to pair the devices. Now your in-store and digital shopping experiences are linked, and all you have to do is shop.

That's how Twyst is transforming brick-and-mortar retail.

In 2015, Schaff, drawing on his background in data analytics, had an idea – eliminate points of friction in retail, primarily the checkout line, and capture in-store behavior to turn it into actionable data. Then he met Avnet business development manager Eric Leahy and discovered the Avnet Innovation Lab located at Arizona State University.

An idea and the team to make it real

Leahy was impressed with Schaff's ideas. Avnet's Innovation Lab was conceived to help aspiring entrepreneurs, like Schaff, to advance their ideas and bring them to market. Through the lab, Leahy was able to connect Schaff with all the resources he needed: technical support, mentorship and design, manufacturing, and marketing expertise.

"Kevin is an amazing guy. He knew that friction within the retail space was a problem. For customers, it's waiting in lines; for retailers, it's trying to understand why people abandon carts. He understood the problem, just not the best way to solve it," recalls Leahy.

No more standing in line
Thanks to Twyst, a wireless, effortless, and secure transaction that automatically charges you for the items in your bag when you leave a store.

Schaff also knew there were already RFID (radio frequency identification) tags in most products for shipping purposes, and that he could leverage that inside a store. Twyst's smart bag (or any other shopping container like a cart) is designed to detect an item's presence and transmit data via a Bluetooth low-energy (BLE) network. Leahy helped Schaff choose and source the right technology – the microprocessor, RFID reader and sensors that go in the bag, and the beacons that go throughout the store – to produce and refine early prototypes.

What's next?

Now well past the design phase, Twyst is entering full-scale production and installation into its first big-box retailer. Its relationship with Avnet has transitioned over time from innovation lab participant to full-fledged customer.

"Having Avnet's help in the design phase as part of the innovation lab was highly valuable. Now I'm at a point where we're putting a sensor platform across 300 stores in different cities. How can a startup handle those logistics? Turns out Avnet does that, too. Production, inventory, distribution, even returns. Their ability to help us rapidly scale is fueling our growth," says Schaff.

"As an entrepreneur, you want to build maximum value before you formalize your venture capital. That's what working with Avnet and having their help in the design phase allowed us to do. So, we get to keep more of our company – more equity. That's every entrepreneur's dream," he concludes.

Plug and Play		The Chicago		Mi-IDEA		Smart Systems Hub		Nasscom CoE			Muru-D
Sunnyvale		Connectory	Startupbootcamp					IoT India	Microsoft		
	RIoT	Chicago	IoT	Manchester		Dresden	Prague IoT Centre	Bangalore	Innovation Center		Singapore
	Raleigh		London				Prague Startup Centre		Taipei		
							Prague				

Innovation factories

WORLD'S 10 BEST IOT HUBS

IoT hubs are not just hotbeds for startups; established companies can also gain a boost by using them. **These communities of innovators offer direct access to hosts of fresh new ideas and plenty of digital expertise.** Choosing the right hub can be tricky but, as a rule, the best IoT hubs offer the widest range of services.

■ By Oliver Schonscheck

Chicago Connection
Created to support the digital startup community, The Chicago Connectory has become a community of entrepreneurs, IoT startups, corporate innovators, and other creative minds.

photo © Prague Startup Centre

Startup hubs have a long tradition in the technology industry but their potential is still underrated by many established companies. They are not only a good starting point but also offer the best opportunities to revolutionize existing business models, further the technology agenda, and generate know-how – even long after the startup phase is over.

Instead of looking at generic startup centers, companies would do better to set their sights on specialist IoT hubs as their nucleus for innovation as well as a way to kick-start their entry into the totally connected world of IoT.

Scores of IoT hubs have sprung up around the globe in recent years, often driven by local, regional, or national governments, but business associations, universities, and research institutes have also become typical hosts.

For startups, most good hubs offer much-needed professional advice and support in areas such as marketing, sales, finance, and tax law – things with which many technology-grounded founders struggle. Many operators provide coaching and mentoring services as well, so hopeful young founders can draw on the experience of seasoned entrepreneurs who, in many cases, were a successful startup themselves just a few years ago. Hubs are also a good place to meet energetic, like-

> In our IoT lab, we offer a lot of tools, a 3D printer, and large work desks. We are also able to connect startups with mentors, partners, investors, and potential customers.

Robert Reich,
startup manager at Prague Startup Centre

photo © ncriot.org

Tom Snyder,
Executive Director, RIoT

photo © ncriot.org

minded people and as a forum for the exchange of ideas.

The same benefits apply to established companies as well, with the added bonus of the chance to pool resources and exchange product and application designs. Hosts and tenants of IoT hubs have direct contacts among local startups and can link them to older enterprises that can provide fresh impetus to established business models as well as entry points into new markets and technologies.

Some IoT hubs are more successful than others in this form of matchmaking which, in the end, is another kind of service, albeit a tricky juggling act requiring a vast network of contacts within government, academia, associations, and the investment community, as well as personal contacts within the business world.

Most hubs operate several business centers where startups, especially, can find room and the necessary infrastructure to get up and running quickly. Many also offer a range of social events aimed at creating interaction and bonding between entrepreneurs and employees, both young and old.

A good example is RIoT, an IoT ➔

Plug and Play (https://www.plugandplaytechcenter.com)

■ Sunnyvale, California, United States, active in 25 locations globally

26 specific IoT corporate partners, including Panasonic, Hitachi, Compal, Rockwell Automation, Fujitsu, ADT, Philips, Kyocera, Nintendo.
Startup references: Sentiance, Angee, Swiftly, BreezoMeter, Stack, Moj.io, DynoSense, Locbit
Services:
➔ Innovation team
➔ Insights of best practices from other leading corporations
➔ Soft landing pads internationally for corporations to explore startup ecosystem in other regions
➔ Ability to select/engage startups
➔ Help to change the culture of the corporation
➔ Platform for better branding, events, networking through the ecosystem

RIoT (http://ncriot.org)

■ Raleigh, North Carolina, United States
IoT ecosystem organizer in the US.
More than 70 partners, the majority of which are large corporations like IBM, Microsoft, Oracle, Nordic Semiconductor, Flex, Verizon, and Samsung.
Startup references: Fokus Labs, ProAxion, BruVue
Services:
➔ Help established companies connect with the entrepreneurial and startup community
➔ Help to find high-growth future customers, exceptional talent and emerging technologies
➔ Organize business development and education focused workshops, conferences and events

The Chicago Connectory (https://chicagoconnectory.com)

■ Chicago, Illinois, United States
Launched in May 2017 as a partnership between Bosch and 1871 (created to support Chicago's digital startup community), it is a community of entrepreneurs, IoT startups, corporate innovators, and creative minds.
Targets: educating about IoT, supporting startups, connecting partners
Services:
➔ Network of IoT trends and in-market solutions
➔ Active community of startups, universities, investors, corporations, civic leaders, technology influencers, and thought leaders all invested in IoT
➔ Experienced innovation team focused on integrating the partner company into the IoT ecosystem

photo © www.startupbootcamp.org

London Socializing and networking are an important function of a good IoT Hub.

Hub founded 2017 in Raleigh, North Carolina, for the express purpose of providing resources to the startup community that are not available in typical co-working and startup incubator spaces. Its RIoT Lab is a fully fledged hardware, wireless, and software prototyping laboratory with all the tools for full-stack IoT prototyping. Tom Snyder, RIoT's executive director, says the hub focuses on being the connective tissue to bring together industry, start-ups, government, universities, and

Cansu Deniz Bayrak,
COO Startupbootcamp IoT

Getting a hand
Successful IoT hubs usually provide coaching and mentoring services where young founders can draw on the experience of seasoned entrepreneurs who, in many cases, were once a successful startup themselves.

investors in the most collaborative way possible. "We only are successful when all these stakeholders are successful," he claims.

Startupbootcamp IoT, founded in 2016 in London, operates a worldwide chain of accelerator programs designed to support early stage tech founders and hardware developers. The programs allow them to scale their companies rapidly by providing direct access to an international network of the most relevant mentors, partners, and investors in their industry. This includes:

● AfriTech in South Africa, which focuses on high-growth startups

in blockchain, connected devices, payment solutions, capital markets, asset management, and integrated supply chains.

● Digital Health Berlin, which is now entering its third cycle, is supported by major pillars of health care, Sanofi, Munich Re, Berlin Institute of Health, and Deutsche Apotheker- und Ärztebank. Its goal is to provide a solid launchpad for fast-growth early stage IoT startups.

● Smart City Amsterdam offers co-working space in Amsterdam's first IoT startup hub and offers three-month innovation programs in areas such as smart infrastructures and urban planning, smart ➜

Europe

Smart Systems Hub (www.smart-systems-hub.de)

■ **Dresden, Germany, Europe**
Partners: SAP, T-Systems Multimedia Solutions, Infineon, GlobalFoundries, Fraunhofer, Silicon Saxony, HighTech-Startbahn, 5GLab
Startup references: Wandelbots
Services:
➜ Consultation on company setup
➜ Mentoring (via FutureSax and others)
➜ Incubation and growth consultancy

(mainly via HighTechStartbahn)
➜ Connecting to relevant industry partners
➜ Marketing to local and regional policy makers as well as the general public
➜ Innovation workshops
➜ Setup and management of pilot projects
➜ Promotion of activities

Startupbootcamp IoT (https://www.startupbootcamp.org)

■ **London, UK, Europe**
Hardware vertical of Startupbootcamp, a family of global startup growth programs.
Funding partners include: Cisco, Rolls-Royce, DLL, Inmarsat, and Farnell/Avnet
Startup references: ThingTrax, Doordeck, Trackener, HUDlog, Mothive,

Odyssey Sensors, Unifi.id
Services:
➜ Insights into upcoming trends in IoT innovation
➜ Aligning a startup's sourcing with its roadmap, so the startup is able to interact in a meaningful way (proof of concept, pilots)

Mi-IDEA* (https://www.mi-idea.com/)

■ **Manchester, UK, Europe**
Program providing one-to-one support, mentorship, and go-to market strategy for disruptive technology companies.
Sponsorship from local and global partners: Manchester Science Partnerships (MSP) and Cisco
Services:
➜ Acting as a co-innovation hub to trailblaze applied research, collaborating with partners, startups, universities, and government research institutions

Prague IoT Centre / Prague Startup Centre (http://en.pragueiotcentre.cz/)

■ **Prague, Czech Republic, Europe**
Launched in April 2017, it helps IoT startups to get its pilot customers and expand internationally through Conrad and Sigfox network operators. Focused on B2B IoT and smart city projects, it offers help and mentoring.
Partners: T-Mobile, SimpleCell, SigFox,

Microsoft, Operator ICT, EY, Conrad, Esa, BigClown
Startup references: Comfort Meter, Larx, Acrios
Services:
➜ Connecting startups, mentors, partners, investors, and potential customers
➜ Regular lectures, workshops, and meetups

* (Manchester Inspired-Innovation Digital Enterprise Alliance)

Asia and Australia

Muru-D (https://muru-d.com/)

■ Singapore, Asia

Startup accelerator program in Australia and Asia (Brisbane, Perth, Sydney, Singapore, and Melbourne). Muru-D is a place for technology startups to access investment opportunities and business assistance in their acceleration phase. The program provides an opportunity for startups to receive ongoing business support, mentoring, and coaching to bring their ideas to life, in addition to a seed capital investment from Muru-D, backed by Telstra.

Its mission is to develop the best entrepreneurial minds in Australasia, giving them the tools they need to solve the world's most challenging problems.

Startup reference: FarmBot

Services:

➔ Connecting founders, investors, and mentors

Microsoft Innovation Center (https://www.microsoft.com/taiwan/iot/iotcenter/)

■ Taipei, Taiwan, Asia

A Community Lab in Microsoft's Taipei office supports an IoT ecosystem of startups, makers, and academic partners

For vertical partners: Based on dedicated IoT verticals identified, each lab comes with "scenario kits" that can be dynamically installed based on specific target device/scenario.

The IoT Open House provides workshops to help address challenges or obstacles that the company may be facing in current IoT projects.

Microsoft's Internet of Things Expo is a global networking opportunity for partners to come together and share and learn about solutions and market opportunities.

Nasscom CoE IoT India (Centre of Excellence for IoT) (http://coe-iot.com)

■ Bangalore, India, Asia

CoE IoT is a startup accelerator, an initiative to build an IoT ecosystem in India that connects various entities, such as startups, enterprises, venture capitalists, government, and academia. Formed by The National Association of Software and Services Companies (Nasscom), the center is designed to foster sustained engagement between large corporate and innovative technology ventures across India.
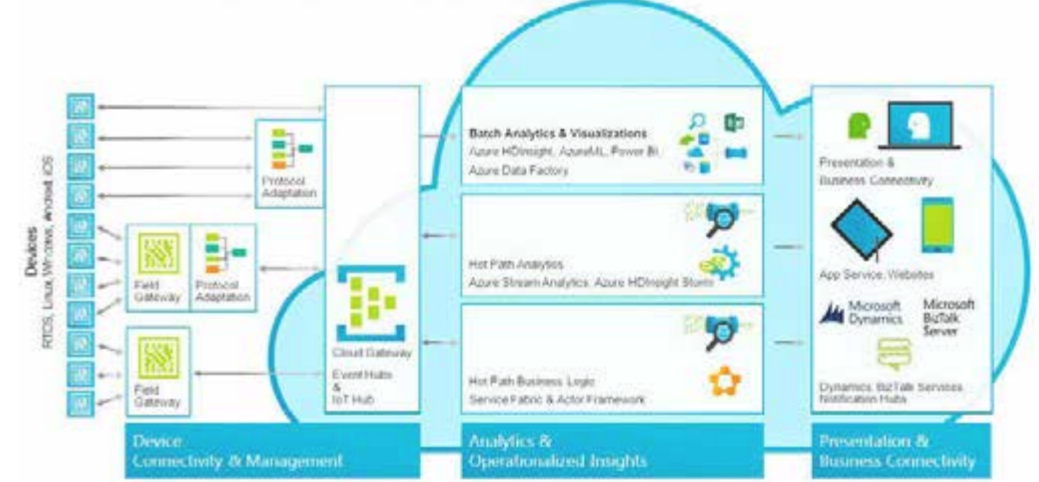
Partners include: Microsoft, Cisco, Intel, IBM, AWS, Dell EMC, Schneider Electric, GE, Texas Instruments

Services:

➔ Access to trend insights
➔ Connect with like-minded businesses
➔ Government policy roundtables
➔ Virtual corporate accelerator to help corporates build their own program

IoT Device & Cloud Patterns

The way to IoT
To help startups find the right strategy, some IoT hubs have developed their own roadmaps.

homes and buildings, smart energy, and clean tech.

"Even with the advanced support ecosystems that exist in Europe, starting up a hardware business is still harder than starting a purely software-based one," says Cansu Deniz Bayrak, COO of Startupbootcamp IoT. "There are not nearly enough hardware-specific propositions for early stage startups; this is why we launched Startupbootcamp IoT in 2016 with the aim of making the journey of building a connected hardware startup clearer, shorter, and more successful for entrepreneurs. We rely on the cumulated Startupbootcamp expertise and our global network of 22 programs in six continents with 150 industry partners to connect the dots for our alumni startups."

IoT Hub Berlin, located in Factory Görlitzer Park, is a newcomer to the IoT hub scene. Founded in July 2018, it is part of a network of 12 digital hubs across Germany, collectively known as De:hub, which is supported by an initiative of the Federal Ministry for Economic Affairs and Energy. Each location is designed to serve as a meeting point, or platform, where new and old economies come together to solve new challenges by using IoT, machine learning, AI, and blockchain. Harald Zapp, CEO of Next Big Thing, a main partner in De:hub, believes that by bringing together governmental support, scientific research, and technological knowledge entrepreneurial innovation can be fueled while also helping to back the German industry's future. "Knowledge, tech, and sustainability must be synched if success in IoT is to be achieved," he says.

As IoT spreads to more industries, the role of IoT hubs is certain to grow. Looking around the globe, Smart Industry has picked our ten favorites from among a pack of contestants.

Digital Twins

MIRROR IMAGE

Digital twins have become one of the hottest IT topics
in years. **They promise to revolutionize innovation and reduce time
and cost of development,** as well as improving collaboration
along the supply chain. But what are they really?

■ By Francisco Almada Lobo*

Going under such monikers as Industry 4.0 or Smart Factory, the technologies involved offer such huge benefits in the way products are made that those who don't plan for and embrace this change will almost certainly be left behind. Modern manufacturing execution systems (MESs) are critical, long-term investments in the future of a business, especially for the manufacture of complex products such as semiconductors or medical devices. They offer a pathway for the transition from traditional, linear manufacturing models to innovative, dynamic models that increase efficiency, raise quality standards, and meet the changing demands of customers today and in the future.

Within the smart factory philosophy sits a concept known as the "digital twin." This concept was first introduced by Dr. Michael Grieves in 2002 through his ideas on product life-cycle management (PLM). It involved mirroring what existed in the real world in a virtual space. The concept was later named digital twin and its application extended to more areas of manufacturing.

A digital twin can be defined as: "A virtual, computer-based copy of something real, modeled to realistically represent and control physical assets through their life cycle and be easily accessible at any time." Importantly, this definition leads to the fact that physical assets can only be represented and controlled properly if they can be modeled.

The digital twins are therefore not only mirror images, but are directly linked to their real-world counterparts: data "flows" from the physical objects into their virtual copy, allowing a correct understanding of their state, while the virtual copy influences its counterpart through information or instructions sent to the physical object and driving behavioral changes.

A digital twin can even consist of multiple nested twins that provide a wider view across equipment and assets. For example, an oil refinery could employ a digital twin for a compressor motor, the compressor itself, and the entire multi-train plant. Depending on its size, the refinery could have anywhere from 100,000 to 500,000 sensors taking measurements which are then represented in the digital twin, which then enables operators to easily compare and benchmark things against one another and thus to understand what's working well and what's not.

The benefits provided by digital twins

Francisco Almada Lobo, "The benefits of using a digital twin can be realized across production quality, efficiency, traceability, and new product introduction."

Getting a better understanding

Digital twins can directly influence their real-world counterparts.

are gaining a lot of attention nowadays. They have been extensively cited by market analyst Gartner as being in the top 10 strategic technology trends in 2018 and detailed by IDC within IDC FutureScape: Worldwide IoT Predictions, which states: "By 2020, 30 percent of G2000 companies will be using data from digital twins of IoT connected products and assets to improve product innovation success rates and organizational productivity, achieving gains of up to 25 percent."

More specifically, the benefits of using a digital twin can be realized across production quality, efficiency, traceability, and new product introduction. The technology enables visualization and control of products, processes, specifications, and attributes to enable optimization of quality. It identifies value-add and non-value-add production steps and processes to help tune production efficiency. The modeling of the real-world entities also inherently means that everything about them can be registered, providing total traceability. When it comes to new product introduc- ➜

*Francisco Almada Lobo is co-founder and CEO of Critical Manufacturing, a provider of software products and services for advanced manufacturing.

tion, quick feedback and complete information helps to accelerate the introduction process.

Which is which?

The original digital twin has been presented as a concept that would span throughout the entire life cycle of the product (creation, production, operation, and disposal) and hence the association with the PLM world.

Considering only the creation and production (manufacturing) phases, the digital twin models fall into three broad categories, which some authors further break down into additional ones: product design, process planning and validation, and execution. In product design, its use is more associated with PLM, with the control and visualization of designs, variations, and specifications. Process planning and validation helps with testing a product's manufacturability

Color counts

Color codes for the states, labels, or charts allow better factory monitoring, covering areas such as the status of machines and the amount of material on the shop floor.

by providing the ability to plan processes, resources, and other related factors.

In product design and planning, while the digital twin is being increasingly explored by PLM providers, at the execution level the power of the digital twin has not yet been fully explored. At first sight it might be surprising that this is the case, especially as IoT in manufacturing, or the Industrial Internet of Things (IIoT), becomes a true enabler for these models. According to Gartner, that's precisely why "digital twin in the context of IoT projects is particularly promising over the next three to five years."

However, to leverage the possibilities created by the relative ease of capturing and transmitting data from physical devices using IIoT technology, a strong model with the appropriate contextual information must exist on the virtual side. This system does ex-

ist, and it's called MES. Unfortunately, in the majority of cases, systems that are currently in use are burdened by legacy technology, and not prepared to become the digital twin.

Building a twin

Gartner says, "Organizations will implement digital twins simply at first, then evolve them over time, improving their ability to collect and visualize the right data, apply the right analytics and rules, and respond effectively to business objectives."

The first level of the digital twin implementation is quite obvious. All manufacturing physical objects have three main elements: a physical location, a state, and additional parameters. So, all that the MES needs to have to implement this first level is x, y, z coordinates, a state model, and a data set for storing values of parameters. Then, it's all about representing them in a

screen and being able to update all of these in real time as changes happen. The representation of these entities, with color codes for the states, labels, or charts allow factory monitoring, covering areas such as the status of machines and the amount of material on the shop floor. A modern MES quickly implements and allows real-time updates of different equipment made available via a web browser to provide supervisors, managers, and engineers with an overview of what is happening throughout the plant. This can also be extended to a digital twin of multiple factories, enabling managers to oversee a complete, global organization from a remote, mobile device.

As digital twins will primarily serve functions to immediately assess and understand the status of production, the more realistic this representation is, the higher the value. At the same time, the shop floor is a very dynamic entity and if the update of the digital twin is very cumbersome, it will quickly be left behind and undermine its main purpose. That is why simple drag-and-drop technology enables rapid implementation of such models. Shapes can be quickly added to a layout, modified as required, and associated with specific equipment. The key aspect is to have a system which can be modeled and updated by the process owners (not only by IT specialists) as easy and quickly as possible.

A quantum leap

3D representation is more difficult to achieve but adds significantly more value because it's a stepping stone towards virtual (VR) and augmented reality (AR) scenarios.

With 3D models and added realism, achieved through allowing the import of existing computer-aided design (CAD) models of manufacturing entities such as equipment, the solution allows a virtual navigation inside the shop floor, in what can be seen as a parallel to Google Maps of the factory.

Possibilities for the digital twin at an execution level continue as equipment can be associated with different

MES entities. The status of machines can be color-coded for a clear overview of process lines. Moving assets can have real-time positioning coordinates, enabling the display of products, containers, and even human resources on the shop floor. This can be implemented using RFID tags, where position coordinates will be updated when close to RFID readers or, for totally up-to-date information, using Wi-Fi triangulation systems and/or image recognition solutions. To ensure the visualization of the shop floor does not become too complicated, the model can be split into layers, so the user can choose to see just equipment, transportation systems, product flow, or human resources, for example.

If all of this allows a great 3D representation of the factory, then using a demo copy of the factory allows a complete virtual reality system, which can be used for training or for simulations.

More than that, the true compelling scenarios arise with augmented reality. In an AR scenario, digital information is superimposed on top of what can be seen. This can be achieved using AR glasses or by pointing a smart mobile device at the equipment or product. The added information could comprise additional data, charts, warnings, or operating instructions. Value-add scenarios for the use of AR include quick views of maintenance requirements, product order information, complete process or product

Added realism

3D representation adds more value because it's a stepping stone towards virtual (VR) and augmented reality (AR).

history, and KPIs for machines and products such as processing times, costs, and yield. Indeed, the application areas of this technology are only just starting to be explored, and future possibilities could be endless.

The future is here

At an execution level, the use of digital twin technology can add rich benefits to the shop-floor operating environment. The increasing amount of data from smart devices open a world of information that, if used correctly, can increase operating efficiency and help maximize the use of assets. With a future-ready MES to add context to data and coordination of processes, the digital twin can be used to provide clear plant visualization, including detailed information on equipment, product, and process KPIs.

2D and 3D models of the shop floor can be quickly and easily created with powerful graphical user interfaces tailored to the specific needs of system users. Alongside the clarity of all shop-floor processes delivered by the MES and factory digital twin, even more exciting benefits can be realized using VR and AR scenarios.

By their very nature, the future moves more quickly towards high-tech industries. With the right partner, realizing the enormous benefits of I4.0, including the digital twin, need not be a long and painful process, but one that fits with business needs today and in the future.

> By 2020, 30 percent of G2000 companies will be using data from digital twins of IoT connected products and assets.
>
> **Gartner, Inc.,** market analyst, Stamford, USA

Quo Vadis 5G?

THE LONG WAIT

Today's IT industry is split between **those who worry that it's already too late to catch the 5G gravy train and those who think they still have plenty of time.** This confusion is partly due to the mixed signals sent by the telco giants, but it is also due to the lack of a clear timetable for the rollout of next generation mobile technology.

■ By Bernd Schöne

Business and industry have been waiting for 5G to happen. Up to 100 bn devices are expected to be connected through the fifth generation of mobile communications, most of them via IoT. With 1,000 times the data capacity of today's smartphone networks, the latency-free, tactile Internet promises a revolution, one which will be especially felt in the field of automation.

In fact, "5G" is just a marketing term that covers a wide range of new mobile technologies. Back in early 2012, the standards committee of the International Telecommunication Union (ITU) – originally the International Telegraph Union – called for a network capacity of up to 20 gigabits. To put that in context: while LTE can theoretically achieve speeds of around 300 Mbps, in reality, we are not likely to get more than around 42 Mbps; standard 4G has real-world speeds of just around 14 Mbps. 5G trials are taking place today, with Verizon in the US, for example, demonstrating that its technology can achieve 30–50 times faster download speeds than currently possible with 4G. That would enable you to download a full movie in around 15 seconds, versus around 6 minutes on 4G.

Most telcos and other providers are talking about 2020 as the likely date for commercial availability of 5G, but some seem intent on stealing a march on the competition. While Chinese manufacturer ZTE was the first handset manufacturer to showcase a 5G smartphone at GSMA Mobile World Congress in 2017, Lenovo has eyes set on 5G smartphone leadership, based on chipsets provided by Qualcomm, an American company.

Has the future already begun? And will 5G really herald a new era, much like the introduction of the Internet itself more than a quarter of a century ago?

One thing is clear: by using a much wider range of frequencies in a more flexible fashion, 5G has the potential to connect billions of mobile devices. Most of them will not be smartphones at all, but rather sensors and actuators included in a plethora of IoT devices, including automobiles, trains, and planes.

Ready, set – go!

Engineers are already busy building robots and entire production lines with connection capabilities that rival today's fixed-line systems, only faster and more securely. 5G is the first mobile standard conceived expressly with machine-to-machine (M2M) applications in mind. Theoretically, at least, this could prove a gigantic shot in the arm for autonomous vehicles and other systems, including "smart factories."

For telcos and providers, the most important feature of 5G is its ability to adapt more flexibly than ever before to customer needs and demands. For that reason, 5G was conceived from the beginning as a software-defined network, or SDN; one which can ➔

Game changer
5G will have a huge impact on our everyday lives, from parcel deliveries to patient records and finding a lost dog or a space to park your car.

M2M in Daily Life
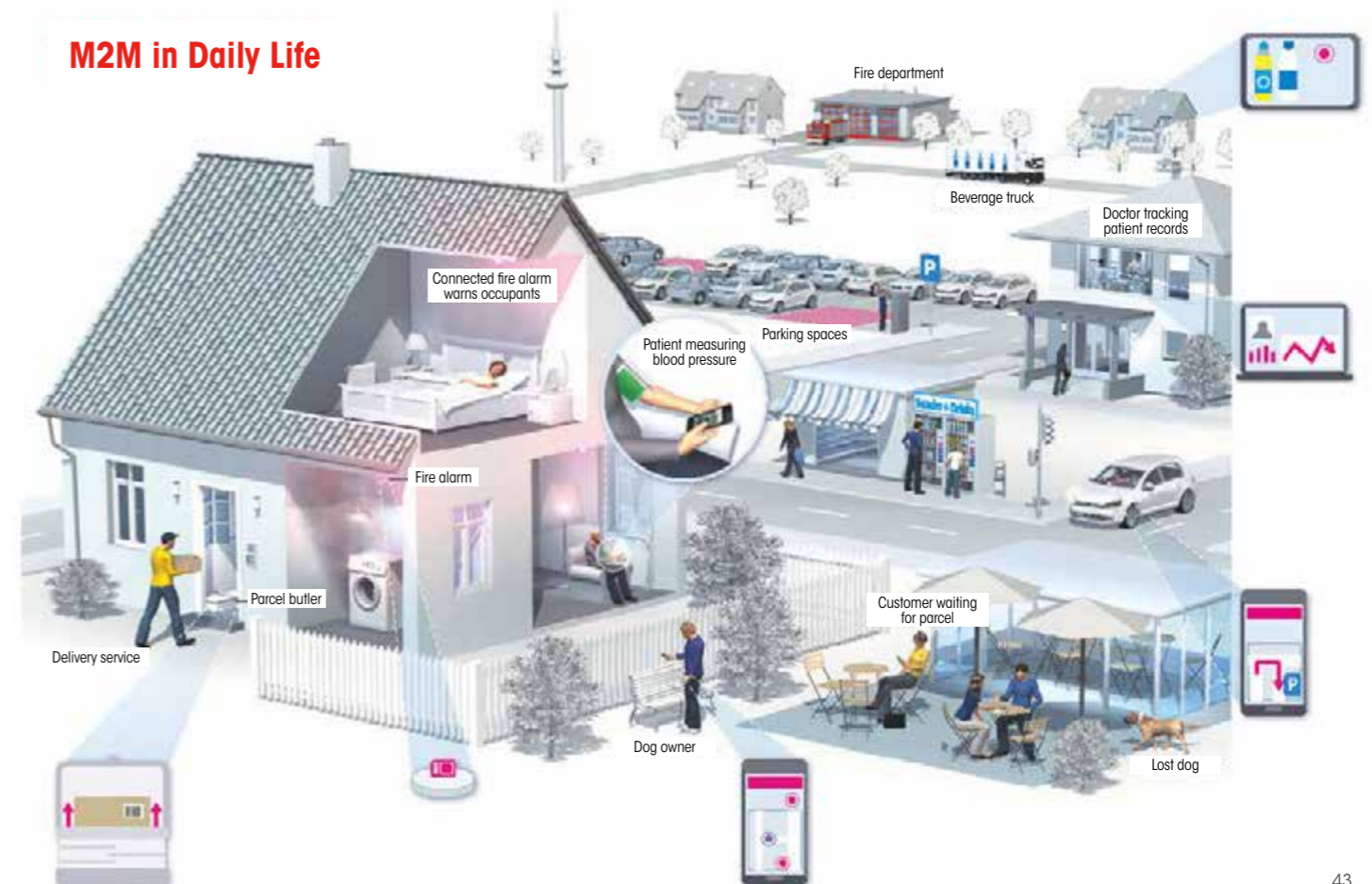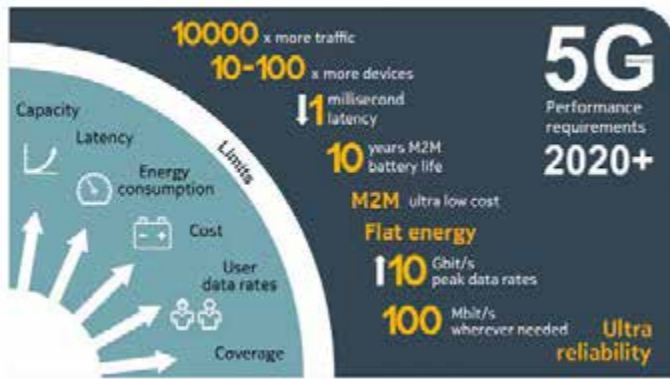
be reprogrammed almost at will and in far less time than its predecessors. Some providers are already testing 5G technology over 4G frequencies, albeit at much slower data rates. They are virtually sure to make this a major point in their advertising campaigns leading up to the actual start of true 5G services. In fact, many countries still need to allot the necessary frequency bands, which in the past was usually done by auctioning off entire blocks of frequencies. In 2015, the three big German players Deutsche Telekom, Vodafone, and O2 (Telefonica) shelled out more than €5 bn for the choicest bits of online real estate, which went directly into the state coffers and was commonly referred to then as the "digital dividend." Plans to auction off G5 territories in late 2018 by the network authority Bundesnetzagentur had to be postponed and are now scheduled for early in 2019. Worldwide, the final decision is expected for ITU's next World Radiocommunication Conference (WRC) in October of next year.

While governments usually assume that all frequencies are created equal, there are significant differences among them. The range between 700 and 800 megahertz (MHz) is ideal for long-distance transmission, for instance in lightly populated, rural areas. The higher the frequency, the more powerful the signal, so operators can service more users through a given radio cell; but this comes at the cost of less distance – hence the need for more relay stations, especially in heavily built-up urban areas or where there are skyscrapers as obstacles to the radio waves. Frequen-

Looking ahead
5G will provide a combination of evolution and revolution, with small and wide networks allowing users to benefit from fast connection and real-time communications never experienced before.

New model
The era of operating wireless systems at the millimeter wave spectrum, ranging from 30 GHz to 300 GHz, is coming. They will operate in a very different manner from conventional cellular systems below 6 GHz, requiring new mathematical models to analyze performance.

cies of between 3.3 and 4.2 GHz will be the most important for G5 since they represent the best compromise between reach and data throughput. Manufacturers and telco operators are pushing for uniform regulation on an international scale, but if the past is any guide, this will hardly happen.

5G is slated to surpass its predecessors in almost every respect. The 600-odd delegates at the 3rd Generation Partnership Project (3GPP) recently announced the first version of a universal 5G standard; called New Radio (NR), it defines the so-called air interface, or access mode, which forms the communication link between the two stations in mobile or wireless communications. However, 5G, by its nature, can do very well without a core or backbone because it relies on multi-hop relaying – a type of communication in radio networks in which network coverage area is larger than the radio range of single nodes. Therefore, to reach some destination, a node can use other nodes as relays. 5G also allows for device-to-device (D2D) or peer-to-peer (P2P) networking, which creates a direct link between sensors and actuators without the help (and cost) of using a telco operator. Telcos, understandably, take a dim view of this practice, and it remains to be seen whether multi-hop will be a viable alternative in the market.

Want a slice?

RG hardly relies on fixed connections; instead customers are allotted slices of the mighty, but flexible, core network, depending on their needs and budget restrictions. Previously, mobile networks did not operate this way. In the future, a customer in need of very high transmission rates might be assigned a relatively high frequency band or maybe even more than one band at a time. Slicing also enables operators to guarantee certain degrees of latency or the maximum number of TCP/IP packets lost over a specified time frame. This will be important for new business models that rely on "always-on" connections. Virtual and augmented reality applications are especially sensitive to latency problems. 5G will be able to operate with latencies of less than a millisecond, whereas UTMS and LTE only manage about 400 and 40 milliseconds respectively.

Failure in autonomous systems such as self-driving cars and trucks or pilotless passenger jets would result in catastrophic loss of life, so 5G adds plenty of redundancy to avoid any chance of something going wrong. The systems will transmit every signal multiple times and, if necessary, through separate radio bands. This trick also means that packet loss is kept to a bare minimum, even over long distances and under unfavorable conditions. This, however, is still

a technological no-man's land, and no one needs to be a prophet to foresee that anyone demanding short latency will have to pay the price, especially if they want it in writing through a service level agreement, or SLA.

If everything goes as planned, 5G will not be able to help being a smash success. While it remains a technology more at home to laboratories and test beds, there is no escaping the fact that 5G will be able to transmit a thousand times more data than older systems, and that with an unprecedented degree of energy efficiency. Bit for bit, energy consumption via 5G will be reduced by at least 90 percent! This will require a new generation of radio and antenna technology which will be able to focus power on individual users as required. The secret here is something called phased array antennas along with beam forming or spatial filtering and multiple-input multiple-output (MIMO) as a safeguard against signal fading. This means that multiple users can share a frequency even when in movement; this is the equivalent of a child holding its hand behind it ear to be able to listen to what someone is saying even if there is a great deal of background noise. Another neat trick that 5G enables is using separate channels for communication in both directions between two persons (or machines), thus effectively doubling the data rate.
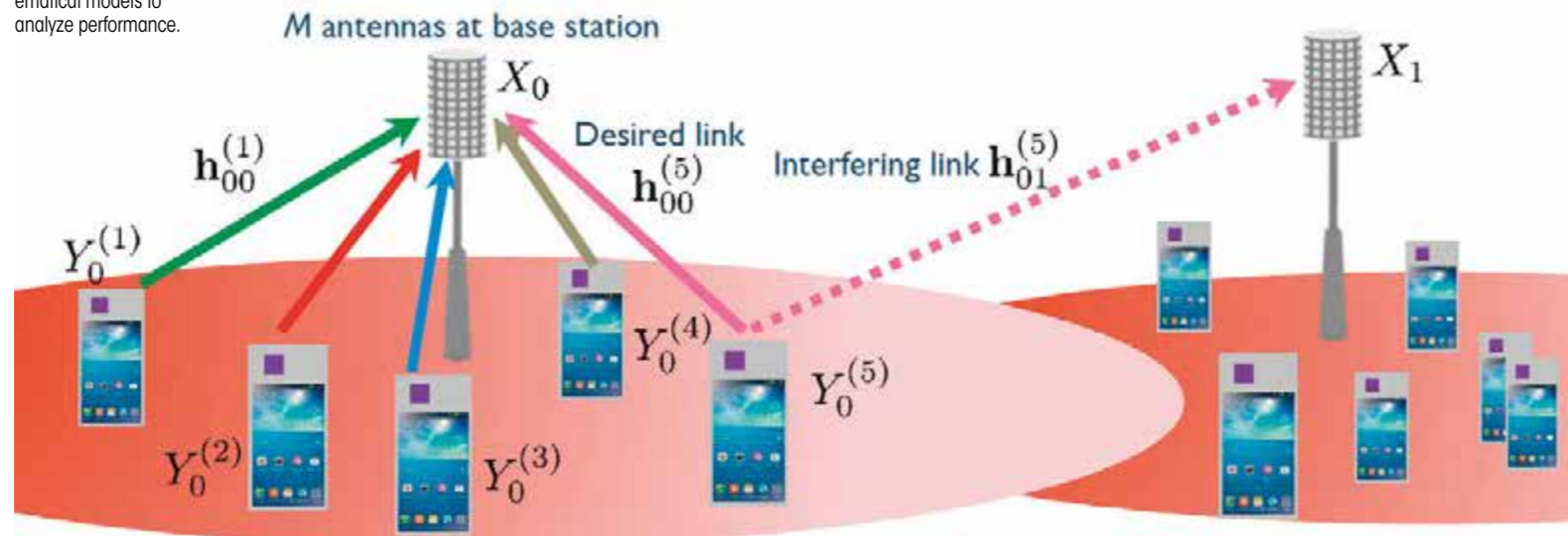
Everything OK?

Most of these frequencies will eventually be auctioned off, some for high prices and under heavy requirements in terms of coverage and expansion. Customers will love this, because it means rapid and widespread availability of 5G, but operators will hate it because of the enormous burden of investments thrust upon them. Availability automatically means more expensive stations; there also could be public backlash from people concerned about radiation issues. Widespread anti-G5 protests could result. G5 will be the most powerful system yet invented, but it could also become a victim of its own success. This will depend on IoT as well as on streaming and interactive gaming; each business model will require huge amounts of bandwidth. The only possible way of satisfying this thirst for

Clients and service providers are in the starting blocks and waiting for the gun to fire. So, does that mean everything is fine? Unfortunately, no. Yes, the first 5G standards have been released as of summer 2018, and chip makers are polishing off their designs. Yet there are still a host of unresolved issues, most of which will only be settled at WRC 2019, such as the radio band reserved for G5 in Europe, Asia, Africa, and North America.

> **5G will be a big shot in the arm for things like autonomous vehicles and smart factories.**

frequencies is to open bands hitherto reserved for the military, especially in the spectrum between 60 and 100 GHz. The generals will resist with all their might, and nobody can predict who will win in the end.

If operators are restricted to bands that are available for civilian use today, that will drive costs per sensor even higher, which will make 5G unattractive for certain business models that will be crucial to the system's overall adoption. And 5G is not without competitors. Narrowband IoT on the basis of existing 4G technology may have its limitations, but it will be good enough for many use cases for a long time in the future, especially given the price degradation that is to be expected once the newer system is rolled out. OK, the data rates aren't so hot, but there are solutions in the pipeline such as WirelessHART and 6LoWPAN, which are only good for local use but which will be much cheaper than the more modern alternative. Besides, 5G operators will first have to retrieve their investments through higher prices, which will make it less attractive to at least some customers. And just how secure the marvelous new mobility will prove to be remains to be seen. The bad guys, after all, are always a step ahead.

5G may be the future, but who really knows what lies ahead? Time will tell.

Generational Change

0G radio telephones (1946)	MTS IMTS Altai OLT MTA - MTB - MTC - MTD AMTS Autotel (PALM) ARP B-Netz AMR	
1G (1979)	AMPS family	AMPS, N-AMPS TACS, ETACS
	Other	NMT, C-450, Hica, Mobitex, DataTAC
2G (1991)	GSM/3GPP family	GSM, CSD, HSCSD
	3GPP2 family	cdmaOne (IS-95)
	AMPS family	D-AMPS (IS-54 and IS-136)
	Other	CDPD, iDEN, PDC, PHS
2G transitional (2.5G, 2.75G)	GSM/3GPP family	GPRS, EDGE/EGPRS, Evolved EDGE
	3GPP2 family	CDMA2000 1X (TIA/EIA/IS-2000, CDMA2000 1X Advanced
	Other	WiDEN, DECT
3G (2001)	3GPP family	UMTS, UTRA-FDD/W-CDMA (FOMA), UTRA-TDD LCR/TD-SCDMA,UTRA-TDD HCR/TD-CDMA
	3GPP2 family	CDMA2000,1xEV-DO Release 0 (TIA/IS-856)
3G transitional (3.5G, 3.75G, 3.9G)	3GPP family	HSPA (HSDPA HSUPA), HSPA+ (DC-HSDPA), LTE (E-UTRA)
	3GPP2 family	CDMA2000 1xEV-DO Revision A (TIA/EIA/IS-856-A), EV-DO Revision B (TIA/EIA/IS-856-B), EV-DO Revision C
	IEEE family	Mobile WiMAX (IEEE 802.16e), Flash-OFDM iBurst (IEEE 802.20), WiBro
	ETSI family	HiperMAN
4G (2009) IMT Advanced (2013)	3GPP family	LTE Advanced (E-UTRA), LTE Advanced Pro (4.5G Pro/pre-5G/4.9G)
	IEEE family	WiMAX (IEEE 802.16m), WiMax 2.1 (LTE-TDD / TD-LTE), WiBro
5G (IMT-2020) (Under development)	LTE	
	5G-NR	

M antennas at base station

X_0
X_1

$\mathbf{h}_{00}^{(1)}$

Desired link
$\mathbf{h}_{00}^{(5)}$

Interfering link $\mathbf{h}_{01}^{(5)}$

$Y_0^{(1)}$
$Y_0^{(2)}$
$Y_0^{(3)}$
$Y_0^{(4)}$
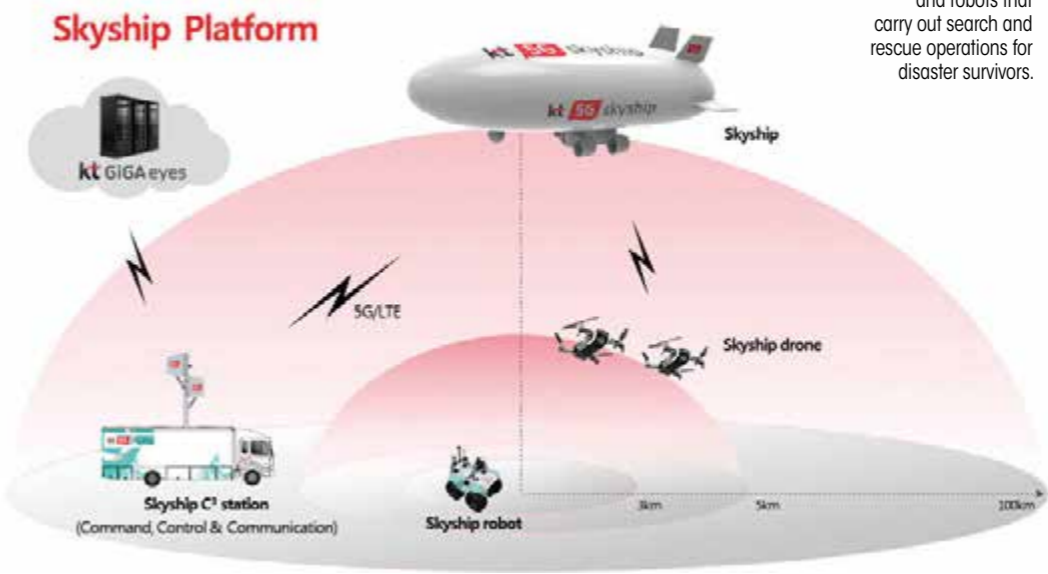$Y_0^{(5)}$

A New Generation of Applications

5G IS COMING FASTER THAN EXPECTED

Mobility is one of the many drivers for the fifth generation of mobile networks (5G). Due to its new features, many never seen before, **5G opens the market for new applications and business models.** While in many ways simply an evolution of existing mobile networks, 5G also represents a true revolution.

■ **By Gerhard Kafka**

N ow that 5G is out of the laboratories, field trials can be followed around the world. Most are based on pre-standard technologies because standardization is still very much work in progress. Final standards are expected by 2020. Another hindering aspect is the lack of dedicated frequency ranges including completely new frequency bands. The assignment of worldwide harmonized frequencies is scheduled for the World Frequency Conference (WRC-19) in 2019. New frequencies for 5G up to 80 GHz are expected to come for the most part from the high-

er frequency bands, thus enabling even higher transmission rates.
One of the first trials, called the "5G Berlin initiative," was established early in 2014 by the two Fraunhofer Institutes HHI and FOKUS. Since then, the 5G Berlin core and access infrastructure has been continuously upgraded and is located in the center of Berlin in Charlottenburg. Compared to other initiatives and beyond its pure role as a scientific and experimental test bed, it provides multiple unique selling propositions due to the specific urban infrastructure in Berlin. The test bed offers the following possibilities:

● Various test scenarios covering urban, suburban, and rural scenarios
● Allows various user groups to evaluate business, customer, and scientific aspects
● Visitors from the world of politics and business as well as major events to increase impact and visibility
● Create multipliers by regional economic development policy and the tourism industry.

After two very successful years, the third edition of the #Berlin5GWeek conference will return in November 2018 to discuss more 5G applications. In general, 5G applications can be grouped according to the following four aspects:

● **enhanced Mobile Broadband (eMBB):** Fulfilling human-centric use cases, such as multimedia content. With data rates going up to 20 Gbps and delays down to 4 ms. As part of the 5G Today research project, a 5G test field for radio is currently under construction in Upper Bavaria. Under the lead of IRT, the project partners Kathrein Werke KG, Rohde & Schwarz GmbH & Co KG, Bayerischer Rundfunk, and Telefonica Germany GmbH & Co OHG are investigating large-scale TV transmission in the broadcasting mode FeMBMS (Further evolved Multimedia Broadcast Multicast Service). Large transmission cells are combined with small transmission cells to create exemplary large-area coverage. For this purpose, TV signals are broadcast simultaneously as test radio in channel 56 from the Wendelstein transmitter and will be broadcast from additional BR transmitter sites in Munich by the end of 2018.

● **massive Machine Type Communication (mMTC):** This is for IoT use cases, e.g. temperature sensors, requiring a large volume of devices

Higher coverage
TV signals are broadcast together with test radio from the Wendelstein transmitter to test large and small cell 5G transmission.

with a low volume of non-delay-sensitive data. Meant for devices requiring battery life lasting ten years.
● **Ultra Reliable Low Latency Communication (URLLC):** These are use cases, e.g. autonomous vehicles, with stringent requirements on throughput, latency, and availability. User plane latency is expected to be no more than 0.5 ms.
● **Wireless Access (WA):** The planned high data rates of up to 20 Gbps positions 5G as an alternative access technology against copper, cable, and fiber. In July 2018, KT introduced SKYSHIP. The SKYSHIP platform operates a special aircraft and a mobile communication center to remotely control drones and robots that carry out search and rescue operations for disaster survivors. Rescuers on the ground are also assisted with augmented reality (AR) glasses that have a direct line of communication to doctors at nearby hospitals for assistance delivering emergency treatment.

Unlimited possibilities

5G will create opportunities for every industry. Combining network speeds of up to 20 Gbps with extremely low latency down to 1 ms, it will be the driving force behind huge new broadband applications. 5G will provide a growth platform for many industries, including IoT, self driving vehicles, broadcasting, smart cities, entertainment, health, and manufacturing.
5G will connect the factory of the future and help create fully automated and flexible production systems. It will support an energy-efficient infrastructure that reduces resource use. And it will enable immersive augmented and virtual reality ➜

Eye in the sky
SKYSHIP is scheduled to provide remote control for drones and robots that carry out search and rescue operations for disaster survivors.

Skyship Platform

technologies to transform business processes.

As 5G emerges, more safety and business-critical applications will run on the wireless network. To support these applications, the network will need to provide reliable and predictable service levels, capacity, throughput, and latency far exceeding today's network capabilities.

Driving new standards

With 5G the dream of self-driving vehicles on the road, on rails, and in the air is becoming a reality. One flagship project is the test field on the German A9 highway between Munich and Nuremburg. Connected cars need a lot of communications power so new standards to be developed for 5G will be the basis for connected vehicle standards. ITU is driving this development. On July 4, 2018, Audi, Ducati, Ericsson, Qualcomm, SWARCO, and the Technical University of Kaiserslautern announced Europe's first live demo of C-V2X direct communication interoperability between a motorcycle, other vehicles, and roadside infrastructure. Last year, these companies formed the Connected Vehicle to Everything of Tomorrow (ConVeX) consortium. The demo featured Audi Q7 and Audi A4 road vehicles, as well as a Ducati Multistrada 1200 Enduro two-wheel vehicle equipped with C-V2X technology. The showcase demonstrated common situations that can occur when motorcycles and cars share the same road space, and how C-V2X

> **What we see now with 5G is the possibility of transforming that type of innovation across a wide variety of industries.**
>
> **Jayne Stancavage,**
> Global Executive Director of Communications Policy for Intel Corporation

Big picture
The European Union places high hopes on 5G in areas such as eHealth, entertainment and smart cars.

technology can be used to improve traffic safety. A project named ConVeX is currently developing C-V2X technology that is expected to enter commercial use in 2019. C-V2X has the potential to provide life-saving safety benefits. C-V2X technology is supported by a broad global automotive and telecom ecosystem, which includes the fast-growing 5G Automotive Association (5GAA) co-founded by Audi, Ericsson, and Qualcomm.

Olympic Games in 5G

The world's first broad-scale 5G network went live in February 2018 during the Korean Olympic Winter Games in PyeongChang. Operator Korea Telecom (KT) developed a special "PyeongChang 5G Specification" with technology partners Intel (5G platform) and Samsung (devices) who provided a series of immersive on-site 5G experiences such as:

- One hundred cameras placed around the Olympic Ice Arena to capture 360-degree views of the action on the rink in real time and transmitting it to nearby edge servers.
- A secondary time-slicing demonstration called Connected Pavilion which allowed attendees to step onto a virtual version of the Gangneung Ice Arena.
- The most popular item among more than 100,000 5G.Connected visitors was the Teleport, a 3D video that enabled the viewers to leap from the ski jump slopes into the future.
- Multiple 5G-connected cameras were set up along the cross-country course. On the slopes, omni-view and multi-angle broadcasting technology provided personalized views of the athletes in motion, triggered by GPS sensors.
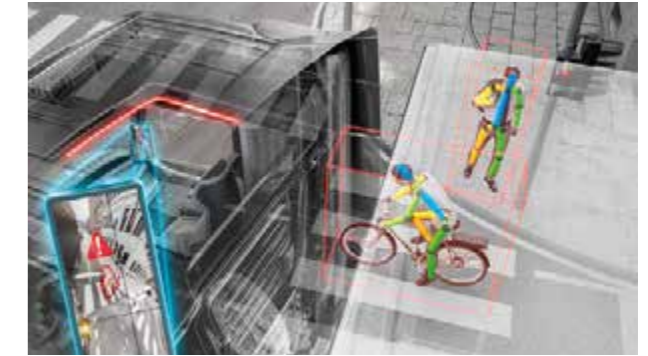
During the 2020 Olympic Games in Tokyo audiences will not only see the evolution of the connected car and smartphones using 5G, but also things like autonomous delivery drones and smart-city applications. The Olympic venues in Tokyo will further showcase a new generation of smart city applications, and 5G will be the underlying technology that will enable these features.

First out of the box

Finnish network operator Elisa has taken the lead in 5G networking. Together with Huawei, the 5G pioneer has built the first network in the world to meet the 5G network standards. In February 2018, the 5G network operating in the 3.5 GHz frequency band was tested for the first time in a moving car simultaneously with two 5G terminal devices in Pasila, Helsinki. The test involved driving a car from Elisa headquarters in eastern Pasila to the other side of the railway tracks in western Pasila. The recorded data speed in the test was 1 Gbps between the network and the pre-commercial terminal devices from Huawei.

In June 2018, Elisa became the first operator in the world to begin commercial use of a 5G network and to

start selling 5G subscriptions. The first person to use the 5G network was Anne Berner, Finnish Minister of Transport and Communications, who made a video call to Kadri Simson, the Minister of Economic Affairs and Infrastructure in Estonia.

5G will boost digitalization and meet the future wireless communications needs of special user groups in a variety of industrial, commercial, and governmental sectors. Use of 5G for fast and reliable machine-to-machine (M2M) communications will enable the development of completely new applications for the needs of, for example, industrial robotics and automation and remote health care.

It is particularly important to consider the potential role of 5G and other future mobile technologies in providing the high-quality services required by intelligent transport systems. The

ConnectedMobility
The A9 highway between Munich and Nuremburg is a flagship test field for autonomous driving in Germany.

Xxxxxxxxxxxx
Automation of vehicles improves security and offers more comfort for the driver and better efficiency.

Finnish Communications Regulatory Authority has issued more than 30 licenses for 5G network test projects, including representatives from the major global players in the telecoms sector, along with small and medium-sized companies, network operators, public authorities, universities, and research institutions. Nokia is one of the most active players in this testing environment.
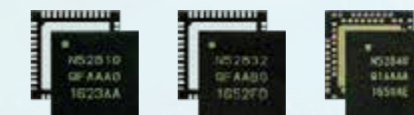
IoT & Supply Chain

UNITED WE STAND

Experts across industries worldwide seem to agree on one core belief: **We are only at the beginning of the Internet of Things (IoT) revolution.** The sizzling pace of innovation in recent years – particularly the proliferation of embedded sensor technology, wearables, and apps – has already caused incredible change, and in just a few short years. So, what will supply chain design look like when not just 3 percent of things, but 30 percent of things, are connected?

■ By Gordon Feller

Consider the scale of future impact: Over the next two years, humans will more than triple the number of "things" connected to the Internet, growing them from 15bn today to 50bn by 2020. But 50 bn still represents only a tiny fraction of what could be connected – something on the order of 3 percent of all connectable things.

For many who own and operate supply chains, IoT is already a big deal – and it will only be getting bigger. According to Jon Stine, Intel's Enterprise Sales GM, Retail, "the global retail industry is in the midst of what might be best understood as accelerated Darwinian natural selection." Some of the retail species are rapidly evolving; others are headed toward extinction.

Supply chain innovation – with a focus upon the digitizing of processes, the use of advanced analytics, and the need for speed – will be a key factor in determining whether a brand survives or thrives.

The largest and most immediate opportunity for value creation will be found in the digitization of the logistics processes, says Stine. In this day and age, the paper trail is simply not acceptable – especially when every delay impacts sell-through and margin.

What then lies ahead for retailers? An ever-increasing demand for fulfillment speed and flexibility, that's for sure! Omni-channel retailing will demand a new set of business processes – and faster and faster responses. To win shoppers who will expect de-

livery measured in minutes and not days, retailers will not only ship from store, but ship one-unit orders from distribution centers.

So far, less than 1 percent of all physical objects that could be connected are currently connected. It's Cisco ➜

> ❝ The global retail industry is in the midst of what might be best understood as accelerated Darwinian natural selection.

Jon Stine,
Enterprise Sales GM,
Retail at Intel

that came up with the "50 bn devices by 2020" estimate. By that time, what we call "computers" – PCs, tablets, and smartphones – will represent just 17 percent of all connected devices; the other 83 percent will be other "Ts" in the IoT, including asset-tracking devices and wearables and smart-building devices like you'd find inside a warehouse or a vehicle.

IoT technologies are vital building blocks of certain types of connections, which, when taken together, make up IoT. So, too, are other enabling technologies: cloud services, big data, mobility (including location-based services), and cybersecurity. Together, they create the opportunity for unprecedented innovation and organizational transformation.

A series of recent in-depth studies have concluded that IoT, by itself, could generate several trillion dollars of new worldwide revenues over the next decade.

Where the money is

Realizing enormous value from data will come from five primary drivers: innovation and revenue, asset utilization, supply chain and logistics, employee productivity improvements, and enhanced customer and citizen experience.

Supply chain and logistics alone are estimated by Cisco to provide $1.9 tn in value, which is a promising indication of the untapped potential and profits to gain from utilizing IoT in this industry.

Experts see optimal conditions for IoT to take off in the supply chain industry. The rise of mobile comput-

Opportunity awaits
Cloud services, big data, mobility, location-based services, and cybersecurity create the opportunity for unprecedented innovation in logistics.

Perfect conditions
The right products, at the right time, place, quantity, condition and at the right cost: the goal is transparency and integrity control along the entire supply chain.

ing, consumerization of IT and sensor technologies, 5G networks, and big data analytics are "pushing" IoT adoption. Logistics providers and their customers are also "pulling" adoption by increasingly demanding IoT-based solutions such as:

- Optimization of efficiency and network utilization
- Transparency and integrity control (right products, at the right time, place, quantity, condition and at the right cost) along the supply chain
- Detailed shipment tracking to have transparency in real time.

IoT in the logistics industry ultimately comes down to two important capabilities: "sensing" and "sense-making." "Sensing" refers to the monitoring of different assets within a supply chain through different technologies and mediums, while "sense-making" is the handling of vast amounts of data sets that are generated as a result, and then turning this data into insights that drive new solutions.

Looking at best practices

As with most technology transitions, it is helpful to look at IoT in a broader context, and to consider some of the best practices from other industries. This can inform and inspire the use of IoT in logistics.

Optimizing asset utilization to derive greater operational efficiency is at the very heart of IoT's value proposition in the supply chain. Vehicles are among the assets most ripe for improved efficiency, especially in terms of traffic and fleet management. In-vehicle telematics and vehicle-infrastructure integration have been vanguard applications in the use of sensor data.

And automotive manufacturers and transportation operators have invested substantially in connected vehicles, including "recovery" systems,

such as LoJack, and in-vehicle driver services, such as General Motors' OnStar. With IoT, traffic and fleet management applications herald a new wave of efficiency gains.

One example is Seoul's City Transportation Information Center (TOPIS), which evolved from a bus management system. It's responsible for providing efficient public transportation services – by managing and gathering information on all public transportation in Seoul, excluding traffic signals. The TOPIS Center gathers data from streets, buses, taxis, and citizens, using GPS devices, loop detectors, road sensors, video, and citizen reports.

This data enables a scientific approach to transportation management policy. Travelers have access to bus arrival times 24 hours a day, enabling them to schedule their routes and choose which buses to ride. The system has increased transit efficiency, reduced traffic, and improved uptake of transport services through clear communication to the public, raising customer satisfaction.

Fleet management is crucial at the Port of Hamburg, which is the second-busiest port in Europe. Its "smartPORT" initiative has raised efficiency and prepared the port for additional growth. The overall goal is to maintain, modernize, and improve the Hamburg Port Authority's IT infrastructure to support efficient operations and economic development, while minimizing the impact of traffic on local citizens.

An IoT-based approach coordinates all aspects of harbor operations impacting ship, rail, and road traffic. So

far, the Hamburg Port Authority has installed more than 300 roadway sensors to monitor traffic in the port area and to track wear on bridges. Digital signs and mobile apps give drivers traffic and parking information. Sensors also extend to waterways (using radar and automatic identification systems to coordinate ship traffic), and a solution that integrates roadway traffic data to help manage traffic disruptions that may occur when ship traffic requires bridge closures around the port area.

Let's now take a look at the impact of IoT and what we've learned around connected logistics, and apply it to the urban environment, deploying it to smarten our cities.

Gateway to the world
Thanks to its smartPORT initiative, Hamburg, Europe's second-busiest shipping hub, manages to raise efficiency while keeping the impact of traffic on local citizens down.

A more scientific approach
Seoul's TOPIS system gathers data from streets, buses, taxis, and citizens, using GPS devices to provide more efficient public transport.
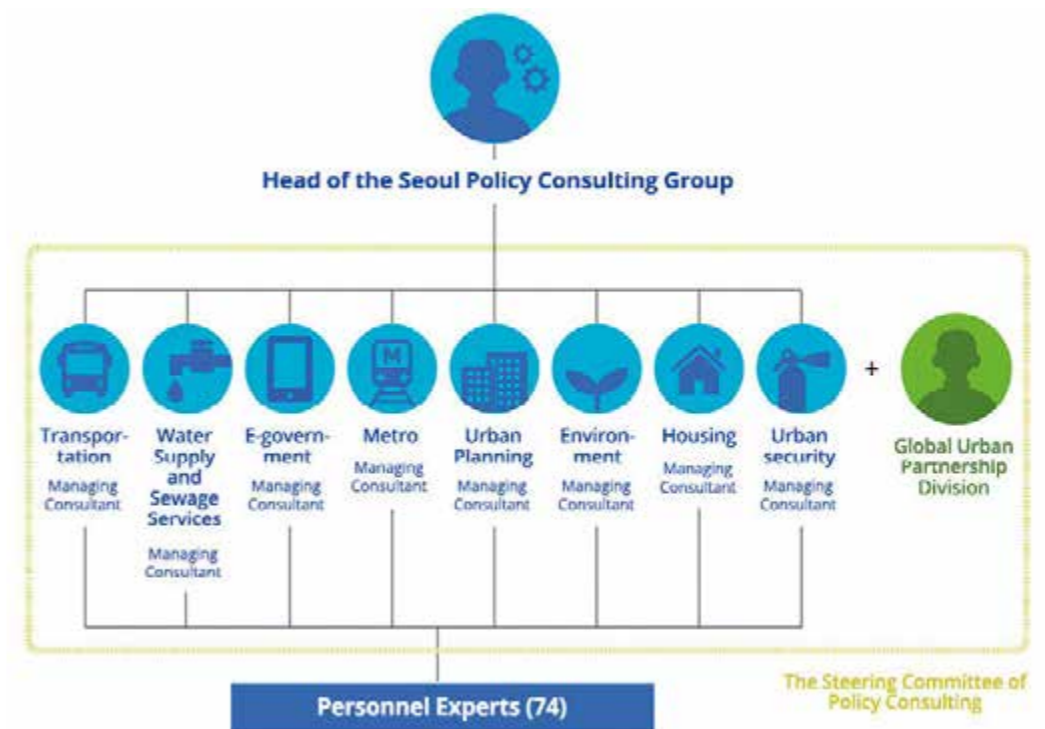
The powerful partnerships between IoT platforms and enabling technologies like cloud capacity, machine learning, and artificial intelligence are the underlying force that today is driving "smart city" efforts around the world.

In the private sector, one of IoT's biggest promises is in increased operational efficiency. But this technology is not exclusively about lowering costs. For a city, other key metrics could be more important than mere year-over-year efficiency savings.

Strong potential

IoT sensors are ideally suited to tracking all kinds of resources, including petroleum and natural gas, electricity, and water. And IoT technology has strong potential to enable greater environmental sustainability. IoT can reduce waste, prevent disasters, and be a critical component of the smart energy grid of the future. Utility organizations, municipalities, oil and gas companies, and consumers themselves are among the many entities and individuals tapping into IoT capabilities to optimize their use of resources.

Hagihon, Israel's largest municipal water utility company, is lead- ➜

Head of the Seoul Policy Consulting Group

Transportation	Water Supply and Sewage Services	E-government	Metro	Urban Planning	Environment	Housing	Urban security	+	Global Urban Partnership Division
Managing Consultant	Managing Consultant	Managing Consultant	Managing Consultant	Managing Consultant	Managing Consultant	Managing Consultant	Managing Consultant		
	Managing Consultant								

Personnel Experts (74)

The Steering Committee of Policy Consulting

Bridging the "Last Mile"

THE NEXT GENERATION OF TRACING

Experts now expect that IoT is likely to provide **the next generation of track and trace: faster, more accurate and predictive, and more secure.**

Using IoT means that supply chain firms gain clearer visibility on the movement of goods – foot by foot, second by second. This translates into item-level condition monitoring, enabling companies to ensure that goods arrive in time, at the right place, and intact.

The final part of the delivery journey (the "last mile") is highly dependent on labor. As consumer demands become more sophisticated and delivery points continue to multiply, logistics providers face new challenges. They need to find creative new solutions for this important stage in the supply chain – cost-effective solutions that provide value for the end customer and operational efficiency for the logistics provider.

IoT inside the last mile connects logistics providers with the end recipient and does it in new ways.

If this level of detailed information becomes available for a single product, last-mile logistics providers have much greater transparency on parcel contents (assuming the customer allows it). This kind of visibility enables the supply chain players to understand, for example, if an item requires specific attention to temperature or if it is particularly fragile. This would, of course, add complexity to delivery, but it would also create an opportunity to increase service standards for customers and end consumers.

In this area, there are many relevant

Gone missing

Theft costs shippers and logistics providers billions of dollars each year, including inventory delay impacts, and in the costs of stolen goods. CargoNet recorded 741 cases of cargo theft last year in the US and Canada alone.

use cases; here are some examples:
- Optimized mailbox collections using sensors inside the mailbox to report if mail is inside
- Automatic replenishment and anticipatory shipping, combining sensor data with customer data
- Flexible delivery address using tagged parcels for customer tracking and flexible change of address, plus possibly smart home sensors for presence detection
- Monetization/optimization of return trip
- Next-gen visibility into individual item condition and integrity over the product's life with more sophisticated RFID or other sensor tags –

including on items on retail shelves. Many new solutions abound for these use cases. Three compelling examples – all from startups – are worth looking at here:

Postybell: Their smart mailbox uses sensors that detect when mail has been placed in a private mailbox and can also monitor the wetness inside the mailbox. A delivery then triggers an alert to the recipient's phone via GSM. They can, for example, be reminded to check their mailbox or keep track of it while they are on holiday.

Shyp: Their flexible shipping services allow consumers to simply take a picture of the item they need shipped

and enter all delivery information in an app – and then a Shyp employee collects the item for packing and delivery.

Thinfilm: This firm's smart memory labels are a sight to behold. The company has recently experimented with Diageo on the concept of a smart whiskey bottle that provides consumers with information on integrity as well as other add-ons such as promotional offers.

Building an ecosystem

Successfully implementing IoT in logistics will require strong collaboration, along with high levels of participation among different players and competitors within the supply chain, and a common willingness to invest. The shared end goal will be to create a thriving IoT ecosystem.

In use cases to date, several key success factors are evident in a good IoT deployment:
- Standardized approaches for the use of unique identifiers or "tags" for various types of assets among different industries, on a global scale
- Seamless interoperability for exchanging sensor information in heterogeneous environments
- Establishing trust and shared ownership of data to overcome privacy issues in IoT-powered supply chains
- Focusing on reference architecture
- Changing the business mindset to embrace IoT's full potential.

Important questions remain about the future of IoT, particularly in the realms of work, security, and privacy. As noted in this report, IoT presents many opportunities for automation, and this is likely to change how some logistics jobs are performed.

Connecting what's previously been unconnected may, in some circumstances, highlight new security vulnerabilities. As information technology and operational technology combine and interconnect, there may well be some new points of ingress for hackers, cybercriminals, terrorists, mischief-makers, and others who wish to do harm.

It's vital that all supply chain actors, including government and the high-tech industry, collaborate to ensure IoT security is prioritized on technology agendas in the coming years. All actors will need to devote significant financial and human resources to counter wrongdoing.

Indeed, as IoT evolves to reach its full potential, IoT solution providers must address the legitimate concerns raised by citizens and policymakers about privacy and control of personal information.

When we connect the unconnected – when we light up "dark assets" – vast amounts of information emerge, along with potential new insights and business value. A connected shoe, for example, can tell its owner (or a researcher, or a manufacturer) the number of footfalls in a given period of time, or the force with which the foot strikes the ground. A connected street light can sense the presence of cars, providing information to drivers and city officials for route planning, optimizing traffic flows. A connected forklift can alert a warehouse manager to an impending mechanical problem, or a safety risk, creating greater location intelligence of warehouse inventory.

What comes next? According to Steven Tiell, Accenture's Sr. Principal, Technology Vision + Digital Trust, "as the birthplace of data, IoT devices and the subsequent data supply chains they're connected to are ground zero for conversations about data ethics."
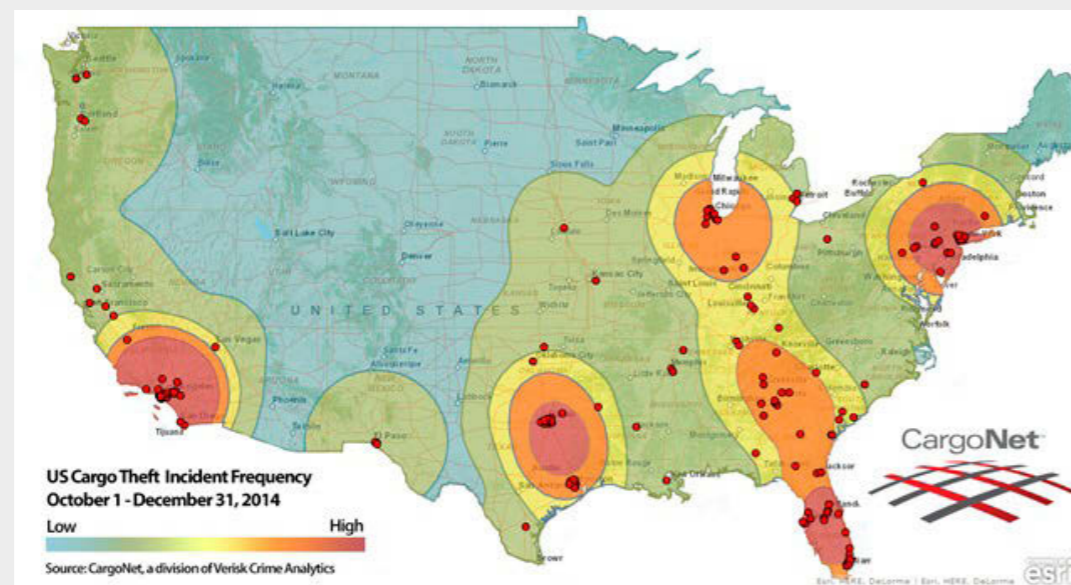
Smart water management

By mixing high- and low-tech solutions, Israeli water supplier Hagihon has been able to reduce water loss substantially while still keeping costs under control.

ing the way in using smart devices to improve water-system management, maintenance, and revenue collection in the Jerusalem area. In a semi-arid climate, Hagihon has reduced water loss while preserving the company's bottom line.

The company replaced a traditional, labor-intensive work model with a smart-technology solution, implementing a mix of both high- and low-tech strategies, and cultivating several key technological partnerships, to increase efficiency and profitability. Pump and in-ground sensors allow easy tracking of water pressure and flow. A supervisory control and data acquisition (SCADA) system controls functions based on sensor data analysis. A geographical information system (GIS) provides a real-time map of current conditions. Fixed acoustic sensors, combined with mobile, cloud, and GPS technology, can pinpoint water leaks underground, while ERP and mobile apps support field technician productivity.

This impressive leak detection system has resulted in a significant ➡

US Cargo Theft Incident Frequency
October 1 - December 31, 2014

Low   High

Source: CargoNet, a division of Verisk Crime Analytics

CargoNet

decrease in overall water loss and has increased profitability. The system has also improved labor efficiency, with sensors taking data collection that was previously conducted manually. This has generated substantial cost savings.

Looking at warehouse logistics

Warehouses have always served as vital hubs in the flow of goods within any supply chain. But in today's economic climate, they also serve as a key source of competitive advantage for logistics providers who can deliver fast, cost-efficient, and increasingly flexible warehousing operations for their customers. With thousands of different types and forms of goods being stored in the average warehouse today, every square meter of warehousing space must be optimally utilized to ensure specific goods can be retrieved, processed, and delivered as fast as possible. The result is a high-speed, technology-driven environment that is ideal for IoT applications. From pallets and forklifts to the building infrastructure itself, modern warehouses contain many "dark assets" that can be
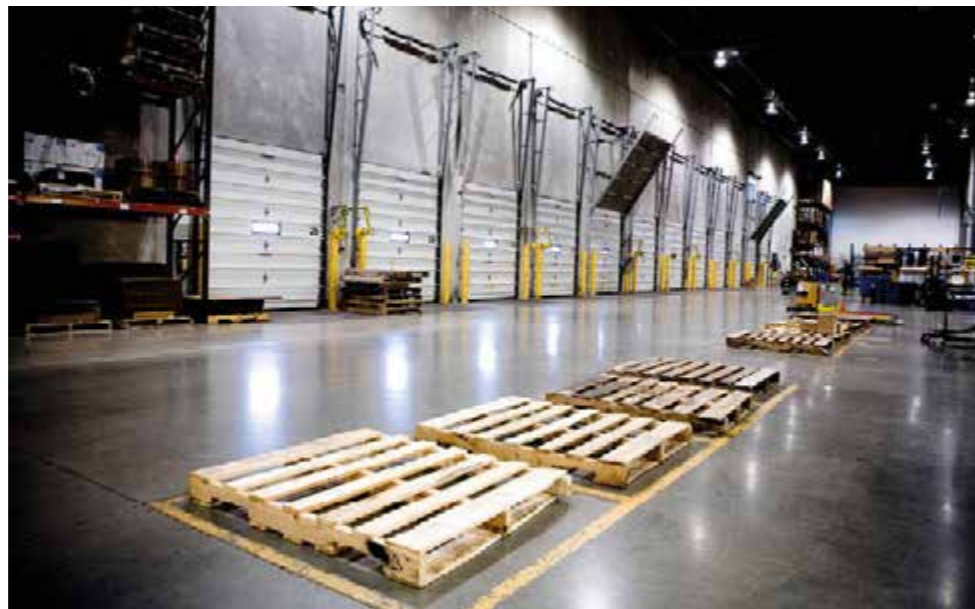
Go with the flow
Flexible warehousing operations are a key source of competitive advantage for logistics providers and their customers.

connected and optimized through IoT. IoT allows for the "dark assets" in warehouses – including equipment and pallets – to be "lit up," generating value from every square meter.

In a city manager's world, consider these public-sector use cases:

- Pallet and item-level tagging for smart inventory management, real-time visibility, accurate inventory control
- Video cameras for damage and theft detection, pile-ups
- Equipment and machinery tagging and central management for optimal asset utilization, predictive maintenance, worker safety
- Connected wearables for safety, workforce efficiency, and work experience

- Connected HVAC, lighting for smart warehouse energy management.

Swisslog's "SmartLIFT" technology combines forklift sensors with directional barcodes placed on the ceiling of the warehouse. With the help of WMS data, these create an indoor GPS system that provides the forklift driver with accurate location and direction information of pallets. A dashboard for managers shows the real-time speed, location, and productivity of all forklift drivers and inventory.

Ravas' "smart forks" technology incorporates weight scales and load-center measurement technology for pallet trucks. An alert is sent to the driver when load capacity has been exceeded or when the load center is uneven.

Locoslab's "connected workforce" is another case in point. Precise localization of mobile devices in indoor environments using active and passive RFID technology monitors the movement of people and objects within an indoor environment and applies location analytics to understand where mundane processes can be improved.

IoT Connects Up Warehouse Assets

1 2 3 Tags on each pallet transmit package data at the inbound gateways, while in inventory, and during outbound delivery.

4 Sensors on a sorting machine detect levels of physical stress by measuring throughput or temperature

5 6 7 Sensors, actuators, and radar/cameras on forklifts and other objects communicate with each other and scan the environment for dangers

8 Sensor-embedded wearables allow workers to share information and interact with machines

9 10 Sensors connecting HVAC and utility networks optimize energy consumption

Advance your robots with technology and insight

Ready-to-use solutions for the latest robotics trends

The robotics sector is booming. Today's robots are able to identify and navigate their surroundings, work alongside humans and teach themselves the skills required to complete a new task. This enables them to serve as farmhands, surgical assistants and domestic everyday helpers.

All this wouldn't be possible without semiconductor solutions. Whether in an industrial robot, a cobot or an automated guided vehicle (AGV), intelligent semiconductors are the key enabler for all major robotic functions, from sensing and motion control to functional safety to security.

Our experience, your benefits:
No matter the precise robotics application, at Infineon you'll find ready-to-use semiconductor solutions that cover all major robotic trends. This includes power management, motor control, security, communication, environmental sensing, and position and condition sensing.

› Unique application insight: As a user and an enabler, our unique application insight adds value to every robotic system.
› Real functional safety: Certified safety products combined with advanced security solutions ensure your robotics system is actually functionally safe.
› Broadest product portfolio: Our portfolio features leading products with proven track record, for the entire control loop, and accelerate your time to market.

Collaborate with us to benefit from our unique capabilities, outstanding robotics expertise and dedicated application support. At our manufacturing sites, we produce flexibly to your specifications while always upholding the highest quality standards.

www.infineon.com/robotics

Infineon
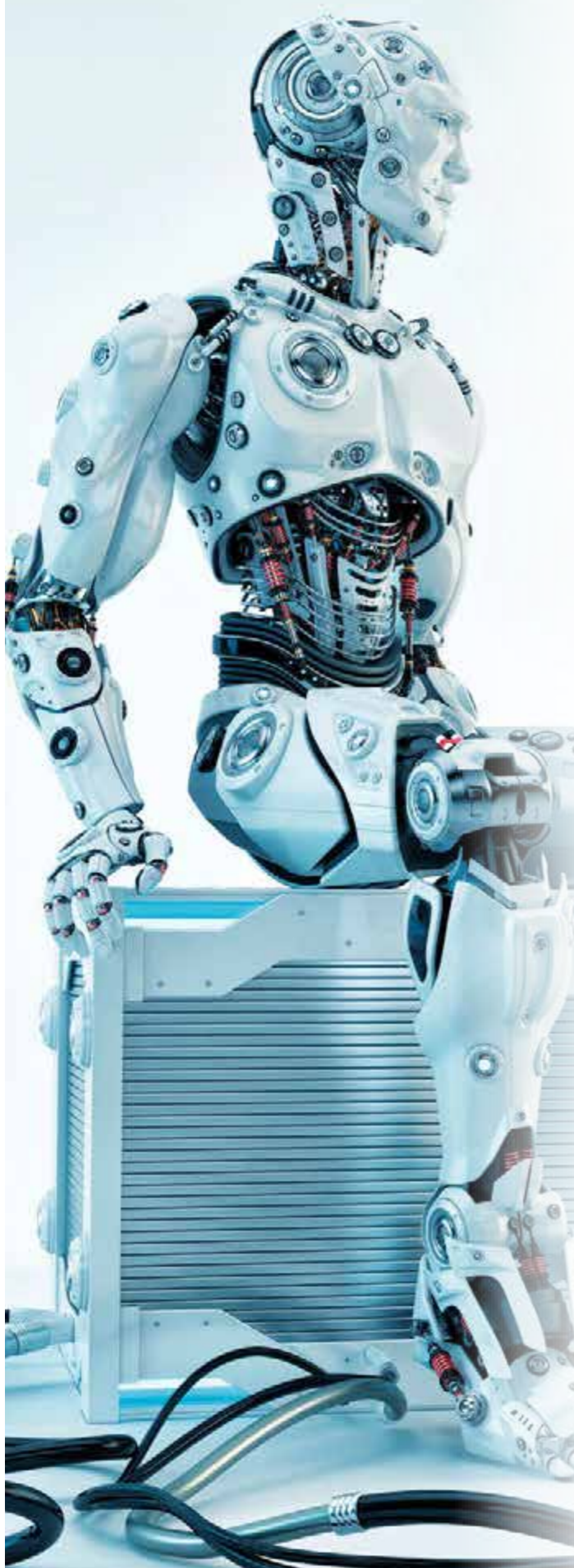
Robots

ONLY HUMAN, AFTER ALL

The latest generation of industrial robots is revolutionizing traditional production processes. **Collaborative robots, known as "cobots," will work alongside humans** and enhance the quality of finished products.

■ **By Dr. Peter Wawer***

Robots have long been workhorses in the production lines of modern factories. Manufacturers worldwide benefit from them in terms of increased productivity and lower cost due to their precision and working methods that support safety.

Technological advances in the fields of sensor technology, the rapid analysis of vast amounts of data, the advancement of artificial intelligence and power electronics – all have made the new generation of robots possible. Meanwhile, the robotics market is undergoing radical change. In addition to the well-known top dogs, many relatively small startups have entered the market; the trend is expected to continue. Their focus is to develop special algorithms as a basis for new robot concepts; these companies prefer to focus on new ideas rather than to spend as much time on the mechanical design and required electronics hardware.

Requiring only a few weeks to gear up, these specialized companies are able, for example, to set up development platforms to develop robots for use in a wide range of fields. Unlike the earlier robot generations, these do not require complex programming for the respective target applications.
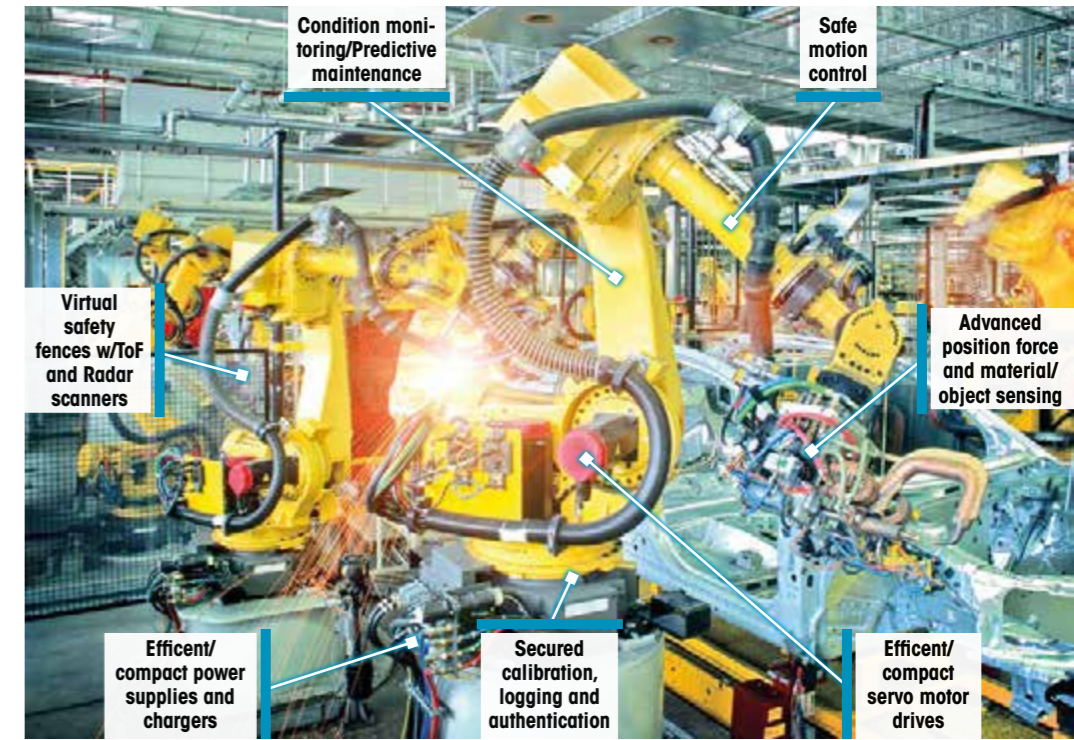
Instead, they can be easily and flexibly reprogrammed and can adapt their motion sequences – sometimes even independently – to new conditions. The new generation of robots provides a broad application field for modern semiconductor products. The spectrum ranges from motor control, high-performance position and object detection, to efficient and compact drives, power supplies, and chargers. It also includes the implementation of virtual safety gates to security functions with secure authentication and calibration.

Escaping their cages

To liberate robots from their cages, users must ensure that people do not come within a critical range of a robot that is working at high speed and with high precision. If people do enter the danger perimeter of a working robot, they could possibly be injured either through their own fault or by machine malfunctions. Designing robots with the corresponding degree of sensitivity is only possible with sophisticated sensor technology.

It is critical to make the area between people and robots safe, and it is also important to make space between the robots themselves. This is about making the protection zones more flexible, i.e., having small protection zones move along dynamically with a moving robot arm, for example. A zone concept is used when implementing these virtual fences. For example, only a warning signal is triggered when someone approaches the first warning level, while the robot continues to operate at full speed. When they get closer, the robot's speed is reduced with a corresponding warning. Only in the immediate danger area does the robot stop.

Appropriate protection mechanisms require extremely precise object recognition. Redundant sampling ensures maximum functional safety. It is also helpful to capture the direction of movement, such as when a person approaches and then moves away, or whether they enter the danger area. Intelligent detection of the actual danger situation prevents unnecessary downtime or slowing down of the robot's work and, accordingly, prevents production losses and associated costs.

Only in terms of data security are secure systems also functionally safe – an aspect that is increasingly important in the context of Industry 4.0 and IoT. Cryptographic encryption can be used to avoid modification of the robot's software code by non-authorized users to ensure that the robot only performs the functions it is supposed to. Accordingly, robots used as part of manufacturing processes are to be secured against manipulation, yet should also be set to permit wired or remote software updates. This requires secure authentication of users and newly added components.

Calibration is necessary for the correct functioning of robots. If, for example, a hacker manipulates the calibrations, a robot could then exceed the specified limits of movement. This is where security and safety converge – without efficient security protection, there is no functional safety. This is an important requirement for future systems, which is addressed by dedicated security controllers or microcontrollers with features such as the Hardware Security Module (HSM). Since the security functions are implemented in the hardware, users require little detailed knowledge of encryption technologies. In addition, the impact on existing software implementations is extremely low.

Mobile for longer

Efficient and compact power supplies and charging functions play an essential role in mobile robots. Based on the latest CoolMOS, SiC, and GaN technologies, Infineon expects an increase in power density by a factor of 2 to 5 compared to conventional battery chargers, with a shorter charging time for mobile robots. Wireless charging is also possible. The energy can be used even more efficiently if the batteries are recharged via the braking process. This is made possible by modern power semiconductors and the improved use of batteries in uninterruptible power supplies, for example for buffering energy. Due to the increasing use of battery-powered automated guide vehicles (AGVs) in Industry 4.0 factories, AGVs could dramatically reduce the outlay and cost of the additional UPS batteries needed in manufacturing. Because the batteries of an AGV are located at the charging station, if networked, they could be used to some extent for the emergency power supply of the factory's internal supply network.

Simply wired

A conventional industrial robot is usually based on a central motor control and numerous drives in the axes. This requires a considerable amount of wiring for a typical robotic arm with

Condition monitoring/Predictive maintenance

Safe motion control

Virtual safety fences w/ToF and Radar scanners

Advanced position force and material/object sensing

Efficent/compact power supplies and chargers

Secured calibration, logging and authentication

Efficent/compact servo motor drives

Taking control
Thanks to powerline-like modulation and modern motor-control electronics, the number of cables can be reduced and transmission speed increased substantially.

❝

Efficient and compact power supplies and charging functions play an essential role in mobile robots.

thick motor cables (three or more phases) per motor, plus an additional communication bus for control purposes and reading out sensor data.

Thanks to modern semiconductors and the integration of powerline-like modulation, together with motor-control electronics, this outlay can be significantly reduced, thus also reducing weight and costs. In laboratory experiments, Infineon has succeeded in reducing the number of cables in a robotic arm from almost 30 down to only two or three. At the same time, transmission speeds for signal communication of well over 100 Mbps have been achieved. Less wiring also means fewer interfaces in harsh manufacturing environments, which in turn increases reliability. An initial prototype of such a motor control, for which Infineon integrates the necessary components, is in preparation.

From controllers and power electronics to sensors and chips for safety and security functions, Infineon offers a comprehensive range of components that can be used to implement efficient electronics for the new generation of robots. Additionally, the company not only manufactures a comprehensive semiconductor portfolio for robots but also uses various generations of robots in its production lines. Many concepts that are currently being discussed in connection with Industry 4.0 are already in use. It is only logical that the knowledge acquired in robotics will then be incorporated into the further development of Infineon's semiconductor offerings.

* Dr. Peter Wawer is Division President Industrial Power Control at Infineon Technologies.

Bionics and IoT

MAN MACHINES

Most people think of science fiction when they hear the word "cyborg." But we do not have to take a trip to the movies to find examples of human enhancements described here.

■ **By Rainer Claassen**

Humans have been using tools since the first homo sapiens stepped down from their trees and started walking. One obvious reason is that frail human beings aren't up to many tasks, so they need tools as an extension of their own capabilities. Science fiction authors have fantasized about this for decades, and by creating characters such as Robocop, Iron Man, or even Darth Vader, writers have introduced their ideas about superhuman capabilities to the rest of us so that they are embedded in the popular mindset.

But now, technology is pushing the envelope, as tools themselves become more intelligent and sensitive, so that fantasy, thanks to advances in fields such as IoT, is becoming reality.

Replacing the work of humans by that of machines has been going on for more than a century, but this has not made people obsolete – not by a long

shot. Even the most modern production facilities still need human workers. The reasons are obvious: people are more intelligent and flexible than machines. On the other hand, people have limits: they are vulnerable to injuries; they get tired sooner or later; they make dumb mistakes; their strength and perception are limited.

In many cases, machines can reduce these restrictions – with the help of a pulley even a child can lift heavy weights. But technology being developed today now goes further than ever by allowing much more intuitive access to new tools.

Artificial muscles and extra skeletons

A good example is the "Power Assist Suit" manufactured by the Japanese Company ATOUN (a subsidiary of Panasonic), and sold under the product name Model Y. The exoskeleton is ad-

justable to people of heights from 1.5 to 1.9 meters and supports them in lifting and carrying heavy weights. Workers in warehouses can easily fit them over their working clothes. The skeleton with its carbon-fiber frame that weighs about 4 kilograms will support the wearer in lifting and transporting all kinds of weights.

The suit is equipped with two sets of motors and sensors that detect the waist movements of the wearer. When a worker is about to pick up a heavy object, the suit senses his movements and goes into operation to provide back support. It helps reduce strain by as much as 10 kilograms, lowering the risk of back injuries common among construction workers. The Hong Kong-based company Gammon Construction Limited lately purchased ten assist suites and is currently conducting trials on its construction sites.

Medicine is another field where you can find many developments in which humans interact very closely with technology. At Swiss University EPFL, a Center for Artificial Muscles was inaugurated in June 2018. Working together with Bern and Zurich University Hospitals, and with the help of a 12-million-frank donation from the Werner Siemens Foundation, they are developing less invasive cardiac assistance systems for treating heart failure. The prosthetic device avoids the complications of hemorrhaging and thrombosis because it will not be in contact with blood at all. It consists of a series of rings placed around the aorta that is made out of dielectric electroactive polymers (DEAPs) and controlled by magnetic induction. The rings will help the heart pump blood through magnetic induction, dilating when a current is applied and contracting when it is switched off. Due to immediate reactions, the contraction-relaxation movement can be controlled in real time. Two other projects will follow: a facial-reconstruction project aimed at restoring patients' ability to make expressions and a project to develop artificial sphincters using the cardiac assistance technology.

A real helping hand

One of the most impairing injuries a hu-

man can experience is the loss of one or both hands. Last year, German prosthetics specialist Ottobock acquired the Bebionic artificial hands from British developer Steeper. These artificial hands are made from high-tech materials used in racing cars and military equipment. The wearer controls them through muscle movements in the upper arm.

Two sensors integrated in the prosthetic socket interpret the wearer's notions and translate them to signals that are transferred to individual motors in each of the fingers of the artificial hand. Microprocessors continuously monitor the position of each finger, giving precise, reliable control over hand movements. The hand has 14 selectable grip patterns and hand positions. It is tough enough to handle up to 45 kg, so people can carry heavy loads or push themselves up from a seated position. Software and wireless technology located within ➔

Lift me up!
The Model Y exoskeleton from ATOUN is already being used in warehouses and on building sites. It allows workers to carry heavier loads and to work longer without getting tired and exhausted.

the myoelectric hand makes it easy to customize the functions to suit its carrier's preferences. An auto grip function senses when a gripped item is slipping and adjusts the grip to secure it.

Wearers of the prosthetic must get used to it first, but with training and practice, people can perform astonishingly complex tasks with the help of Bebionic, like tying shoes or picking up pieces of paper. Currently, Ottobock engineers are developing a model with eight sensors that will allow even better control by the wearer and a deeper integration.

But what is still missing in this solution is a sensory feedback from the hand to the brain. In the USA, the Defense

Expanded vision
Wearing Google Glass, craftsmen can get additional information about the piece they are working on displayed right in their view.

Artificial feelings
The Defense Advanced Research Projects Agency (DARPA) is currently working on ways of connecting human nerves to digital sensors. This will allow people to conduct prosthetics by thought – and to feel with artificial limbs.

Advanced Research Projects Agency (DARPA) is currently working on that. So far only prototypes have evolved from their cooperation with eight universities and clinics. Researchers at Cornell University have already created an artificial nerve that can sense touch, process information, and communicate with other nerves much like those in human bodies do.

There are more examples of high-tech body equipment that find their way into industrial production. Take Google Glass for example. The development of the intelligent spectacles for the consumer market was cancelled in 2015. But under the brand "Glass" the product is now

quietly successful in many business applications – like for DHL in logistics and General Electric in manufacturing, to name only two clients. Wearers can see additional information on things that are currently in their view with the help of the spectacle. That can facilitate work in warehouses, manufacturing, medicine, and logistics.
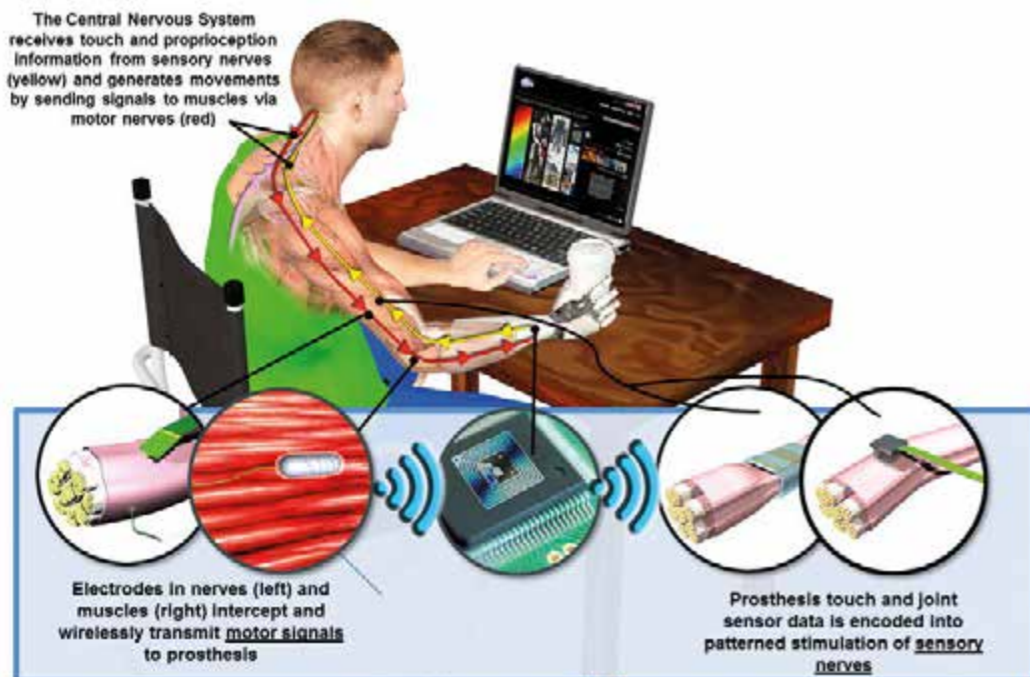
Listen well

Since 1981, Sydney-based Cochlear Limited has helped deaf people to hear again. By amplifying noises and transferring vibrations to the bones of the skull, the company's implanted devices allow hearing-impaired persons to "hear" voices and ambient noises. Danish hearing-aid pioneer ReSound has now teamed up with Cochlear and developed what they call a "bimodal hearing solution": wearers have a cochlear implant on one side and a hearing aid on the other. This enhances sound quality and spatial sense as well as the capability to recognize spoken words. With the help of a smartphone app, the system seamlessly integrates with sound systems, TV sets, or even microphones at lectures and conferences. Results of this project are also helpful for business use cases – allowing seamless communication in loud surroundings like warehouses or production facilities.

The examples described in this article have one thing in common: they all rely on interfaces that stimulate original human sensory organs. Of course, science is also working on overcoming this limitation. There have been some spec-

tacular experiments, in which people were able to steer machines through electrodes directly connected to their brains. But so far none of them has been reliant enough for long-term use outside of showrooms and laboratories. It seems that the way the human mind and body are organized internally is too complex to be controlled by the technology available today – but it is developing at incredible speed. In his book *The Singularity Is Near*, Ray Kurzweil wrote: "One cubic inch of nanotube circuitry, once fully developed, would be up to one hundred million times more powerful than the human brain." We have to prepare for questions that arise once the integration of technology starts to go deep beyond the outer layer of our skin and skulls. And with the examples given in this article it is clear that we should do this quickly.
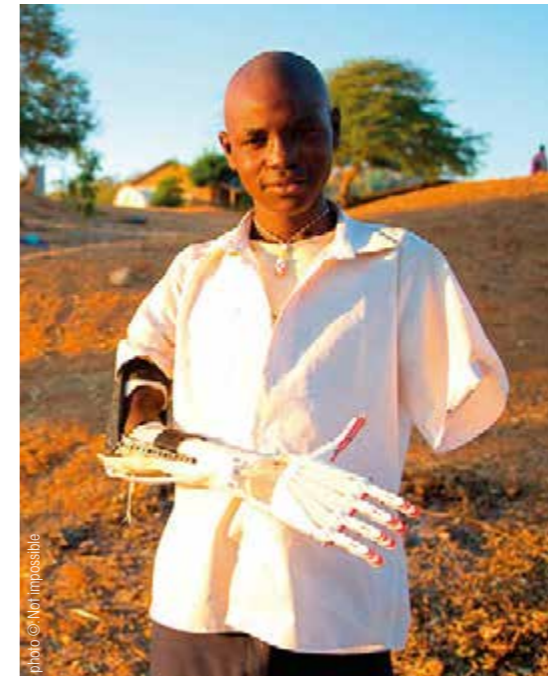
Give a Hand

■ **Printing Artificial Arms**
Even in the field of bionics, a do-it-yourself attitude can lead to great results. Mick Ebeling, who founded the organization "Not Impossible," came across news about a 14-year-old boy from Sudan who had lost both his arms from a bombing in 2013. He decided to do something about that – and not only help this one boy. He put together a team and traveled to Yida to build an artificial arm for Daniel – and to give locals the means and information on how to create prosthetic limbs for other victims injured in bombings. Regular hospital prosthetic arms cost more than €10,000 – the one that Mick created with the help of a 3D printer was only about €100. And with the equipment and the know-how his team left behind, locals were able to build one prosthetic each week after the organization had left Yida.

The Central Nervous System receives touch and proprioception information from sensory nerves (yellow) and generates movements by sending signals to muscles via motor nerves (red)

Electrodes in nerves (left) and muscles (right) intercept and wirelessly transmit motor signals to prosthesis

Prosthesis touch and joint sensor data is encoded into patterned stimulation of sensory nerves

Health Care

A SHOT OF IOT

The value of the IoT health-care sector is set to surpass $136 billion by 2021. As the prospect of truly connected health care becomes a reality, which digital services should hospitals be looking to adopt to better serve patients – and **are they prepared for the impact on existing networks and systems?**

■ **By Nicole Hill**

Care providers are under pressure to deliver high standards of care to larger volumes of patients – at a time when many health-care services across the world are being squeezed financially. Patients expect rapid diagnosis and, increasingly, access to health services even while outside hospital or clinical boundaries. This is made possible through the widespread use of mobile devices and wearable health tech which can provide on-demand feedback on condition or fitness. So, how can clinicians do more, for less money, without the introduction of thousands of extra staff? Technology holds part of the answer.

Industries such as manufacturing, hospitality, and the public sector are already embracing greater digitization and automation – whether this is connecting status sensors to machinery for automatic maintenance scheduling or meeting day-to-day personal requests through an AI chatbot. With

Nicole Hill
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a fully connected approach and a resilient, scalable backbone – key for critical health monitoring applications – health care can start to exploit real digital transformation, driving new efficiencies and improving patient health outcomes.

More digitization, more data

As the cost of deploying IoT devices continues to fall, hospitals are increasingly able to connect different areas of the health-care ecosystem, linking together previously isolated systems and siloed data.

Devices as varied as pacemakers and ventilators to insulin pumps now have some form of connectivity, while wearable health and fitness tracking devices are also generating large amounts of data. This presents an opportunity for hospitals to harness data for greater accuracy in diagnosis, treatment delivery, and further personalization of the patient experience.

This digital transformation of health care doesn't stop at simply connecting existing devices. Many hospitals are digitizing existing patient records and other paper-based documentation as part of a wider push towards improving workflows by creating a "paperless hospital."

But all these digital transformation efforts can reap many more health-care benefits. All this data can not just be processed but analyzed to generate valuable patient and diagnosis insights – another job we can turn to technology for.

AI and automation are easing staff workloads

Once portrayed as a futuristic technology, artificial intelligence is redrawing the way hospital staff generate, compile, and action medical records and other health data. By automating generic or recurring tasks, AI will help rescue clinicians from excess "red tape," freeing more time to spend with patients.

Advanced AI solutions for the health-care sector are making their way into hospitals and delivering broad benefits for clinicians and patients alike:

- In the UK, the National Health Service has collaborated with Google DeepMind *Streams*, an analysis and diagnosis application for acute kidney injury that will lay the groundwork for a fully AI-powered solution.
- An AI-powered virtual nurse is being trialed in the US and UK, allowing patients to check in and report any symptoms from their conditions that will then be shared with doctors for a follow-up video appointment.

- AI is also being used to enhance the knowledge of pathologists from Harvard identifying the presence of cancer in biopsies, raising the detection rate to 99.5 percent.

When combining the back-office efficiency savings generated from AI handling patients' records and hospital data with the rapid diagnosis of conditions to assist clinicians, it is clear that AI and wider machine learning solutions will play a critical role in the health-care ecosystem of the future.

Although digitization and automation of back-office processes are helping staff spend more time attending to the needs of patients, constant mobile communication is an absolute necessity for staff to collaborate with colleagues, respond to patient emergencies, and optimize workflows. Gone are the days of doctors only being accessible through a pager – CPaaS solutions such as ALE Rainbow™ offer the capability to integrate specific health-care applications and workflows into the core collaboration service.

Collaborative health care on the move

By rolling out secure Wave 2 Wi-Fi throughout the hospital, we can guarantee continuous availability and a high-quality user experience for both staff and patients. Health-care facilities should also look to adopt a secure mobile platform for clinicians to collaborate on, share patient files, and receive emergency calls. The high degree of programmability of these platforms allows existing systems to be integrated into the same platform using open APIs, such as nurse calls, alarm notifications, and alerts in the event of a patient deteriorating.

With the introduction of secure and resilient mobile communications, hospitals can move towards telemedicine and remote care, providing video consultations and appointments for patients who may struggle to regularly travel for care; this can benefit in particular citizens living in remote areas and the elderly or disabled. Offering these virtual appointments helps continue the care pathway beyond patient discharge, ensuring a quality

patient experience and access to expert support at every stage of assessment, treatment, and recovery.

Recent security breaches in the news – ranging from Equifax to Yahoo – have compromised the details of millions of consumers worldwide and pushed data protection to the top of the agenda. Regardless of the vital services they provide, hospitals are not immune from today's data protection requirements.

Health care is due for a compliance check-up

Health-care providers should ask themselves: is patient data being used correctly, is it being protected? Are electronic medical records secured, only accessible to relevant staff, and fully compliant with data protection best practices?

Health care is a particularly high priority target to hackers due to the huge amount of sensitive data stored, ranging from full medical history to payment details, address, and date of birth. This could be data theft, or ransomware – a recent Beazley report found that 45 percent of all ransomware attacks targeted the health-care sector.

To combat this, hospital IT departments must ensure they operate a fully secure network and control access to specific systems and applications – for example, creating different permissions for visitor Wi-Fi and clinician network access. Devices and equipment requesting network access should be identified, profiled, and assigned suitable access rights before being "set loose" on the network.

IoT devices offer a new angle of attack for unauthorized access into health-care networks, especially if left unsecured, or rolled out quickly without careful consideration. By developing an IoT security strategy, such as the IoT Containment approach offered by ALE in which the hospital network is divided into virtualized segments without direct access to unrelated systems on the network, it eliminates the prospect of a security threat spreading to other areas of the network and compromising patient data.

> **All this data can not just be processed but also analyzed to generate valuable patient and diagnosis insights.**

Healthy development
As the cost of deploying IoT devices continues to fall, hospitals are increasingly able to connect different areas of the healthcare ecosystem.

Connected health care is no longer just a trend – it is an inevitability as hospitals look to meet the needs and expectations of today's patients.

Connected devices – helping health care get personal

As services and applications are increasingly linked, we can begin to picture how a typical hospital visit may unfold. A patient is admitted to hospital and the assigned clinician is able to immediately access full historical medical records on their secure mobile device. Once scans are completed, an AI-powered application analyses the results and aids diagnosis – sharing a recommended course of treatment. After consulting with colleagues via a mobile collaboration platform, the clinician is able to action this treatment and offer personalized patient care and advice throughout the care pathway.

Care providers are set to benefit from further developments such as location-based services for wayfinding, asset tracking, and staff location. But health-care facilities must first lay the infrastructure of a secure, easily scalable network to take advantage and reduce risk.

Tracking Tech
WATCH MY DUST!

More than a decade ago, rumors made the round among tech writers that intelligence services had managed to develop miniscule surveillance microphones that could be stirred by the handful into buckets of paint going on the walls of office buildings. Instantly dubbed "smart dust," these tiny sensors could then be linked together via wireless technology to form all-hearing, self-organizing snoop networks at a fraction of the cost of bugging a building by conventional means.

These miniscule mikes, it was said, were so extremely energy-efficient that they would continue to listen in on conversations for years and years. The ideas seemed entertaining at the time, but not even James Bond, we all believed, would ever be able to make it happen.

Maybe it's time we all woke up. "No IoT device is so wildly fantastic (or outrageous) as 'smart dust,'" David Monahan, an information security executive for Enterprise Management Associates recently wrote on ForeScout. He explained that he believes "IoT miniaturization seems to be working its way into the realm of nanotechnology."

Smart dust is essentially a bunch of small wireless micro-electromechanical sensors (MEMS) that can detect everything from light to vibrations. A tiny device with extraordinary capabilities, these miniature mikes are equipped with nano-structured silicon sensors which can spontaneously assemble, orient, sense, and report on their local environment. This new technology combines sensing, computing, wireless communication capabilities, and autonomous power supply within the volume of only a few millimeters. It is very hard to detect the presence of smart dust and it is even harder to get rid of them once deployed.

The concepts for smart dust emerged from a workshop at RAND Corporation, a think tank, back in 1992, which led to the development of a working "mote" or sensor node smaller than a grain of rice. While much of the research is highly classified, we can safely assume that scientists are now down to the size of dust particles.

Spying aside, let's take a minute to ponder what other uses smart dust could be put to. How about farmers mixing a few handfuls of smart dust sensors in with their seeds? Later, they could detect the needs of the crop, which could result in better fertilization management. Or how about dusting my next Thanksgiving turkey before it sets out on its way to my local supermarket, keeping an uninterrupted record of the bird's temperature along the way so I can be sure it won't poison me and my family on the Big Day? Doctors could dust me, inside and out, and maintain a constant record of my bodily functions so when the time comes they will be able to determine which of my vital signs have deteriorated and exactly what to do about it – instead of relying on average dosages and such primitive forms of medication.

There are literally thousands of applications for smart dust if you think long enough. How about detecting corrosion in aging pipes before they leak? Or improving safety, efficiency, and compliance in industry? I sincerely hope that one day every wrapped item of food in my refrigerator will be able to tell me how fresh it is. Smart dust will be capable of measuring vibration, so when I buy a TV set or a computer drive I can check to see if it was handled with care all the way from the factory to the store shelf. Museums could dust the works of the Old Masters and monitor them for the effects of sunlight or humidity before they fade or molder away – after all, that Rembrandt may just have cost us a cool 23 million bucks!

The key to all this, of course, is power consumption. Modern wireless protocols like WirelessHART, 6LoWPAN, Bluetooth Low Energy as well as S-NET in Germany are so good at conserving power that they can function for up to a decade. These protocols also have the ability to self-organize thousands of particle-sized sensors into close-knit networks capable of transmitting the data they gather to a router and from there off into the cloud. Cost? Negligible!

Some sensors now can even make their own electricity. They use light, temperature differences, vibrations, or even variations in the magnetic field of nearby power lines to drive themselves for years and possibly even for decades. This is called "energy harvesting," and a number of manufacturers of these so-called low-power microcontrollers (LPMs) such as Texas Instruments, STMicroelectronics, and Microchip Technology are already producing them in bulk.

So maybe it's time we dusted off our old notions of what is possible in the field of miniaturization. Yesterday's science fiction is today's business opportunity!

> ❝
> **Some sensors now can even make their own electricity.**
>
> **Bernd Schöne**
> is a veteran German Internet journalist and an expert on cybersecurity

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We seem to be in the middle of what you could almost call an AI bubble. Countless companies are finding ways to squeeze "AI" and "machine learning" into their descriptions to gain investment and clients and the Internet is awash with companies offering "smart services" for almost any problem. But AI has been around for quite a while, so what's all the fuss about?

TW: There are four exponentials that together mean we're making real progress on the goal of building intelligent machines. First, the doubling every two years or so of compute power, otherwise known as Moore's Law. Second, there's a similar doubling in data, which is helping support much of what we do today in AI via machine learning. Of course, the Internet of Things is only going to add to that trend! Third, we've had a doubling again every two years or so in the performance of some of our algorithms. Deep learning is a case in point. And the fourth exponential is in the amount of money flowing into the field. This is also doubling every two years. Put all of these in a pot and you have a recipe for progress.

Are we actually getting ahead of ourselves here, or could we be closer to general machine intelligence than we think?

TW: No, artificial general intelligence, or AGI, is still a long way away; 50 to 100 years, if you ask most of my colleagues, or perhaps even longer. We have only made progress on building narrow intelligence.

There was a time back in the '80s and 90s where AI was almost a dirty word.

TW: Well, it's nice to come back into fashion again. There was some overpromise in the '80s that led to a bit of a backlash. But this time, we're having a real impact on real problems so I'm not too worried about another AI winter.

Some people say that we have reached a point in the last five years that is akin to the "primordial soup" for AI. If this is the case what are the key ingredients that have allowed AI to thrive?

> **Artificial General Intelligence is still a 100 years away. We have only made progress on building narrow intelligence.**

TW: Compute power, data, and better algorithms!

What for you is the most exciting current development in your field?

TW: It's hard to pick on one area as AI is having so much impact on so many aspects of our lives. It really will be like electricity in this respect. But if I had to pick one, it would be the impact it is starting to have on health care.

What advice would you have for a manufacturing company looking at injecting some machine intelligence into their operations?

TW: Don't start too big. Start small. Don't start on a critical path. Look perhaps to help strategic decision-making first before you go into the operational.

If you could give advice to manufacturing companies on how to approach the three most important aspects of their operations, what would they be?

TW: Business models and market strategy, human vs machine roles and skills, and social corporate responsibility. Take the savings from AI to improve your product or service, not simply to reduce costs. Look to augment not replace people. And where you do replace, look to reskill. And think carefully about the ethics of what you do. AI is powerful magic. It's easy to encroach on people's privacies and other basic rights.

"AI IS POWERFUL MAGIC"

A Conversation with Toby Walsh*

*Toby Walsh is often called the "rock star of AI." He works as a professor at the University of New South Wales and is a fellow of the Australia Academy of Science. As a leading voice in the discussion about killer robots, he has been asked to speak before the UN in New York and Geneva. This interview was conducted by Dale Rickert, Portfolio Director at Industry of Things World in Berlin.

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Data

THE SECRET SAUCE OF IOT

Discussion about the Internet of Things often centers around sensors and hardware, the additions to our physical environments. They may be built into street lights and bus stops, or in factories and on assembly lines – or even inside shipping containers. But in fact, the ability to connect the dots will be even more important for the future of IoT.

■ **By Volker Hirsch**

In its first wave, the "I" in IoT has been mainly used to describe devices that can connect to other devices: we can now fire up our central heating from a smartphone so we won't freeze when we come home, we can tell our TV set-top boxes to record the football game we would miss because of a business dinner, and we can tell the postman via a video doorbell where to leave that parcel. More interestingly, and in the longer term more relevant, will be what connectivity also brings – masses and masses of data, all nicely time-stamped and associated with a specific process in a specific device.

Deeper insights

In short, machines, robots, and sensors have become data nodes and the true opportunities can now be unleashed. Few important use cases would be possible without meaningful processing of data and increasingly this involves artificially

intelligent systems because they can amplify the usefulness of a solution by instilling deep insights, not apparent to humans, into structured data sets. As a result, IoT becomes the focal point of a number of meta-trends of the near future,

namely ubiquitous connectivity and ubiquitous computing power, decentralized, in the cloud and with data-processing capabilities that puts everything previously known to shame.

In this way, a simple tracker beacon

Wipers make weather forecasts
By capturing the data of auto-wipers in cars, manufacturers could create the timeliest weather forecasting service ever.

system in a store becomes an analytics tool that delivers rich information about customer journeys and habits, the attractiveness of certain product groups, and a plethora of other information, for a hardware cost of a few hundred dollars. ➔

The combination of structured data sets with the insights of skillfully trained AI opens additional value streams not otherwise accessible. Another simple example is the amalgamation of all data on auto-wipers in cars (wiper on = rain). A car manufacturer that captured and processed that data could become the timeliest weather forecasting service. Remember that The Weather Company was sold to IBM – which is housing it under its Watson AI group – for a reported $2 billion in 2016.
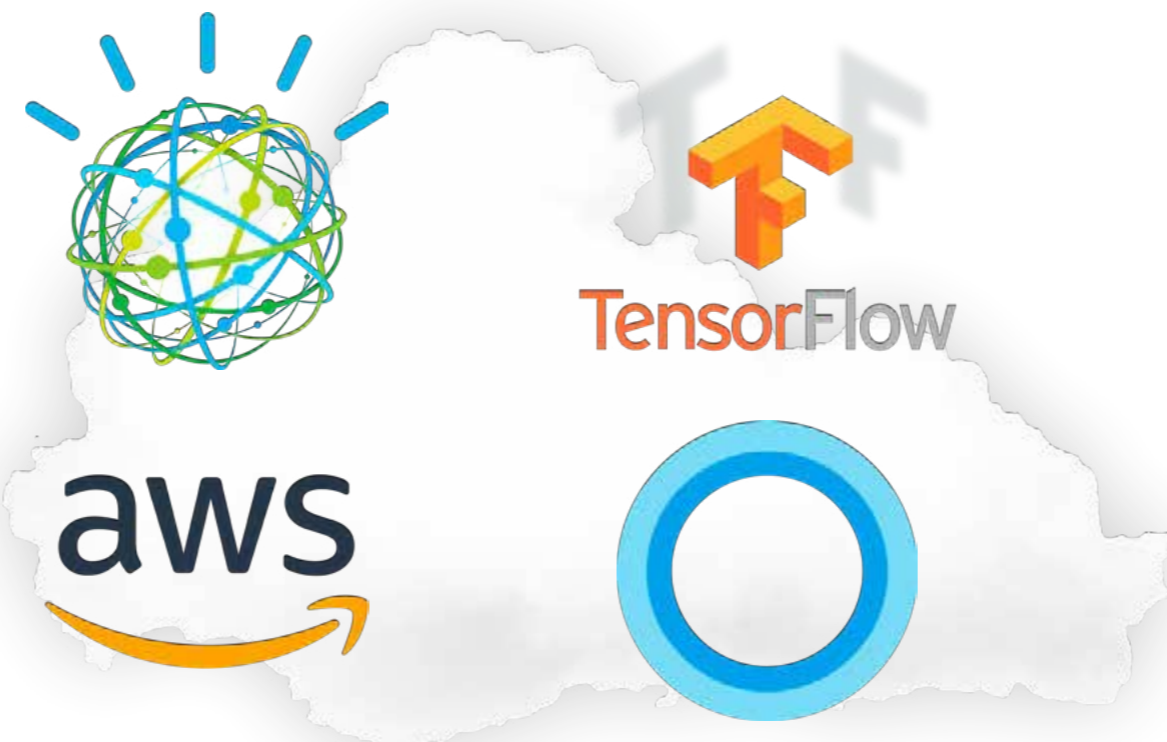
Look at the infrastructure

These developments could have a bigger impact on industry than any incremental steps of automation because they allow value to be unlocked in parts of organizations that were not deemed valuable in the past. For example, Volkswagen would arguably not have attributed a ten-figure valuation to its wiper division.

To be able to surface these values, it is necessary for organizations to look at their data infrastructure and

> Machines, robots, and sensors have become data nodes and the true opportunities can now be unleashed.

Now everybody's doing it!
All major players are now offering a new wave of enterprise services that come with a specific sensitivity as they handle the very core of a company's data infrastructure.

bring it into a shape where it can easily be accessed and processed. Arcane legacy systems will hamper the efficient deployment of IoT solutions as value can only be partially unlocked.

This requires the building of a data science function that can dive deep into the leading edge of AI systems. The building blocks for such systems are now widely and easily available but the minutiae in their deployment is varied (do Monte Carlo systems perform better than multi-armed bandits? No, I wouldn't know either…) and the integration of such functions are not trivial. When well implemented, they will boost almost every organization's ability to extract, analyze, and action data sets to improve performance on all facets of the value chain: faster and better product development, deeper customer understanding, more focused product innovation cycles, higher productivity.

We are thus looking at a new wave of enterprise services that come with a specific sensitivity as they handle the very core of a com-

pany's data infrastructure. This will likely take the shape of a layered cake: the various data layers residing in the company's domain, whilst the processing of (often anonymized) data sets taking place in standardized AI frameworks hosted in the cloud. All major players are now offering suites of services and tools to handle the key elements of this, including Google (TensorFlow), Microsoft (Cortana), IBM (Watson), and Amazon (Lex and Polly via AWS).
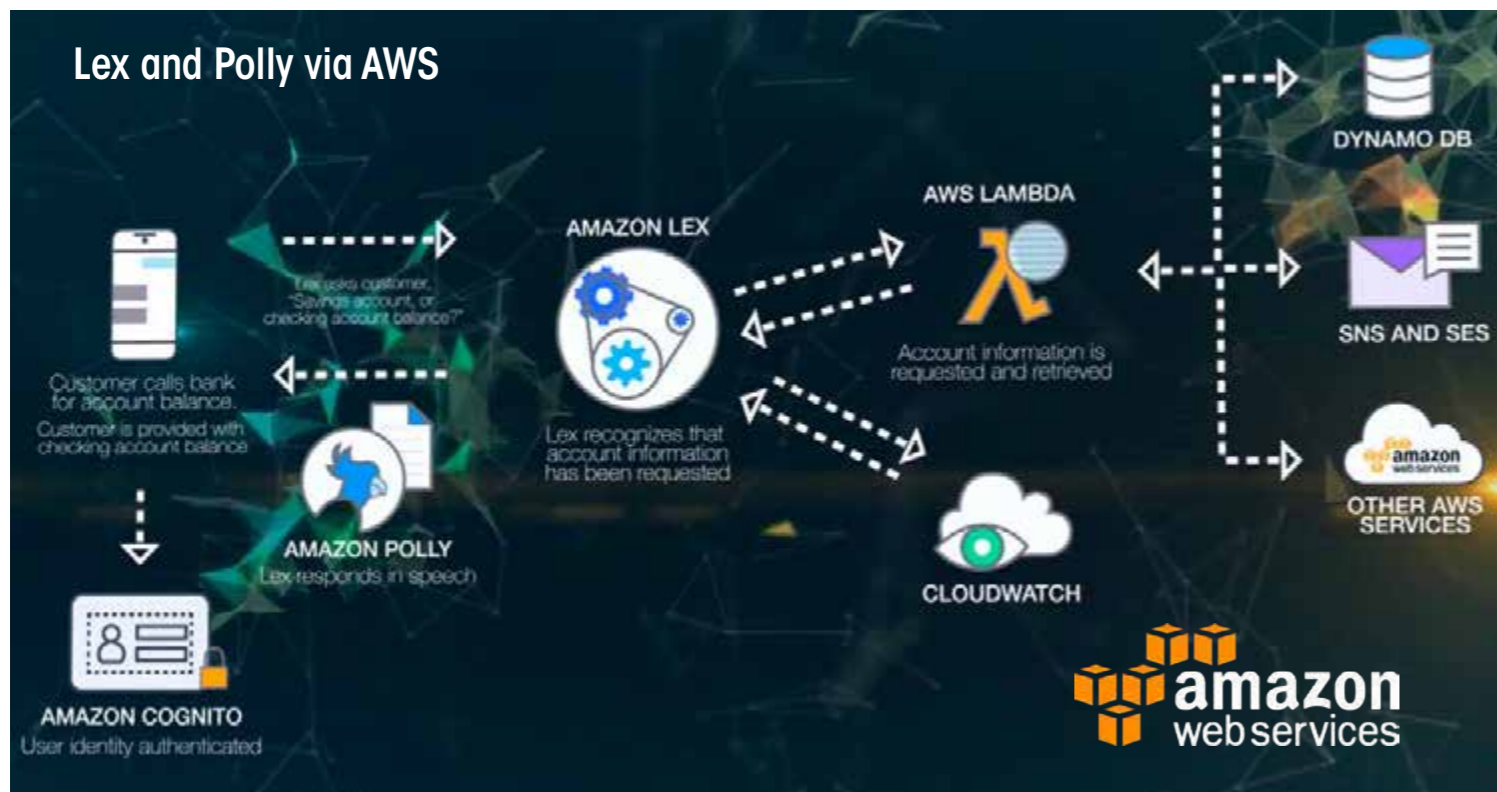
In the middle, we will often find specialized frameworks that focus on specific tasks and processes found in particular industries and market verticals (some of which are shown below). These come in at different points of the process – some come in at the time of data capture, some do the heavy lifting of the data collected, and others focus on the data output, for example in the way of virtual assistants.

Bringing dark to light

In industry, the first two will often be the most significant ones because they deploy relatively inexpensive tools to capture, structure, and analyze existing data and processes to propose improvements in processes along the entire value chain without the need for spending big on capital expenditure. The raw data has existed for a long time but it was largely unstructured and thus "dark." It is the combination of data capture by deploying sensors, the amalgamation of the various data sources available in and to the company, and, last but absolutely not least, the analysis of ongoing comparisons and the iterative improvement AI affords, that is bound to make the biggest difference to the world we know. It lights up the data we have to hand by providing structured outputs that humans can process and understand.

This is the true superpower that the "I" in IoT holds for us.

Harnessing the power of the cloud
The various data layers reside in the company's domain, but the processing takes place in standardized AI frameworks hosted in the cloud.

Leaders of the Data Revolution

■ Tesla

Elon Musk, in his missionary Master Plan Part Deux, explained in 2016 how Tesla uses "fleet learning," whereby it amalgamates every mile driven in a Tesla to inform its AI in order to improve autonomous driving capabilities. Two years ago, he said Tesla vehicles collected data for three million miles daily and the number of cars has increased annually. This would mean that Tesla now has data from about five billion miles driven to train its self-driving AI.

Although it is rumored that Tesla uses components in its air-suspension system from Bilstein, the same manufacturer as Mercedes, and both have on-board GPS systems, Mercedes has not yet made the software connection that currently allows Tesla vehicles to automatically adjust ride height based on previously encountered road conditions.

■ FiveAI

This Cambridge-based startup in the UK not only builds out its own self-driving system but combines it with data garnered from Transport for London, the operator of London's traffic systems, as well as from insurers and other stakeholders, to ease traffic and optimize traffic flows and the utilization of transport networks. Its hardware gets "smart" by receiving the traffic-related data from a number of sources, including traffic lights, parking spaces, and

public transport flows. Working with the UK Government's StreetWise program, it will commence on-street testing in the complex traffic of London in 2019.

■ SenSat

This London-based startup creates super-high-definition 3D point maps for infrastructure and large-scale construction, accurate to 6 mm (which is engineering-grade). Once construction is complete, any sensor on the project can be assigned its specific location and the map becomes a real-time equivalent of environmental, traffic, and other data in this location, which can be used by planners, property managers, and citizens. Data outputs can also be used to shape future projects more effectively.

■ Big River Steel

At the other end of the spectrum, an Arkansas-based steel mill is not the place where you would expect high tech. It has installed sensors and AI to optimize its processes, improving its workflows and, ultimately, its profits. Besides predicting demand, sourcing, and scheduling based on historical patterns which are continuously updated as new data flows in, it also deploys predictive maintenance to minimize downtime of its machinery.

Lex and Polly via AWS

Innovation and IT

MAKING DATA WORK HARDER

Making the most of IoT involves building new applications and services based on data. Implementing sensors, devices, and networks is **the first step to getting value from IoT.**

■ **By Martin James**

T he term "Internet of Things" has been around now for nearly twenty years, but the level of understanding of its potential is not fully embraced across all industries. While some companies have started on Industry 4.0 deployments and smart supply chain implementations, there are still many that are only dipping the proverbial toe in the waters of IoT. Why is this? What is holding many companies back from making better use of IoT across their operations? In most cases, it is due to difficulties

Martin James
is Regional Vice President, Northern Europe, at DataStax

around making use of the data that IoT creates.

Connected things feed back detailed data to the business. By collating all information from multiple devices, patterns in behavior or usage become apparent. In theory, at least, this data should lead to more insight and therefore better decisions over time.

However, simply gathering data will only take decision makers so far. For instance, getting granular data on energy use, or location of assets, can support more accurate decisions than might have been made previously. A

utility provider may be able to forecast demand more precisely, while logistics companies can reduce waste or loss. However, if this data is used solely for getting more detail on one facet of operations, then other opportunities to be innovative are missed.

Getting the right approach to analytics in place can help by using the data to generate in-depth insight for operations. In practice, this means linking IoT data up with other sets of information. These may be external sets like weather or consumer behavior.

However, this creates its own set of problems that cross over from the technology side into areas like business process and people skills. For example, how can the company bring the sets of data together in real time, so that they can be used effectively? What sets of data does the company have, and what can be brought in from outside? And what questions can be answered using that data combination?

Answering these questions requires more thought on how the business functions and what its goals are. Looking at device data on its own won't be enough to show all possible applications, so exploring how to use other internal and external data sets will probably be necessary.

For example, many businesses are looking at how to improve customer service and loyalty, but the link between better customer experience
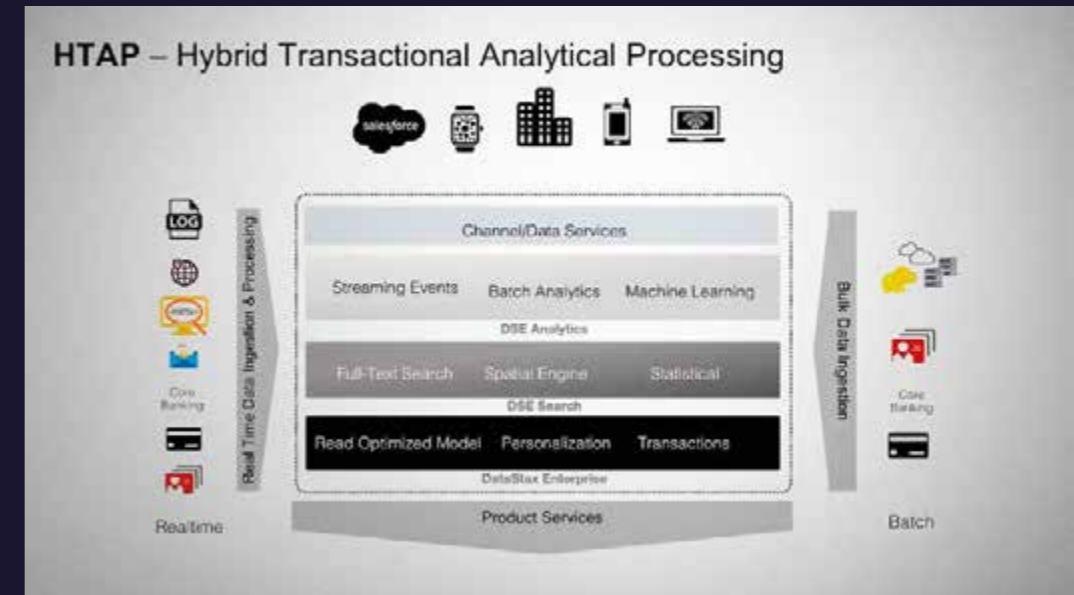
and IoT data may not be immediately obvious for, say, utility companies. Getting more insight into the status of smart devices over time can help highlight possible problems with assets. In the utility sector, boilers or heating systems can be tracked and companies can proactively recommend service in advance of possible equipment failure. Providers like First Utility in the UK use data analysis to see energy reduction opportunities for customers, helping them cut their bills.

Combining these different approaches to analytics should add up to a wider improvement in customer experience. Stopping device failures and helping customers reduce their spending should increase long-term loyalty and keep customers happier over time, which should then result

The right mix
A combination of different approaches to analytics can lead to improvement in customer experience.

Outside views
Insights must be drawn from both internal and external data sets in order to provide true value.

in higher average revenues per customer for companies.

In the logistics sector, increased accuracy can help with customer service through more in-depth tracking. Rather than simply providing generic information, information from sensors can provide real-time insight into where each delivery is. For customers, this level of insight should be a valuable extra, while the logistics company should see how its overall network is performing.

Making it all work

Getting data and using it effectively does mean thinking about new applications and how those services are delivered. Gradually, it may mean building on existing IoT data alongside other sets of information. Scaling up from initial IoT projects, therefore, requires an integrated approach to data, processes, and implementation where further applications or different use cases for the same operational data can be added over time.

Whichever approach your company has around new ideas and innovation, it's worth looking at how to devote more time and resources to supporting internal research and development. Using data from IoT devices, companies can power new and interesting services for their customers. However, getting the approach to innovation balanced across the business requires a combination of the right people, the right data, and the right platforms to pull it all together.

FLEXIBILITY IS KEY

G5

G3

G4
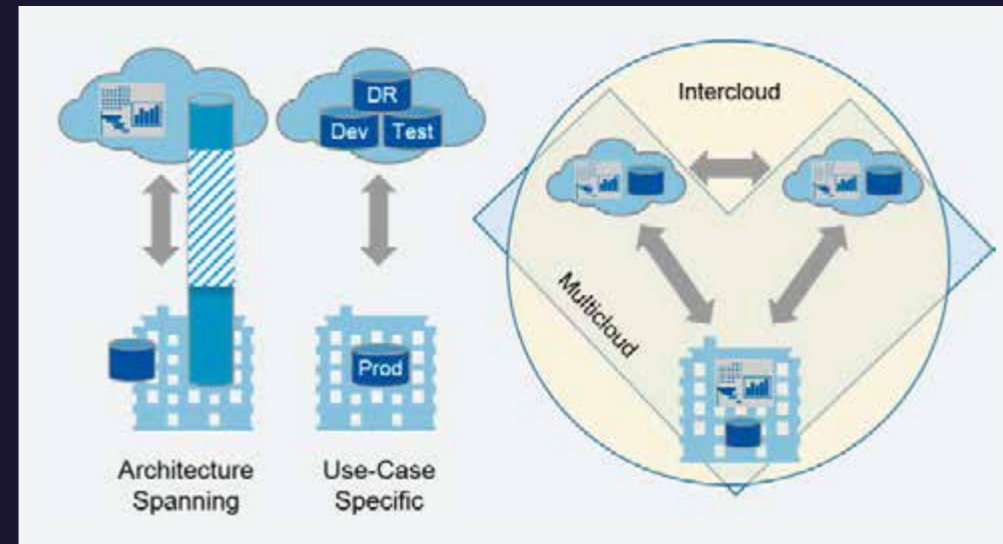
NB-IoT

If you need global IoT connectivity for your devices and want to be able to change providers and services at will, you need to be flexible. Such flexibility is no longer a challenge with **NB-IoT, a new wireless standard that works with all existing G3, G4, and G5 cellular technologies**, which makes it ideal for the next generation of cellular machine-to-machine (M2M) communications.

■ By Chris Young*

Many applications do not require high bandwidth or permanent connectivity. Often, devices need to connect only from time to time to check in and send small data packets. This saves connection costs and valuable energy, enabling smart and affordable connectivity solutions with long battery life of up to ten years.

For this purpose, the wireless standard NB-IoT was created by the 3rd Generation Partnership Project (3GPP), a collaboration between groups of telecommunications standards associations, known as the Organizational Partners. NB-IoT is a low-power wide-area (LPWA) technology developed to enable a wide range of new IoT devices and services.

Supported by all major mobile equipment, chipset, and module manufacturers, NB-IoT can coexist with 2G,

❞ eUICC allows users to switch providers without physically changing the embedded SIM card itself.

3G, and 4G mobile networks. The underlying technology is however much simpler than today's GSM/GPRS and its cost is expected to decrease rapidly as demand increases. NB-IoT also benefits from all the security and privacy features of mobile networks, such as support for user identity confidentiality, entity authentication, confidentiality, data integrity, and mobile equipment identification. NB-IoT offers up to 250 kbps bandwidth and supports a particularly large number of connections per base station. NB-IoT further offers an additional 20-decibel link budget. Given the right infrastructure, this makes it possible to increase network coverage even in areas with previously poor coverage. It also boosts interference immunity and transmission quality – even for connections inside cellars. Compared to alternative LPWANs, NB-IoT allows significantly more data to

be transmitted in the licensed band and provides higher bandwidth. NB-IoT therefore addresses a much larger number of applications. In addition, the base station infrastructure for NB-IoT is usually already in place as it can rely on existing mobile networks.
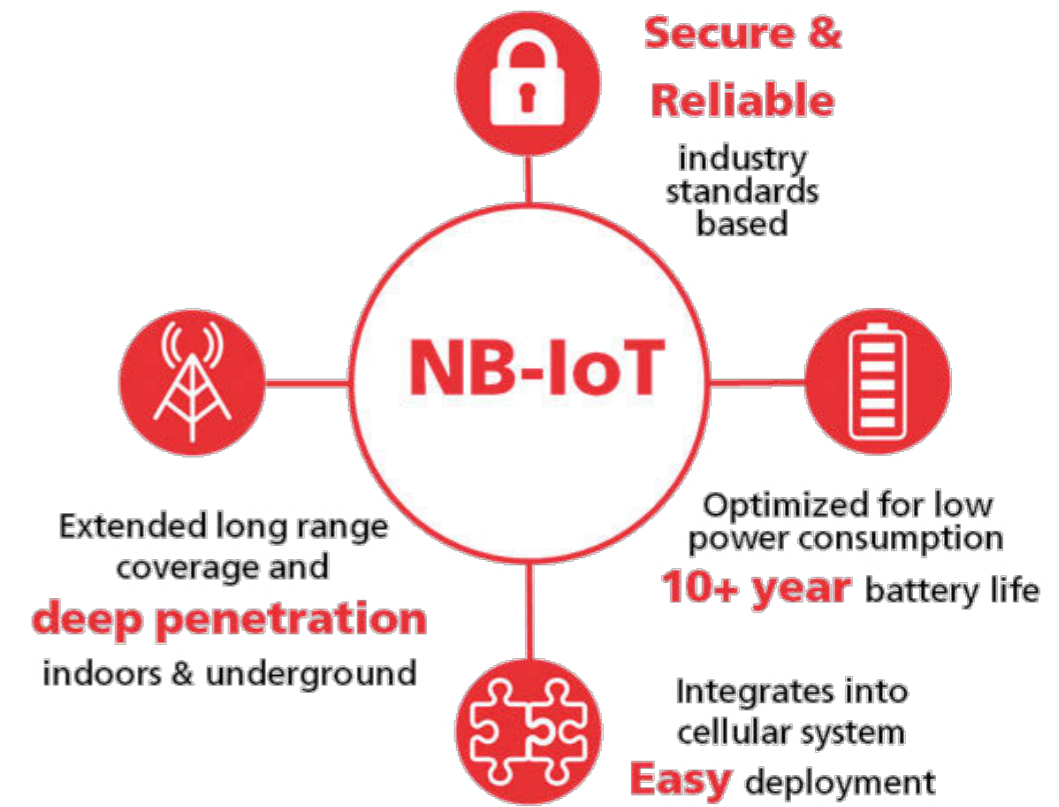
To use them, all that's typically required is a software update of the base stations. Only a few locations need an additional hardware upgrade that's relatively easy to implement. The use of NB-IoT by major mobile operators is therefore expected to accelerate exponentially in the near future. Areas of application can be found wherever limited data rates, such as Sigfox LP-WAN, which can send 144 messages per day at 12 bytes in the direction of the cloud, are no longer sufficient. But even NB-IoT has its limits.

A valuable addition to NB-IoT is Cat M1. Like NB-IoT, this is a 3GPP Release 13 standard. It offers an even higher

peak data rate of up to 1 Mb/s full duplex compared to NB-IoT and supports mobile solutions, something which NB-IoT cannot do because the network must establish a new connection after leaving a cell. Cat M1 further supports Voice over LTE (VoLTE), which may be of interest for IoT applications such as home care and elevator alarm systems, equipment access control and remote assistance solutions as well as ticketing systems and vending machines. Measuring 10 to 15 ms, latency is significantly lower here compared to NB-IoT, where values range from 1.6 to 10 s. Combining these two technologies with 2G EGPRS fallback for regions where NB-IoT has not yet been rolled out, multi-mode connectivity cards can be used to generate extremely high network coverage for the large number of mass use cases that benefit from many years of battery operation and do not require a constant connection at high data rates.

Mobile M2M applications, particularly those that are deployed globally, are flawed by the fact that the management of the SIM cards can be extremely complex, resulting in an immense administrative burden for large field deployments. However,

a lot of the effort can be avoided by using Embedded Universal Integrated Circuit Card (eUICC)-compatible SIM technology. Dubbed the "next evolution of the SIM card," eUICC offers users the ability to change service provider over-the-air (OTA), without needing to physically change the embedded SIM card itself. eUICC represents the most radical change in over two decades of GSM connectivity, in terms of how customers can select and change service provider profiles based on the criteria or business rules of their choosing.

Secure & Reliable
industry standards based

NB-IoT

Extended long range coverage and **deep penetration** indoors & underground

Optimized for low power consumption **10+ year** battery life

Integrates into cellular system **Easy** deployment

A big step ahead in mobile technology
Standards-based NB-IoT offers significant improvements over existing technologies, such as extended range, lower power consumption, and easy integration.

For global solutions, this makes it possible to quickly secure the right tariffs from one or more of the world's 20 largest network operators – which according to Vodafone already service 90 percent of the IoT coverage area – and install suitable MNO profiles depending on the location of the device. Corresponding updates of all base stations provided, of course. Another option are global virtual network operators (VNOs) like Arkessa, especially if you want to use one provider for everything.

NB-IoT by Avnet

■ Sense and Control

Avnet Silica has developed an application-ready Arduino-compatible board for this new performance class. Ardunio is a set of open-source computer hardware and software products that enable manufacturers to build digital devices and interactive objects that can sense and control objects in the physical and digital world through single-board microcontrollers and microcontroller kits. In addition, Avnet has created NB-IoT Sensor Shield, which makes it easy to optimize administration and maintenance tasks without having to buy additional Arduino shields. The NB-IoT Sensor Shield supports all popular operating systems such as Android, Linux, and Windows.
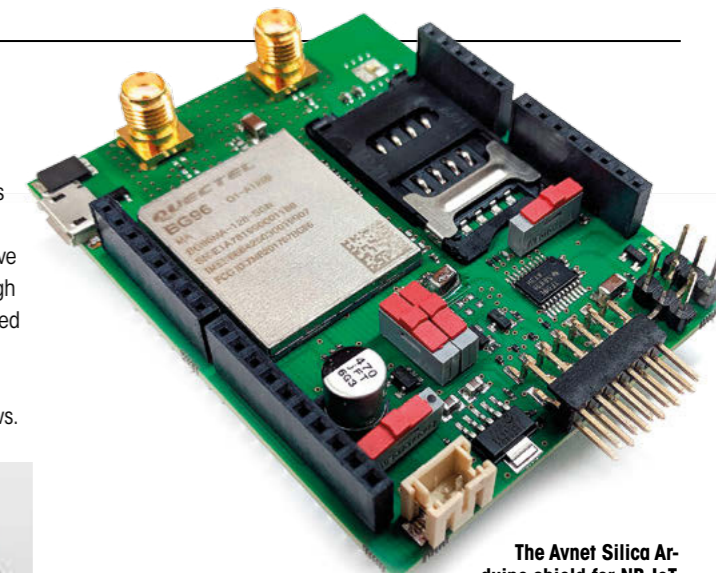
The Avnet Silica NB-IoT Sensor Shield starter kit with X-Nucleo sensor board and STM32 Nucleo-64 processor board already has its own test cloud for evaluating connectivity.

The Avnet Silica Arduino shield for NB-IoT, Cat M1, and EGPRS also offers optional geolocation, and can be equipped with eUICC SIM components or cards.

*Chris Young is an Embedded Software Specialist at Avnet Silica.

Clarius

TAKING ULTRASOUND FURTHER

Despite a century of innovation, the multi-billion-dollar ultrasound industry is still dominated by large, clunky, cart-based systems normally found only in clinics. But what if instead of bringing the patient to the machine, you **bring the machine to the patient** – and for a fraction of the cost?

■ By Mark McCoy

From the magical to the unimaginable, ultrasound technology gives a real-time glimpse into the human body without the potential harm from radiation like with X-rays. Contrary to popular belief, ultrasound goes far beyond women's health and pregnancy follow-ups, which represent less than 20 percent of their overall use in health care. In fact, diagnostic ultrasound is routinely used to diagnose a wide variety of healthcare conditions such as cancer, gall stones, and cardiovascular diseases. Since patient anatomy varies, an ultrasound allows the physician to see under the skin to guide their needle to exactly the right area.

Founded in 2014 by Laurent Pelissier, Clarius Mobile Health in Vancouver has combined advanced ultrasound technology and decades of experience to produce a "point-and-shoot" ultrasound imaging device that fits in a pocket and works with a smartphone.

Pelissier believes that this is just the kind of tech to shake up the $6 billion ultrasound industry. But only if it's executed to perfection. In the design and prototyping process, Clarius found the small form factor made the already challenging field of medical device development even more complicated. In an interview with Forbes, Pelissier said: "The digital health industry is at a crossroads where rapid progress in consumer technology is facilitating significant efficiencies in the development of medical device and health IT technologies. Whether through miniaturization, ease of use, or connectivity – companies are leveraging mainstream technology to improve the way healthcare is delivered."

"In the very beginning, we were having a lot of issues with the product heating up too quickly, for example. We did a lot of back and forth with the technical team at Avnet about how to manage the power properly," says Daniel Rahardja, a Clarius engineer. "Avnet definitely gave us a lot of invaluable support, not just from a bill of material point of view, but technical expertise about products."

Once they began ruggedizing the scanner with a waterproof metal enclosure, the designers ran into even more challenges. That's where the support of an end-to-end distributor really came in handy. "In building this kind of technology, what helps is direct factory contacts. To have that exposure and knowledge, to talk to the guy who actually designed the chip, that all helps our design move much more quickly," says Kwun-Keat Chan, director of hardware development at Clarius.

Avnet introduced Clarius to Xilinx's Zynq All Programmable SoC and the development team behind its design. Clarius was able to leverage this component to enable key analytics and hardware acceleration. "To make this product viable, feasible, and sellable, the price of the component and especially the Xilinx system was critical," he says.

Clarius Wireless Ultrasound Scanners are now available across the world, being used everywhere from Canadian ski resorts for on-the-go diagnoses to Haitian villages for Zika studies with newborns.

But the ultimate goal of the scanners is clear. "Where every medical practitioner has their own stethoscope now, in the future we want every medical practitioner to have their own handheld ultrasound," Rahardja says. "That's the dream: a product that's like your visual stethoscope."

Looking deeper
For medical practitioners, the Clarius Wireless Ultrasound Scanner is like a handheld ultrasound stethoscope.

Quality images
Handheld ultrasound scanners can mean the difference between life and death for first responders and emergency doctors.

XILINX®

Building the Adaptable, Intelligent World

Hanhaa

A RICHER PICTURE

Every month, €13 million of packages go missing. Solving this thorny global logistical issue is a lucrative Internet of Things (IoT) opportunity – one that businesses and entrepreneurs around the world are scrambling to address. **And time is of the essence in this competitive space**, as the number of large-scale IoT projects doubled in the year 2017 alone.

■ **By Tim Cole**

Azhar Hussain, CEO of London-based IoT innovator Hanhaa, had a small business with a big mission: to enable businesses to monitor their global shipments at massive scale – meaning, tens of thousands of parcels – and make detailed information more easily accessible. Where was the parcel? Was it within the allowable temperature range? ➜

Had it got wet? Had it been tipped, dropped, or opened?

What's more, Azhar wanted to make his product, the smart parcel solution ParceLive, operationally feasible for a broad range of customers. "By offering it as a tracking service, our customers can stay focused on using their IoT data to improve their business without worrying about the up-front logistics and expense," he said. "Customers won't need to buy the trackers, or charge them, or test them, or ship them around the world. We look after all of that while providing near-real-time data about their parcels."

This startup founder's promising vision hinged on one small, yet surprisingly complex, piece of technology: the parcel tracking device itself.

Tackling technology complexity

At first glance, the ParceLive device sounded straightforward: it was based on individual pieces of proven technology, from GPS and other sensors to the wireless communication equipment.

"It was when we started combining
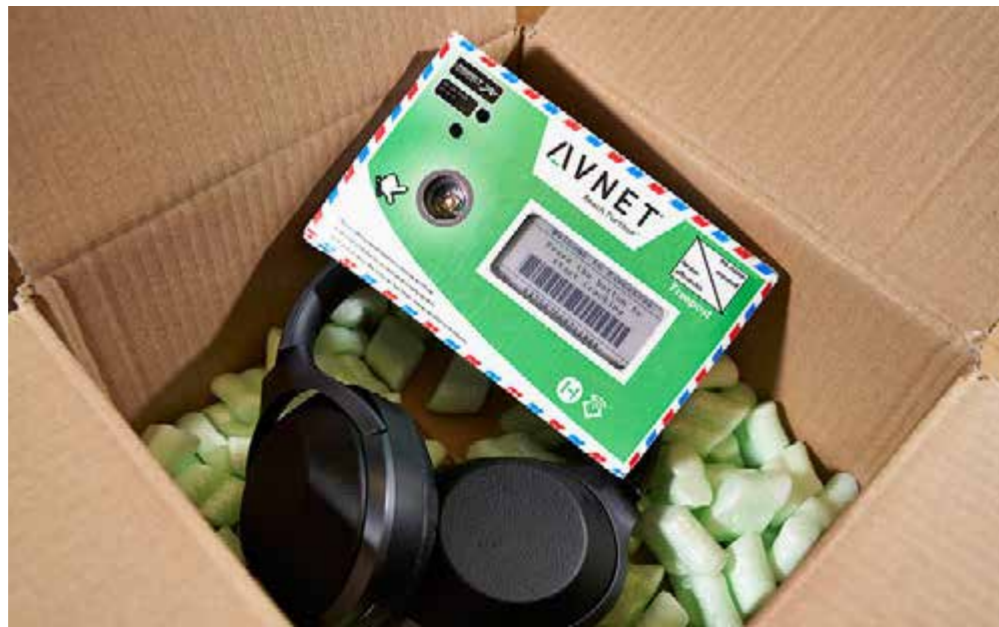
Right combination
ParceLive combines various proven technologies such as GPS and other sensors and combines them with wireless communication equipment.

Worldwide service
Near-real-time parcel tracking as a service without the need to buy, charge, or test tracking devices.

these different capabilities that things quickly become more complex – especially the antennae. A small tweak to one part of the design had a big impact elsewhere," Azhar said. The product simply wasn't meeting the requirements. So, he turned to Avnet for a solution.

The team faced challenges on multiple levels. For one, the MCU architecture was not performing at the required levels; battery life was proving too short for international tracking; and the existing chip antenna would not allow ParceLive to track with the granularity required for the product to reach its full potential in the market. The solution for the first problem was

to migrate to STMicroelectronics for a significantly enhanced performance with full design support. The battery problem was solved with the help of VARTA's certified solution to increase battery life from seven days to more than 20 days. And finally, engineers from TE Connectivity were brought in to upgrade from a chip antenna to an embedded antenna that could offer a far greater granularity of data and a tracking performance that was previously unattainable.

Paul Jones, Business Development Manager at Avnet Abacus, has worked with many startups at this same point in their product development process, when they're beginning to grasp how complex and challenging it is to recognize and mitigate design risks. "In IoT especially, a small mistake early in the design process can cost vast amounts of time and money further down the line," he said.

TE's engineers reviewed Hanhaa's designs and highlighted issues that could affect the tracker's performance or battery life, working in tandem with Avnet's experts to balance both the requirements of the overall device and those of global markets. "TE helped us refine the designs and tune the performance so that the tracker delivered the level of accuracy we needed," Azhar said. Among other things, ParceLive's passive antenna arrays enable GPS readings from inside a building.

"Global product development is one of the most complex and resource-heavy endeavors you can take on – especially for IoT entrepreneurs," Paul Jones says. "We're committed to helping startups succeed because nobody can do it alone."
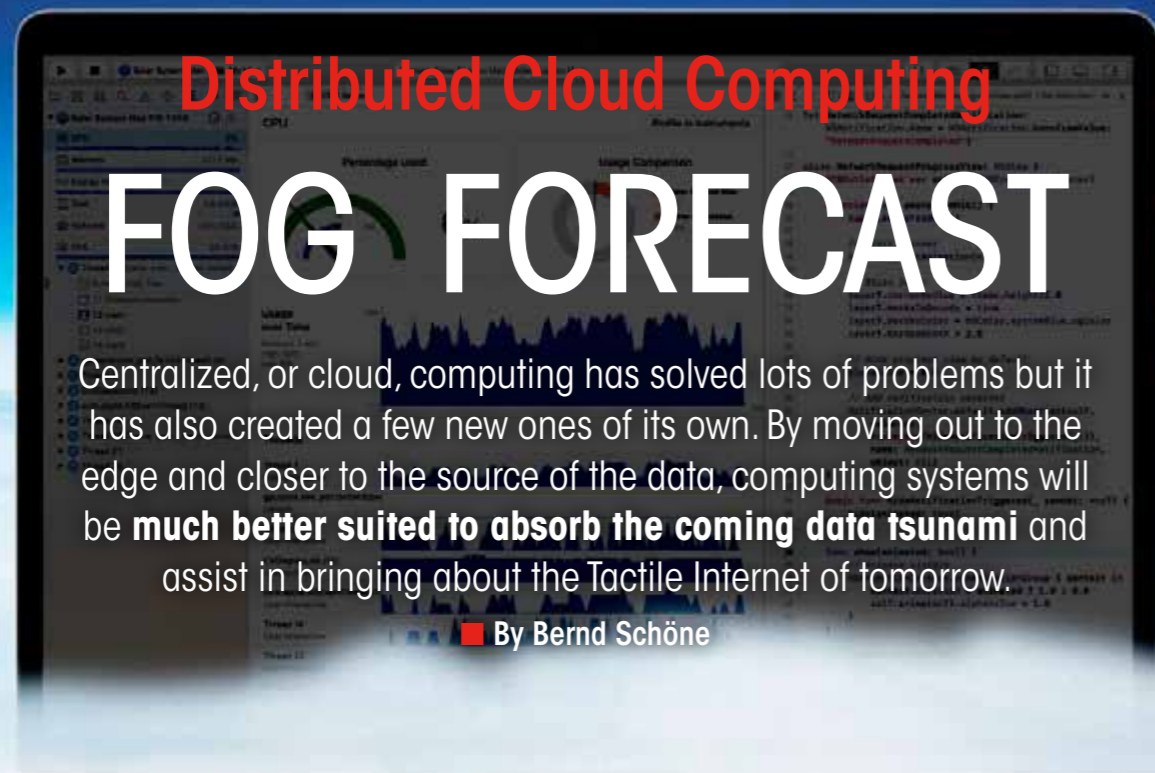**www.avnet-abacus.eu/te-startups**

Distributed Cloud Computing

FOG FORECAST

Centralized, or cloud, computing has solved lots of problems but it has also created a few new ones of its own. By moving out to the edge and closer to the source of the data, computing systems will be **much better suited to absorb the coming data tsunami** and assist in bringing about the Tactile Internet of tomorrow.

■ By Bernd Schöne

Ever heard of Fog Computing? If not, you are in good company because most people haven't the foggiest idea either. Nonetheless, it is probably one of the hottest IT trends in recent years. The basic idea is simple: Move your centralized cloud structures closer to the data on the fringe of the network. This concept is called Edge Cloud and has been around for years. In June 2018 the OpenFog Consortium published the OpenFog Reference Architecture which was immediately adopted as an international guideline to meet the data-intensive requirements of the Internet of Things.

"We now have a ... blueprint that will supercharge the development of new applications and business models," says Helder Antunes, chairman of the OpenFog Consortium and senior director at Cisco, the network company that provided the reference model. "We are constantly wasting time and bandwidth by transferring all the data gathered by our IoT devices first to the cloud for processing and then moving the results back into the network."

It would be much more sensible, he believes, to do most of the processing on the network's edge where the data resides. Of course, this calls for some pretty fancy routing – but intelligent routers are what Cisco does.

It also means that the networks themselves need to get smarter and a broad consortium of manufacturers, from Google to Apache and Dockers, are on board this push towards the edge. They are joined by mobility experts who have incorporated Fog into the blueprint for the emerging 5G wireless standards. Despite the wireless community's interest, Fog is actually based on wired data processing but, here, the new motto is: "Less centralism, more distribution of tasks". Central computer systems are prone to overloadd. That was one reason companies began switching to PCs in the 1980s, each operating as a central server on the department level and connected through a client-server architecture. Sometime around the mid-2000s the whole idea was turned around when virtualization of servers made it possible to centralize computing power once more, which saved a ton of money but didn't really solve the bottleneck problem – in fact, it made it worse.

Centralization has its obvious uses, of course. You get to store all your data at a convenient single location where you have it under control and can process it anytime you want.

Protecting Data through Fog

■ GDPR

The newly enacted European General Data Protection Regulation (GDPR) is expected to become a major driver for fog, or distributed cloud computing. Authorities in Europe are tasked with overseeing the use of personal information at the local level and non-compliance can lead to heavy fines. Edge computing could provide a foolproof way of making sure sensitive data is stored and processed within the territorial limits of the European Union, as stipulated by the new regulation.

The price you pay is the time it takes to transport the data to the central server and then you wait until it's your turn to crunch numbers. Afterwards, the data has to move all the way back to its place of origin.

In IT, the weaknesses of centralization are becoming more apparent as we enter the Age of IoT because the gap between the amounts of data and the processing power needed continues to widen. For instance, examine data outputs of a typical wind turbine, an airplane or a surveillance system. A wind turbine can boast 1,000 sensors or more, each capable of producing anywhere up to 60,000 individual bits of data per minute. The engine of a late-model Airbus A320 jet liner generates terabytes of data every hour from more than 24,000 measuring points, each producing millions of data sets that need to be downloaded after landing and sent to a data center for further processing. Many digital surveillance cameras already provide 4k resolution which means 10.2 gigabytes per second – and 8k cameras are just around the corner.

In each of these cases, operational efficiency does not demand that all data is moved to the center, what counts is the message the data conveys. For instance, the results of an analysis performed at the edge will suffice to determine if unscheduled maintenance of a wind turbine is necessary or a jet engine is in danger of shutting down in mid-flight.

Fog deals with these issues by doing away with gridlock and thereby with pain points for the customer. It comes in many shapes and sizes, for instance Fog Computing, Fog Networking, Edge Computing or Edge Cloud. Perhaps a better term would be Distributed Cloud Computing.

Users could care less which name the techies stick on their systems, just as long as it works. But how to make thousands of devices, processors and storage points function seamlessly as a distributed network? This will require more powerful routers with new kinds of software and, possibly, new operating systems. A key component will be the Edge Controller, a kind of

Typical Use Cases for Fog

■ **IoT**
Latency-critical applications, such as IoT or self-driving cars, which require data centers to be located at a maximum of 50 kilometers from each other.

■ **Server**
Replacement of classic corporate or branch-office servers.

■ **VoD**
Content streaming and video-on-demand for local audiences.

programmable logic controller (PLC) – a small computer with a built-in operating system optimized to handle incoming events in real time. These tiny processing units need to be based as close as possible to the sensors where they can be filtered more rapidly.

It's early days and much of the technology needed is still under development. To create a network of smart devices and local clouds, the system must be capable of finding the necessary programs and transporting the required data to them as quickly as possible. This is sure to require thousands, possibly millions, of small, modular data centers or even tiny Micro Modular Data Centers (MMDCs). The standards authority of ETSI, the regional standards body that was set up in 1988 by the European Conference of Postal and Telecommunications Administrations (CEPT) in response to proposals from the European Commission. Their goal is an open application framework called Multi-access Edge Computing (MEC) which will allow for the deployment of services such as radio-aware video optimization, which uses caching, buffering and real-time transcoding to reduce congestion of the cellular network and improve the user experience. Fog and the mobile world, it seems, are moving ever closer together.

A final issue Fog developers worry about is latency, the time taken by a unit of data (typically a frame or packet) to travel from its originating device to its intended destination which is

> We are constantly wasting time and bandwidth by transferring all the data gathered by our IoT devices first to the cloud for processing and then moving the results back into the network.

Helder Antunes, chairman of the OpenFog Consortium and senior director at Cisco

usually measured in milliseconds. Delays of more than ten microseconds in a video transmission can be annoying for viewers and wearers of data glasses experience dizziness if latency exceeds five milliseconds. Machines are even more sensitive to signal delays, and anything below a millisecond can lead to shut down.

Since latency is a function of distance, Here, Fog and Distributed Cloud Computing have a distinct advantage. The fastest way to transmit data is through fiber optic cables. Light travels 300,000 km per second but fiber optic cables can only achieve 200,000 km per second due to the delay created by switches and routers. It seems that the laws of physics actually demand Edge Computing. To achieve a latency below one millisecond, controllers and sensors cannot be further from each other than 100 km.

Expedrts have high hopes for even faster applications. Below a millisecond we enter the realm of Tactile Computing which offers users the same immediacy as their sense of touch. This will be crucial in areas such as telemedicine or in piloting drones. Combined with haptic gloves to simulate physical sensations, these systems will open up new possibilities, for instance, allowing doctors to perform tricky operations on a patient who is halfway across the world, or to enable bomb squads to defuse explosive devices from a safe distance.

The future, it seems, looks bright for Fog.

Transport Supply Chains

AFFORDABLE TRACKING

The world is entering a new era in logistics; one where it is possible to oversee the complete supply chain in real time by **tracking containers, pallets, trailers, and trucks anywhere, anytime,** cheaply and using little energy.

■ By Frank Sauber

> Logistics companies can now choose from a wealth of technology options.
>
> **Frank Sauber,**
> Director Ecosystem Partners Sigfox

The supply chain is complex and involves many actors, including subcontractors and transportation companies, making it difficult to have an end-to-end view. Supply chain managers can be almost blind on some parts of the physical flows, which creates instability, reduces planning accuracy and agility, and increases lead times. Business success is rooted in supply chain visibility. However, achieving that presents a real challenge, because there are so many actors and factors that can cause bottlenecks and delays.

Across all industries, however, digital technologies are fundamentally changing how logistics works. The Internet of Things (IoT), cloud computing, and especially geolocation technologies are dramatically boosting the transparency of supply chain operations – for suppliers, manufacturers, and end customers.

Smart logistics make it possible for companies to constantly evaluate and optimize their supply chains. With a system that's drawing on a wealth of data from many connected devices, companies can now expect instant visibility of warehouse delays and routes taken, helping them to address supply chain inefficiencies or even eradicate them altogether.

Next-generation IoT

IoT is transforming logistics and supply chain management. Cisco and DHL estimate that IoT technologies like asset tracking solutions could create $1.9 trillion in economic value for the global supply chain and logistics sector. Innovation is happening at the level of sensors attached to goods and assets as well as at the networks level, capturing and transferring data all the way from the production line to the point of final delivery.

Logistics companies can now choose from a wealth of technology options. Right now, they may be using RFID or Bluetooth technologies to moni-tor goods in the warehouse, but what happens once the goods exit past the gate? Trucks might have GPS, but the trailer sitting in a parking lot probably doesn't. Cellular technology could be used to track a container cross-continent, but it may run out of battery.

Although geolocation technologies have been around for years, their spread has been limited – mainly because network services lack worldwide coverage, global reach, and a low total cost of ownership (TCO). Today, change is being driven by new geolocation solutions that use network services based on low-power wide-area (LPWA) networks. Global IoT services provider Sigfox is one such network bringing down the cost and energy consumption required to securely connect IoT trackers and sensors to the cloud. The network currently spans 50 countries and will cover more than 60 by the end of 2018.

Thanks to Sigfox's radio technology and disruptive network architecture, long-battery-life tracking devices and low-TCO solutions are now available on the market, with global network coverage able to meet international business needs. Ideally suited for small amounts of data, such as geolocation information, Sigfox's IoT network is currently being used across supply and production chains, logistics, and shipping and packaging.

Sigfox is unique in the LPWA landscape in that all its base stations catching radio signals sent by objects are part of the same network. That means that moving containers, pallets, RTI, ULD, and trailers equipped with IoT trackers can transmit their data all over the world – a real game changer when compared to existing GSM-based solutions.

Geolocation solutions are coming fast

There are many ways to locate an asset and the right combination of technologies will depend on each organization's requirements. GPS is available to companies that require very precise location details – mainly for outdoor purposes – using the low cost and low power advantages of LPWAN technologies to transmit the geolocation data captured by GPS trackers. GPS, however, is usually a more power-hungry feature.

Another option is to use LPWA network data. By leveraging the received signal strength indicator (RSSI) coming from the messages sent by the tracking device and received by the network infrastructure, it's possible to locate any asset. Such a network-based location solution enables the geolocation application to operate with very low cost and low energy location devices – equipped with just a Sigfox module. This method provides a kilometer-level tracking accuracy of between 1 km and 10 km.

When even greater accuracy is needed and for urban, indoor environments, surrounding Wi-Fi signals can be intercepted to obtain their location, and then by querying worldwide databases, MAC addresses sent to the cloud by the trackers via the Sigfox network can be translated into geographical positions. This technology is leveraging the global footprint of the Wi-Fi infrastructure, which has both indoor and outdoor coverage and a high density in urban areas.

Smart logistics tracking

Intercontinental flows like sea freight with long lead times, production flows involving external players like suppliers or subcontractors, and equipment monitoring like reusable packaging are all blind flows that can benefit from using geolocation technologies in this way. There are huge advantages associated with more ac-

Eye in the sky
There are huge advantages associated with more accurate asset tracking, and blind flows can benefit most from geolocation technologies.

curate asset tracking. Improvements to service levels for clients might include a reduction in lead times because detecting containers unloading at the arrival port helps to accelerate logistics operations at its destination. Likewise, alerts about delays can help trigger corrective actions to better manage priorities between clients and improve supply chain planning.

Any company can benefit from increased visibility around its supply chain. Among the early adopters of IoT geolocation and tracking solutions is Michelin, the global tire manufacturer, which tracks its intercontinental sea-freight containers in real time. By providing freighters with a geolocation service with which to monitor its containers from the initial warehouse to the final point of delivery, Michelin has been able to improve its operational value by reducing lead time, providing alerts about delays, and ensuring appropriate transport conditions.

Using this IoT solution has enabled Michelin to decrease transit stocks by 10 percent, increase estimated time of arrival (ETA) accuracy by 40 percent and reduce out of stock (OOS) situations due to exceptional causes, such as bad weather, by a factor of 4.

Other companies, including Airbus and Total, are now following suit, working with Sigfox and its ecosystem of partners to deploy global geolocation solutions, in order to improve logistics flow and track freight, optimize rolling stock, and help manage trailer fleets.

The global supply chain

IoT tracking devices don't need to send huge amounts of data and can run seamlessly on simple networks. The success of the connected supply chain of the future will, therefore, rely on the solution, as well as the network it connects to, and their ability to meet key supply chain requirements such as compatibility with multiple transport modes, stakeholders, and destinations. Having a worldwide footprint, a global reach for data, and a business-consistent TCO will also be critical factors.

MEMS

BUILDING A SMARTER SENSOR

Sensors have been around in industrial environments for a long time as critical elements in process and environmental control. Often, **sensors have been built with specific applications and operating conditions in mind** and they are relatively costly and time-consuming to manufacture.

■ By Andrea Onetti*

MEMS (micro-electronic-mechanical system) sensors were originally designed to replace or upgrade some of these industrial sensors with something smaller and more power-efficient. However, MEMS quickly took off in consumer applications such as gaming and smartphones thanks to their size, performance, and low power consumption; but they also took off because they can be manufactured in very high quantities. In the past de-

cade, tens of billions of sensors have been shipped into high-volume consumer applications.

Now MEMS are coming back to industrial applications as one of the key enablers of smart industry trends like Industry 4.0 and IIoT. As industrial systems become more automated and autonomous, and with the proliferation of artificial intelligence and big data processing capabilities, the need is growing for various types of sensors that can provide critical data on processes, machine conditions, and

safety; factories can use them to become safer and more collaborative for the people working in them.

In industrial settings, accuracy is key. Whether temperature and pressure control in a manufacturing process, inclination measurement for equipment installation, or vibration measurement for condition monitoring, accuracy is indispensable. To build a great, accurate sensor that fits an application requires three key items:
- First, the ability to measure a certain phenomenon – movement,

vibration, sound, pressure, etc. Here the mechanical and electronic parts of the MEMS device are key, with a combination of a tiny moving mechanical part and an electronic part. The electronic part converts changes in the device characteristics due to the movement of the mechanical part into an electrical signal and then into digital information about the physical change being measured.
- Next, the sensor needs to have all the right features to address the application in question – for example, the right size, the right power consumption, the right temperature range, and smart features that it needs to fulfil the application needs.
- The final critical element is accuracy – a measure of how closely the output from a sensor matches the "true" or actual value of what is being measured. Accuracy in a sensor depends on its ability to deal with noise in the measurement environment, its stability over time and ambient temperature, and its tolerance, i.e. the limits of variation.

While a sensor's noise capability is a function of the sensor design (mechanical and electronic), the stability and tolerance are mainly functions of the testing and calibration processes, and the associated algorithms that are embedded in the sensor.

Highly accurate industrial sensors have been produced in relatively low quantities up to now due to the need for long test and calibration times for each sensor. This is where the consumer heritage of MEMS plays a significant role. High-volume consumer

MEMS manufacturers like ST have a huge test and calibration capacity installed and therefore the ability to produce industrial sensors in large volumes (relative to the volumes of industrial sensors today) using the same test and calibration equipment used for consumer sensors. The tests are, of course, different from those for consumer sensors, using highly accurate stimuli, wider temperature ranges, a larger number of calibration points, multiple degrees of freedom testing, and high levels of parallelism in the testing processes.

Stability over time

In addition, since the functionality of the sensors is often the same as those used for consumer applications, a small proportion of the consumer sensors can be sorted based on the best characteristics and then calibrated to meet the more demanding industrial requirements.

Take the example of condition monitoring of a motor through vibration measurement. This is an application that requires high accuracy in the measurement of the vibration and stability over time and temperature in a harsh factory environment.

The more accurate the measurement, the more insight can be gained into the evolution of the condition of the motor. This is an important enabler of predictive maintenance where data from a large number of motors is analyzed over time to produce insights into how and when a working motor should be maintained.

ST offers a range of compact, high-accuracy, high-stability, low-power

Running hot and cold
Condition monitoring of motors through vibration testing requires a high degree of accuracy over time and in harsh environments.

industrial sensors such as accelerometers, gyroscopes, six-axis inertial measurement units (IMU) and magnetometer sensors. ST also offers a range of temperature and pressure sensors suitable for environmental monitoring. These sensors can be combined with microcontrollers and connectivity to create smart solutions for industrial equipment monitoring throughout its life cycle – from transport and installation to long-term operational maintenance. During shipment, accelerometers can be used to monitor shock and vibration while temperature and pressure sensors monitor environmental conditions encountered during transport.

In the installation phase, a high-resolution, high-stability accelerometer can be used for inclination measurement and other accelerometers can be used for shock and vibration measurement. Environmental sensors also enable monitoring of conditions during installation. These measurements enable equipment manufacturers and end customers to be sure installed equipment hasn't suffered deterioration before it is put into operation.

During equipment operation, accelerometers for monitoring inclination and shock as well as microphones and environmental sensors can be used to gather valuable information to enable condition monitoring and predictive maintenance.

Sensors have a great future ahead as one of the key enablers of smart industry trends and ST is working to make that a reality today.

Making double sure
An industrial sensor needs to meet stringent performance requirements including extended temperature range, sensing stability, and accuracy as well as ensure long-term availability, all of which require constant testing.

*Andrea Onetti is Analog MEMS Sensor Group Vice President – MEMS Sensor Division General Manager at STMicroelectronics.

End-to-End Solutions
IOT DRIVES MARKET CONVERGENCE

The stories around IoT may seem like hype, but there is no denying connectivity is rapidly changing our world of living and working. In the past, innovations have typically been confined to clearly defined vertical market segments like transportation, industry, or building and home automation. A survey of the combination of the latest technologies across markets and a look beyond the garden gate reveal tremendous opportunities for new business models. Smart interconnection enables not only end-to-end solutions within a vertical but also helps to grow the segments together.

Smart cities are forcing new approaches to urban mobility. Connectivity enables not only guiding your car to a parking space reserved for you, but it also takes you to a spot conveniently located next to your shopping destination, thus saving you time and soothing your nerves. On your way, you receive information via your dashboard about the battery status of your car. With green energy available in your area, you get a special offer from the local energy provider. Your car charges directly at the parking lot while you're shopping via wireless charging. Billing is generated automatically via an app. The participating shops provide not just a voucher for your parking charges and maybe subsidize the energy cost, but also inform you about the newest offers related to your desired shopping activities. While you are driving, smart traffic management systems inform you about the average speed, which supports a rapid traffic flow and generates a wave of green traffic signals. But what's going on at home? You manage the alarm system or provide access to the garage because your package is now being delivered.

Dreams of a distant future? Hardly: a tremendous amount of data is already available, and more will be generated by the growing number of sensors in cars, around cities, and at home. Smart analysis and combining the data will be driven by artificial intelligence and the results will inspire many new business models. At the same time, the price of IoT is falling rapidly due to lower tariffs from the cellular providers, but also due to other methods of connecting like LoRa, Sigfox, or NB-

"

We need a clear focus on end-to-end solutions.

Marco Giegerich
Director Vertical Markets & 3rd Party Management EMEA at Avnet Silica

IoT. More standardized cloud solutions, for example from Microsoft, as well as easy ways of connecting devices, make it even more convenient to assemble comprehensive solutions.

In the past, our customers have usually focused on hardware to drive their business models and to generate clear differentiators in their specific markets. As hardware is becoming more and more commoditized, adapted or new business models supported by the newest technologies open opportunities to enter new value creation stages. Here, the focus is clearly on end-to-end solutions.

In the beginning, new business models often lead to major innovations, but more strategic steps will be required in the overall approach in order to maximize benefits and find solutions to the subsequent challenges. This calls for a new mindset to distinguish between the core competencies and the related parts of the development. Companies will need to decide whether to manage change on its own or to bring in external expertise. Cost targets and schedules have to be met. But in addition, new levels of security, service requirements, and maintenance need to be considered.

There is a fantastic array of new technology out there – but how to choose the right ones? What connectivity solutions will work if subterranean parking is needed? Is the system available globally? What security levels are required? What is already in place and what needs to be developed afresh, and by whom?

At Avnet Silica, we reduce complexity by driving and supporting the use case approach, meaning we have a clear focus on end-to-end solutions. Market knowledge on the commercial as well as the technical side, software engineering, and a strong network of market and technology leaders are key elements. To support the entire ecosystem, we work closely with a strong network of internal and external R&D partners.

The Internet of Things is changing our world as we speak. It will bring exciting new opportunities within individual markets, but it will also drive market convergence. Reducing complexity will continue to be a major requirement to kick-start innovation.
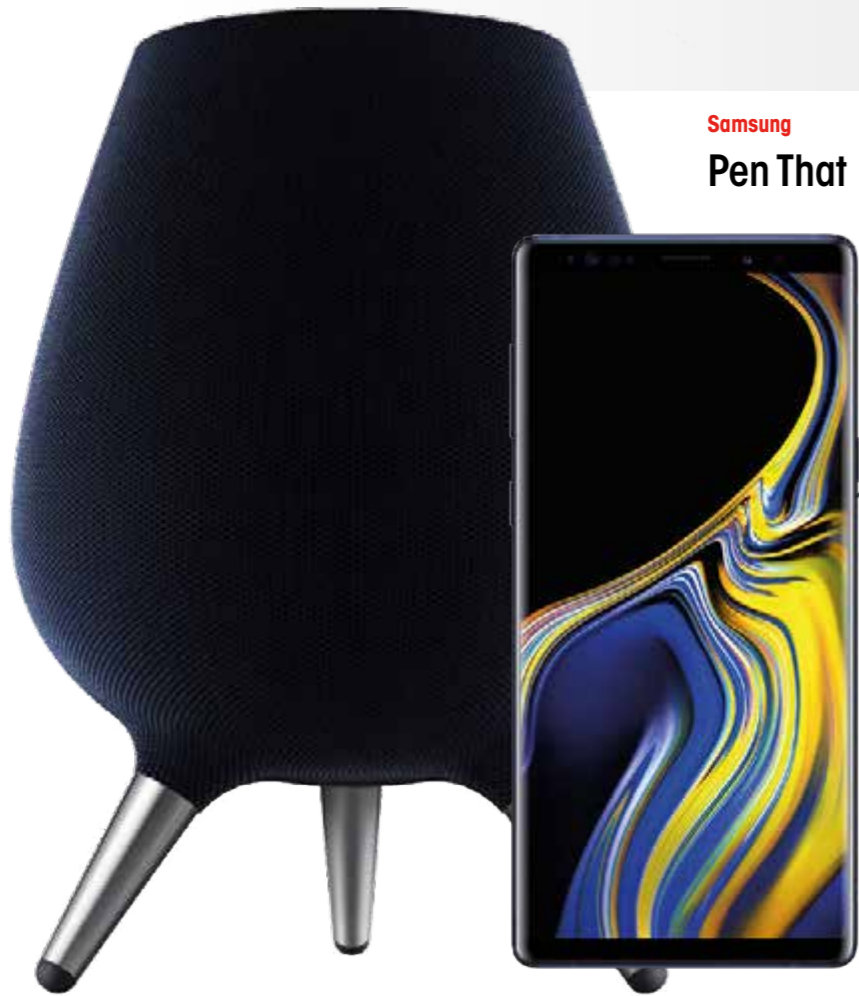
SMART
PRODUCTS

Samsung
Pen That Down

The times when people go crazy over a new tablet or smartphone may be over. But the new **Samsung Galaxy Note9** – a smartphone that is almost the size of a tablet – is astonishing enough, and it may be the one still to impress: it comes with a 6.4-inch Super AMOLED display, a 4,000 mAh battery that will let it work for a whole day without recharging and it supports network speeds of up to 1.2 gigabits per second. It also comes with a pen that is equipped with Bluetooth Low Energy (BLE). The S Pen may be used as a remote control to take selfies and group pictures, present slides, pause and play video; developers can even integrate the BLE functionalities into their own apps. Connected to a monitor, the Note9 can power a virtualized desktop or serve as a fully functional second screen. And it can also be controlled with the help of Bixby, Samsung's digital assistant, that will also come to more living rooms. Together with the new tablet, an intelligent home speaker was also announced by Samsung: the "Galaxy Home" will be available later this year in selected markets worldwide. It not only allows you to control smart home devices by voice control, but also brings powerful sound by AKG in every room. The Note9 costs about €1,000. Samsung has not yet released a price for the "Galaxy Home"-speaker.

to

Anki
Vector: The Smart Home Robot with Personality

So far, robots for home use have been rather boring – they do nothing but their jobs, like cleaning the floor or playing music. They are far from being a true home companion. Now, however, consumer robotics and artificial intelligence company Anki has announced Vector, a home robot with "personality." A Qualcomm APQ8009 processor enables it to be smart, approachable, and autonomous. A 120-degree field of view camera allows it to see the world and recognize faces, while an array of four microphones lets it hear and understand each individual in the room. There's

no need for a smartphone to be tethered to it – it is only needed for the initial setup. Vector can display different animations on a color IPS display and reacts to its environment in a way that's full of personality and meaningful. It even responds to human touch, thanks to the capacitive touch sensor built on its back. Vector is also able to play games like Blackjack. If it hears music, it may even dance to the beat. And when it's feeling tired or low on energy, Vector can locate and roll back to the charger. The initial price for the smart robot will be €250.
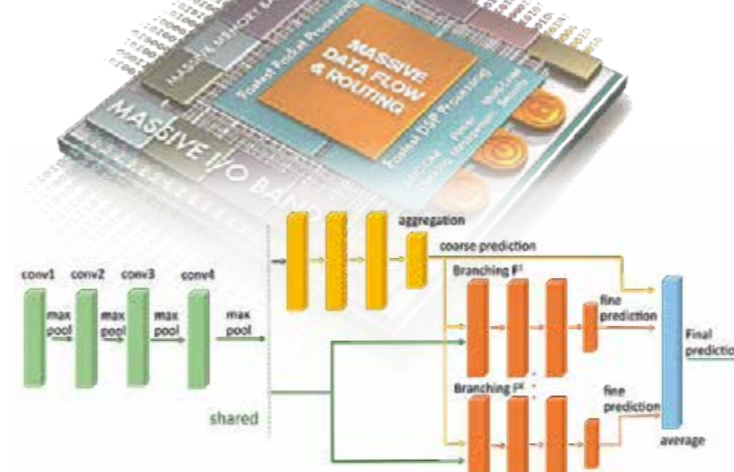
Kortiq
AIScale – Universal CNN Hardware Accelerator

Deep learning and deep neural networks (DNNs) are currently two of the most intensively and widely used predictive models in the field of machine learning. DNNs are not a new concept, but after the recent initial breakthrough applications of DNNs in the fields of speech recognition and image recognition, as well as due to the availability of large training data sets and extensive compute and memory capability in the cloud, they have returned to the focus of both academic and industrial communities. Today, different types of DNNs are being employed in areas ranging from autonomous driving and medical and industrial applications to playing complex games. In many of these applications, DNNs and, in particular, convolutional neural networks (CNNs) are now able to outperform humans. This arises from their ability to automatically extract high-level features from large amounts of raw sensory data during training in order to obtain an effective representation of an input space. This approach differs from earlier machine learning attempts using manually crafted features or rules designed by experts.

"We recognize a strong and increasing demand for object recognition and image classification applications, says Michaël Uyttersprot, Technical Marketing Manager for Avnet Silica. "CNNs are widely implemented in many embedded vision applications for different markets, including the industrial, medical, IoT, and automotive market." CNNs are a type of feed-forward artificial neural network in which the connectivity pattern between the neurons is inspired by the neural connectivity found in visual cortex of animals and humans. Individual neurons from visual cortex respond to stimuli only from a restricted region of space, known as receptive field. Receptive fields of neighboring neurons partially overlap, spanning the entire visual field.

However, the superior accuracy of CNNs comes at the cost of their high computational complexity. All CNNs are extremely computationally demanding, requiring billions of computations in order to process single input instance. The largest CNNs (from the VGG neural networks models) require more than 30 bn computations to process one input image. This significantly reduces the use of CNNs in embedded/edge devices. All CNNs are extremely memory-demanding, requiring megabytes of memory space for storing CNN parameters. For example, VGG-16 CNN has more than 138 m network parameters. With a 16-bit fixed-point representation, more than 276 Mbytes of memory must be allocated just for storing all network parameters. Kortiq GmbH, a Munich-based company, has recently developed a novel CNN hardware accelerator, called AIScale. AIScale, distributed as an IP core implemented using FPGA technology, provides high processing speed and low power consumption. Kortiq's AIScale accelerator is designed to process pruned/compressed CNNs and compressed feature maps – this increases processing speed by skipping all unnecessary computations, and reduces memory size for storing CNN parameters as well as feature maps. All these features help to reduce power consumption. It is also to support all layer types found in today's state-of-the-art convolution, pooling, adding, concatenation, fully-connected (CNN). This yields a highly flexible and universal system, which can support CNN architectures without modifying underlying hardware architecture. It is designed to be highly scalable, by simply providing more or fewer compute cores (CCs), the core processing blocks of the AIScale architecture. By using an appropriate number of CCs, different processing power requirements can be easily met.

Omni
A Smart Helmet for Cycling

Coros makes cycling safer and smarter with a new helmet called Omni. It is designed to help riders get the most enjoyment, freedom, and awareness out of their rides and enhances safety and performance at the same time. The helmet uses bone conduction technology placed on the helmet straps and allows the rider to hear without the safety issues of using ear buds. Bone conduction sends small vibrations directly to the inner ear and bypasses the ear canal, leaving the ear completely open and aware of external noises such as cars or conversations with fellow riders. The helmet also has a microphone near the forehead for two-way communications. Omni also ships with a wireless smart remote so riders can keep their eyes on the road and hands on the bars while controlling media and calls with the tap of a button. The helmet has a USB chargeable battery with 8+ hour battery life. In addition, it includes an emergency alert system that is triggered when the G-sensor senses significant impact, sending an alert with GPS notification to a designated contact. The price of the smart helmet is €200.

IKEA
A Smart Plug at a Low Price from IKEA

Ikea appears to be expanding its Trådfri line of smart lighting products, adding new smart plugs that can make any offline product controllable via an app or a remote control, according to Swedish tech blog Teknikveckan. The new smart plug will reportedly come in two versions: a "Control outlet kit" with an on / off remote is $15 and the "Wireless control outlet" will be $10. The power button remote can attach magnetically to metal surfaces and has a range of 10 meters. There will also be a package including a physical remote control at a price of €20. Like other Trådfri products, the new plug will most likely also support Alexa, Apple HomeKit and Google Assistant.

GN Hearing
Hearing Aids with Connection to Android

GN Hearing will be the first manufacturer to enable a full spectrum of direct audio streaming from Android devices to hearing aids. Direct streaming is likely to become available to users of the recently launched hearing aids ReSound LiNX Quattro and Beltone Amaze in coming Android releases. "According to the World Health Organization, around 466 m people worldwide have disabling hearing loss. This number is expected to increase to 900 m people by the year 2050. Google is working with GN Hearing to create a new open specification for hearing aid streaming support on future versions of Android devices," states Seang Chau, Vice President of Engineering at Google. Users will be able to connect and monitor their hearing aids, so they can stream sound from their Android devices without additional hardware. This will allow more people to call friends and enjoy music and brilliant sound experiences. Google's hearing aid specification for Android smartphones is published as "Audio Streaming for Hearing Aids" (ASHA) on Bluetooth Low Energy (BLE) connection-oriented channels. GN Hearing will be the first manufacturer to be able to utilize the new specification – in time, other hearing aid manufacturers will also employ native hearing aid support for Android.

Vodafone
Dedicated IoT SIM Cards in V by Vodafone Products

Since the beginning of August, **Vodafone** has started shipping dedicated Internet of Things (IoT) SIM cards to consumers. They are integrated into IoT-enabled consumer electronics products like V-Auto, a plug-and-drive dongle that can be added to cars, giving them an SOS and tracking function. Other products already launched are V-Camera, a wireless HD mobile security camera that connects to Vodafone's IoT network, and V-Bag, a briefcase, handbag, and schoolbag tracker that will alert users if their bag leaves a designated area such as a playground or a crowded bar. Setting up a product requires scanning a QR code to register it and add it to the monthly fee of an existing Vodafone mobile account. A smartphone app provides users with an overview of all IoT-enabled products they have registered. The new IoT SIMs can connect to Vodafone's LPWA IoT networks in 32 countries.

Snapchat
A Hands-Free Camera for Snapchat

Snapchat's first attempt to sell glasses with integrated cameras was not a huge success. Still they seem to be convinced to pursue the idea, so decided to give the product an update: the new **Spectacles 2** are more comfortable to wear, have a smaller profile, and they're water-resistant. Wearers may tap the button to record video with improved audio or can press and hold to take a photo. Captured snaps will be transferred to Snapchat up to four times faster than with the old model. Snaps are captured in a circular format at a resolution of 1216 × 1216 for videos and 1642 × 1642 for pictures. The glasses have storage for up to 150 videos or 3,000 photos, which are transferred to a phone through the Snapchat app. A pair of glasses costs €150. In the announcement, Snapchat set ambitious targets: "Our Snap Lab team is responsible for ensuring that the Snap Camera remains the most used camera in the world long-term, even as camera devices evolve."

Integrated Roadways
Smart Road Products Installed in Colorado

This summer, Kansas startup Integrated Roadways installed its first "smart pavement" set to an intersection in an industrial corner of Denver. The installation consists of four slabs of concrete embedded with sensors at an intersection between a PepsiCo bottling plant and two parking lots. This pilot test is carried out in cooperation with the Colorado Department of Transportation. The technology can detect crashes when they occur, and automatically notify emergency responders. A piece of concrete manufactured as a slab has an integrated three-axis accelerometer that measures vibrations to predict vehicle paths. A fiber-optic cable detects strain in the pavement and a magnetometer gauges the width of cars' axles to help figure out what kind of car is currently passing over the slab. An additional gyroscope records the position of the slab, determining whether the road has shifted out of place. Data is sent through a Power-over-Ethernet connection to control centers along the road. If this pilot project goes well, Integrated Roadways plans to replace 500 meters of pavement along a dangerous curve just south of Denver in early 2019.

Philips
Start Your Day: Look in the Smart Mirror

Philips now comes to the only room the company has not entered so far with its product line of smart lights by the name of Hue. The new Hue Adore range was designed especially for use in bathrooms. Signify – the new brand for Philips lighting – launched the new collection in Europe and the United States this summer. The Hue Adore range consists of a mirror light, a single spotlight, a double spotlight, a triple spotlight, a ceiling triple spotlight, a ceiling panel, and a lighted vanity mirror. The whole range is splash-proof and is certified for use in bathrooms in Europe and North America. Pricing for the collection ranges from €80 to €250. The light color as well as the brightness of all products can be controlled through a dimmer switch or the Hue app.

Vorwerk
Smart Tea with Vorwerk's Temial

Until a few years ago, **Vorwerk** was best known for vacuum cleaners. Then the German company developed the smart cooking machine Thermomix, that revolutionized the kitchen. And now they are going for tea, with the **Temial** tea-maker. The product was developed by a startup group within the company. The tea-maker is the centerpiece of a system that makes the preparation of individual tea varieties possible with the help of a code scanner and an accompanying app. The Temial comes with a range of ten different loose-leaf organic varieties of teas – and an extensive portfolio of accessories. After scanning the barcode that is printed on each bag of tea, the Temial will automatically provide the perfect treatment of that special variety of tea. With the help of the app, individual treatments for different kinds of tea can be configured individually. A water filter and a boiler are integrated in the stylish machine that can be ordered directly from Vorwerk at a price of €600.

German Autolabs

German Autolabs Brings Artificial Intelligence to Every Car

Most new cars are equipped with intelligent systems that allow drivers to control their smartphones or make phone calls while driving. But drivers of older models often hold the phones in their hands or tap at them while behind the steering wheel – behavior that often leads to terrible accidents. The technology startup German Autolabs has developed a solution: They call Chris the world's first digital co-driver with artificial intelligence. The elegantly designed device will integrate with any car. It offers entertainment, connectivity, and navigation capabilities that are more convenient and proactive than other market offerings. Holger Weiss, CEO of German Autolabs, said, "While automotive manufacturers like Tesla, Lexus, Audi, and BMW pursue building connected vehicles over the next several years, consumer demand for AI-enabled technology is rapidly on the rise today. Drivers and passengers can have this AI-powered technology at their disposal now, and with a low barrier to entry both in installation and cost. Chris works in every car, regardless of the age or model." Drivers can attach Chris to their windshields or dashboards and connect it with their smartphones via Bluetooth – iOS and Android versions are available. The device enables drivers to send and reply to messages or emails, listen to streamed music, get traffic updates and navigation instructions, and make and receive phone calls using speech and gesture recognition technology on a full-color screen display. As Chris is specifically designed for cars, it offers a human-centric user experience that proactively communicates with the driver. Powered by AI and NLP (natural language processing) technologies, it makes drivers feel like they have a human navigator at their sides. Chris will be available for a price of €200.

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eBlocker

eBlocker Now Comes with Mobile Function

eBlocker is a smart piece of hardware that makes privacy on the Internet very easy: when the device is attached to an Internet router and a short setup routine has been completed, users in this network can no longer be tracked on the Internet. With the latest firmware update, the eBlocker can also provide privacy when you are not at home. Mobile devices can access the device from any place via a VPN connection. Now trackers and phishing pages will be blocked automatically, even when surfing through a mobile connection or at a hotspot. Current owners of the eBlocker will get the function through a firmware update. The device is available at eBlocker's online shop at www.eblocker.com, starting at €99.

Samsung

A Connected Closet from Samsung

The "connected refrigerator" is one of the most utilized examples of IoT technology. Samsung just topped that with the presentation of an Internet-connected personal garment care appliance. The "Air Dresser" takes care of clothing in four ways: airing, steaming, drying, and purifying. The product, which is available in Korea starting late summer 2018, will be shipped in four different colors – gold, brown, rose, and lifestyle – at a price equivalent to €1,500. The CEO of Samsung Electronics Consumer Electronics Division said: "Samsung Electronics has been leading the market with product innovation, IoT leadership, and lifestyle of the millennial generation. We will open the era of clean clothing and change the lifestyle of consumers." The appliance uses technology from different sources within Samsung: steam technology from washing machines, treatment from refrigerators, and filtration from air purifiers. Air Dresser is able to connect with Samsung's SmartThings. It will recommend different cleaning programs and vary the air flow force depending on the detected garment material. The SmartThings app will also send notifications when garments are ready and alert owners when the air filter needs replacement. Samsung claims that the Air Dresser can remove 99 percent of dust on clothes within 25 minutes and that it can almost eliminate germs people encounter in everyday lives.

RoWrite

Paint on Paper – Edit on Tablet

Many people prefer the surface of paper to that of smart devices for sketching or handwriting. But transferring scribbles from paper to the digital realm can be a hassle. RoWrite brings the traditional notepad into the digital age. When you write or sketch on paper attached to the device, every pen stroke is captured digitally by RoWrite. When the system is not paired with a smart device, the work is saved internally and can be edited or shared later. Paired devices will display anything that is sketched on the RoWrite in real time. The hardware includes a notepad with an integrated flexible sensor that tracks motion of the RoWrite pen on the surface of paper. This pen is a hybrid ink/digital writing device with 2,048 pressure points of sensitivity. Transferred to a smartphone, the captured sketches or writings can be edited in a versatile app, available for iOS and Android. You may even record the whole process of sketching as a movie. Not everyone may need this gadget – but at €130, it is an affordable investment.


Nissan

Nissan Cars, Check Your Backseat

Nissan was the first car manufacturer that integrated sensors to prevent people from leaving stuff in the backseat of their cars. Now they are taking the system, called RDA (which stands for "Rear Door Alert"), to a wider range of vehicles. "I'm proud to see Nissan lead the way by making Rear Door Alert standard on more models," said Marlene Mendoza, a mechanical engineer who helped create the technology. "What started as a chat with my colleague, Elsa Foley, is now innovative technology being adopted in more Nissan models. It is a testament to Nissan's culture." RDA monitors when the rear door is opened and closed before and after the vehicle is in motion. A series of notifications is given if a rear door was used before a trip but was not reopened after parking the car. The system will first display a notification in the instrument panel and progresses to subtle, distinctive chirps of the horn. From 2019 on, the system will be integrated as standard equipment to eight additional Nissan nameplates in the USA. By model year 2022, Nissan plans to have RDA standard on all four-door trucks, sedans, and SUVs.

Tufts University

Bandages That Monitor and Tailor Wound Treatment

Band-Aids and bandages have hardly evolved within the last decades. But now a team of engineers at Tufts University in Massachusetts has developed a smart bandage designed to actively monitor the condition of chronic wounds and deliver appropriate drug treatments – thereby improving the chances of healing. Chronic skin wounds that may result from burns or diabetes can overwhelm the regenerative capabilities of the skin. They often lead to persistent infections and, in serious cases, also to amputations. The new bandages contain heating elements and thermoresponsive drug carriers that can deliver tailored treatments in response to measurement data from integrated pH and temperature sensors tracking infection and inflammation. A microprocessor reads the data from the sensors and can release drugs on demand from its carriers by heating a gel. The entire construct is attached to a transparent medical tape to form a flexible bandage less than 3 mm thick. Smart bandages could provide real-time monitoring and delivery of treatment with limited intervention from patients or caregivers. "The smart bandage we created, with pH and temperature sensors and antibiotic drug delivery, is really a prototype for a wide range of possibilities," said Sameer Sonkusale, PhD, professor of electrical and computer engineering at Tufts University's School of Engineering. "One can imagine embedding other sensing components, drugs, and growth factors that treat different conditions in response to different healing markers." The smart bandages have so far been tested successfully in the laboratory. Next are preclinical studies, so hopefully smart bandages will be available to patients within the next years.
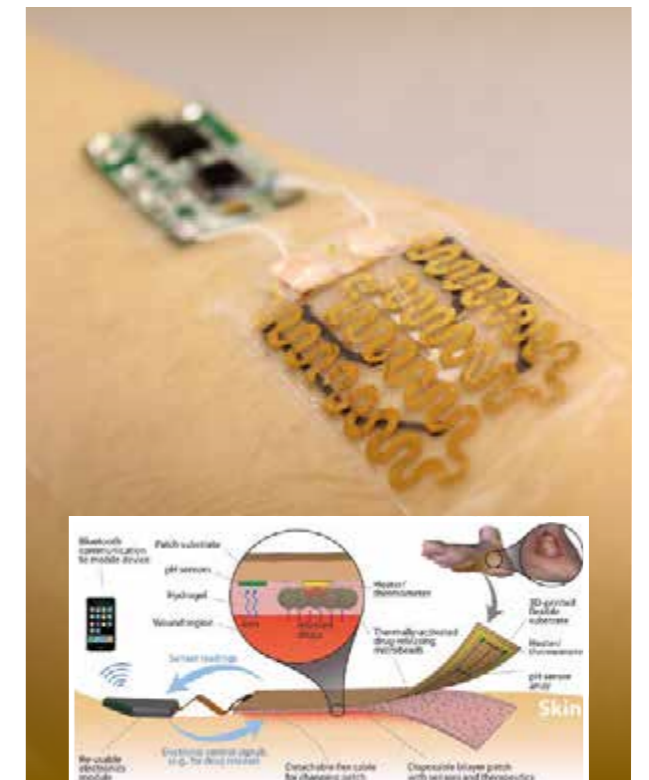
THE ETHICS OF TECHNOLOGY

The next 20 years will bring more change than the previous 300 years – and that's a conservative estimate.

If you don't believe me, please keep in mind that we are now crossing a crucial threshold; one that was previously unthinkable. Technology is no longer simply a tool, it is well on its way to becoming a creative force – and a thinking machine, as well.

If intelligent machines are to perform our routine work for us, we will need to train them, teach them, connect them to us – in effect making digital copies of ourselves, cloning our knowledge (and possibly some of our unique human intelligences) in the cloud. This will change us – and it will change our view of who and what we are, what we could be, and what machines are. And this is only the beginning.

Imagine this, if you can:

- Nanobots in your bloodstream monitoring and even regulating cholesterol levels
- Augmented, virtual, or mixed reality devices that look like regular eyeglasses or even contact lenses, giving you ready access to the world's knowledge in the blink of an eye
- The ability to connect your neocortex directly to the Internet and transform thoughts into action or record what you think
- Developing meaningful relationships with your digital assistants because they seem so real, so very human.

None of this is as far away as you may think, and the societal, cultural, human, and ethical implications will be mind-boggling. Clearly, we must prepare for this challenge today or we will find ourselves unequipped to deal with it later.

Defining digital ethics

Before we venture further into why ethics in technology will be crucial to our future, let's first try to define "ethics." Riffing off the late US Supreme Court judge Potter Stewart, I propose the following working definition: "Ethics is knowing the difference between what you have a right or the power to do and what is the right thing to do."

Today, we are standing at the takeoff point of exponential progress. Henceforth, change will no longer be slow and gradual but sudden and steep, and this goes for almost all areas in which scientific and technological progress is made – in AI and quantum physics, in nano- and biotechnology, cloud computing, solar energy, 3D printing, autonomous vehicles, and, most certainly, in IoT.

Technology, of course, is morally neutral – but only until we apply it. Let's imagine the world a mere ten years from now – some 50 to 100 times more advanced – a world where most science fiction has become science fact. It is likely to be a world where literally everyone and everything around us is connected, observed, recorded, measured, and tracked, where at least a trillion devices are connected to the Internet of Things and where 80 percent of the (by then) 10 billion earthlings are connected at high speeds, on cheap devices, wearables, and via digital assistants and robots with which we can communicate as if speaking to a good friend. Add genetic engineering and the rapid convergence of technology and biology to this equation, and literally anything is possible. Exponential thinking, therefore, becomes mission-critical, both to realize opportunities and to foresee and address the consequential ethical challenges and moral quandaries. We need to find ethical frameworks that can keep up with this headlong pace. Without these, unrestricted, socially destructive growth will become increasingly toxic – a disaster just waiting to happen.

Getting an ethical upgrade

The bottom line is that we are now moving to a whole new era in technology. At some point in the next five to ten years, it will no longer be about technical feasibility, cost, or time. Rather, it will be about why we are doing something at all – it will be about context, purpose, values, and goals. We will need to ask who is in control, who is overseeing and securing it. The real question is, of course: who is in charge of shaping our digital ethics? In my opinion, security in technology will only be as good as the moral, ethical, and political frameworks we create for them. The most advanced security technology will be useless if those who hold the keys act unethically, with evil intent, or with great negligence. In fact, the very same technology that is employed to protect consumers and users can be used to spy them out and manipulate them. IoT could turn out to be the biggest and most powerful panopticon ever built. Do we want this? Of course not! But to stop it from happening we will need to do more than improve our technological firepower; we must also redesign and embolden our ethical frameworks. We need to reach a global agreement on what is good for humanity in general – and what isn't. And we will need to find ways of enforcing these tenets. In many ways, this task might even be more daunting than creating the technology itself. Just remember: technology doesn't have ethics, but societies depend on them. Civilizations are driven by their technologies and defined by their humanity. Technology is not what we seek but how we seek it.

> Ethics is knowing the difference between what you have a right or the power to do and what is the right thing to do.

Gerd Leonhard is the founder of The Futures Agency based in Zurich. This article was adapted from Gerd Leonhard's chapter *The Ethics of Technology and the Future of Humanity*, which appears in *Navigating the Digital Age* (www.navigatingthedigitalage.com)

MEMS Sensors for Industry 4.0
Ultra-low power and high performance solutions

- Dedicated products family for Industry 4.0 with 10 year committed availability
- Accelerometer, gyroscope and 6-axis Inertial Measurement Unit offer with high accuracy, flexibility, and ultra-low power in tiny packages
- Wide range of sensors drivers and free software libraries from ST's Open.MEMS SW environment and STM32 Open Development Environment

Part number	Description	Idd (mA)	Package
IIS2DLPC	Ultra-low-power 3-axis accelerometer	<0.001 (Active low power mode) 0.12 (HP mode)	LGA-12 – 2 x 2 x 0.7 mm
I3G4250D	3-axis gyroscope with digital output	6.1	LGA-16L – 4 x 4 x 1.1 mm
IIS328DQ	3-axis accelerometer with digital output for industrial applications	0.250	QFN-24L – 4 x 4 x 1.8 mm
ISM330DLC	iNEMO inertial module: 3-axis accelerometer and 3-axis gyroscope	0.75 (HP combo)	LGA-14L – 2.5 x 3 x 0.83 mm
IIS3DHHC	High-performance 3-axis inclinometer with digital output	2.5	LGA-16L Ceramic – 5 x 5 x 1.7 mm
IIS2MDC	High accuracy , ultra-low-power 3-axis digital output magnetometer	0.2 (HP mode) 0.05 (LP mode)	LGA-12 – 2 x 2 x 0.7 mm
ISM303DAC	High performance, low power, compact eCompass: 3-axis magnetometer + accelerometer	0.032 (LP combo mode) 1.45 (HP combo mode)	LGA-12L – 2 x 2 x 1 mm

Evaluation tool	Description
X-NUCLEO-IKS01A2	Motion MEMS and environmental sensor expansion board for STM32 Nucleo
STEVAL-IDP005V1	Predictive maintenance kit with sensors and IO-Link capability
STEVAL-MKIT02V1	Sample kit for industrial MEMS

For more information, visit us at : **http://www.st.com/MEMS**