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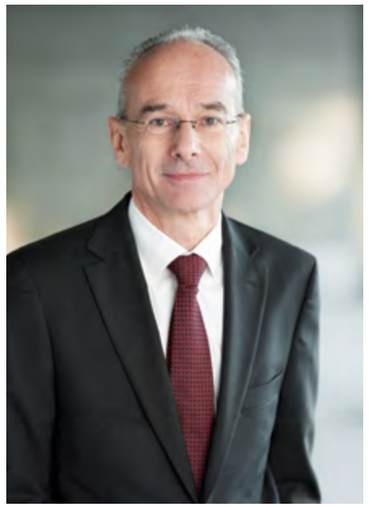

Dear Readers,

Do you talk to your home? And more importantly, does it listen? Just a decade ago, these questions would have seemed absurd. Today, they reflect reality in millions of households around the world, as the Internet of Things expands into – and enables – a new generation of smart, connected buildings.

In this seventh edition of our u-blox magazine, we examine how connectivity is transforming our homes, our workplaces, and the other buildings we inhabit, as well as the business opportunities that these new technologies create.

But there's more to this transformation than increasing our comfort, convenience, safety, and productivity. According to The Global Alliance for Buildings and Construction, in partnership with UN Environment, buildings are responsible for 40 percent of our CO_2 emissions and 36 percent of our total energy consumption. That's why they need to be front and center in our efforts to reduce our environmental impact while improving the quality of life of the growing, aging, and urbanizing world population.

It's a sector that plays to our strengths at u-blox, as providers of wireless communication and positioning technologies – key enablers of connected building solutions. That's why we'd like to invite you to join us in exploring this rapidly evolving world – the great digital indoors.

We wish you an informative and enjoyable read.

Yours sincerely,

Thomas Seiler, CEO

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The Internet of Buildings

Tomorrow's smart, connected buildings could help solve many of the major challenges looming on the horizon. Not only that, they'll even dim your lights!

Buildings are home to a huge part of our lives. We spend, on average, upwards of 90 percent of our time inside them. They are where we eat, work, shop, entertain ourselves, and sleep. Many of us work out indoors. Some of us even ski indoors. Practically all of the consumer goods we purchase were made in buildings. And with the advent of vertical farming, even food production is starting to move into built structures.

As trendy as outdoor activities are these days, we are actually the indoor generation.[1] As result, our expectations for our buildings have never been as high. We've always wanted the buildings we frequent to be safe, comfortable, and convenient – places in which we can feel at home, be productive, and thrive.

But increasingly, we also want our buildings to respond to, or even anticipate, our needs, and those of our workforce, our customers. This dream, until recently only within reach of a fortunate few, is becoming more and more accessible. Home owners, retailers, and businesses large and small all stand to gain from boosting their buildings' smarts with Internet of Things (IoT) technology.

[1] The Indoor Generation, YouGov, Velux, 2018

282m

smart homes by 2022.

Source: ABI Research

Driving adoption from the ground up

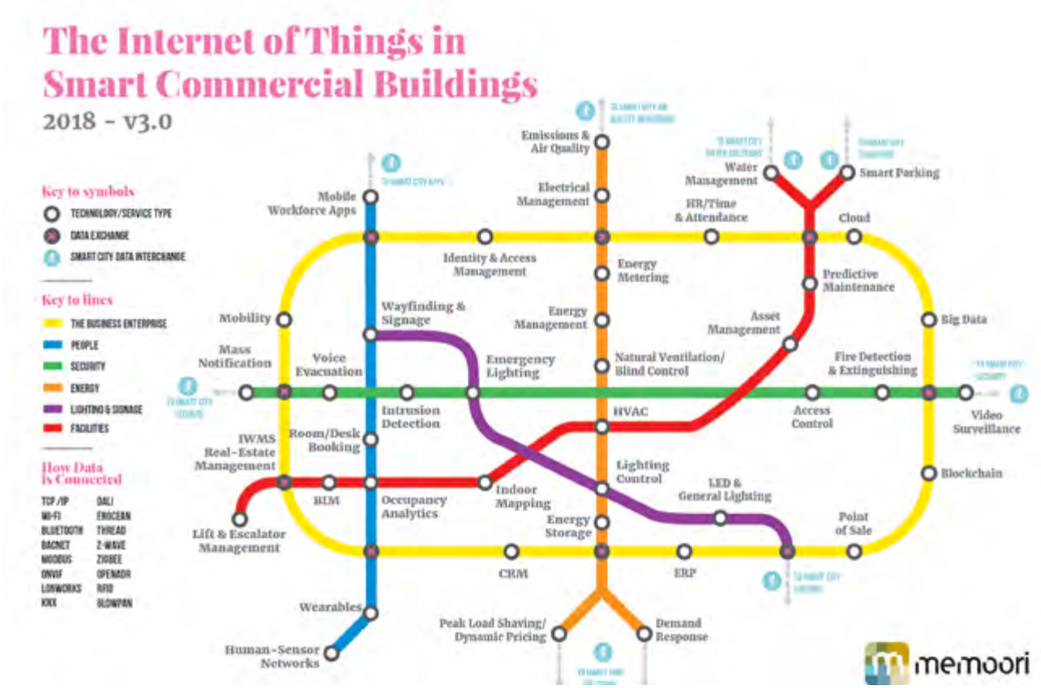
The past few years have seen the smart home take off and enter the mainstream, with North America leading the pack ahead of the Western Europe and Asia-Pacific markets. Globally, ABI Research estimates the number of smart homes to reach over 280 million by 2022, more than five times the number in 2017. During these five years, consumers will purchase more than 2.2 billion wirelessly connected smart home devices.[2]

This rapid growth will coincide with a transition from fun to more functional use cases. An Ernst & Young survey revealed that, so far, consumers in the UK have focused on lifestyle products including smart speakers and digital home assistants. By 2022, however, over 30 percent of respondents expect to own much more pragmatic devices, enabling smart heating, smart lighting, and home security.[3] The fun is far from over, but consumers seem to be getting more serious.

One reason why is because smart buildings save money. Businesses have also recognized this and are tapping into the savings potential offered by connected offices. As per Memoori's report on IoT in smart commercial buildings, those prepared to invest in upgrading and integrating building management systems can reap savings of between 30 and 50 percent.[4] Applied to offices, data sensing and analytics can be used to detect inefficiencies and propose solutions. Today's frequently traveling workforce, to take an example, leaves a significant portion of office space unused – space that could be reallocated or rented out. According to a study by McKinsey,[5] offices stand to gain between US$ 100 and 200 billion per year until 2025 by investing in IoT technology.

"The distributed sensing, wireless communication, and smart analytics that make up the "Building IoT" enable predictive maintenance, better management of resources, and also offer improved building security, access management, and physical safety."

[2] The emerging role for smart homes in the smart city, ABI Research, 2018
[3] Taking stock of the smart home market, EY, 2018
[4] The Internet of Things in Smart Commercial Buildings 2018-2022, Memoori, 2018
[5] Unlocking the potential of the Internet of Things, McKinsey, 2015



Smart buildings can make money, too. In retail, McKinsey estimates that tracking customers within stores could deliver US$ 170 to 500 billion per year through a combination of store layout optimization and real-time in-store promotions. This so-called proximity marketing, which tracks customers' smartphones using a network of Bluetooth beacons, might sound somewhat creepy, but the fact that customers can easily delete the app it requires means that companies will have to wield their power carefully.[6] Other IoT enabled measures such as improved energy management, condition-based maintenance, and smaller, better optimized inventories would further benefit retailers' bottom lines.[7]

And connected buildings are simply worth more – a fact that real-estate owners are unlikely to overlook. The distributed sensing, wireless communication, and smart analytics that make up the "Building IoT" enable a variety of value-added services such as predictive maintenance and more efficient management of resources such as power, water, and heat. In addition, they offer improved building security, access management, and physical safety. As the commercial real estate service firm Jones Lang LaSalle put it in a report on smart buildings, the capital investment, i.e., the upfront costs that smart buildings require, ultimately reduce their operational expenses, making them a better investment in the long run.[8]

Driven primarily from the ground up, the smart building market has successfully taken hold. When the perceived benefits, financial or otherwise, outweigh the perceived risk (and hassle) and costs involved in implementing smart building solutions, a tech-savvy group of early-adopters – home owners and businesses

[6] https://www.beaconstac.com/proximity-marketing
[7] ibid
[8] The changing face of smart buildings: The Op-Ex advantage, Jones Lang LaSalle, 2013

– have shown their willingness to do so. Today's incentives have been enough to get the ball rolling, but several barriers to adoption – lack of awareness and expertise, cybersecurity and privacy concerns, fear of dependence on technology, reluctance to change – mean that bottom-up driven adoption can only go so far.

Growing adoption from the top down

Taken together, the world's built up areas make up about 0.65 percent of the planet's terrestrial surface, excluding Antarctica and Greenland.[9] Yet despite their small footprint, buildings are responsible for 40 percent of our CO_2 emissions and 36 percent of total energy consumption.[10] Most incur during construction. Heating and cooling make up another significant piece of the pie. And buildings are notoriously difficult to dismantle and recycle.

Demographic trends are further compounding the challenge. By 2050, the UN estimates the world's urban population to climb to 68 percent, from 55 percent today, as the population grows by another 2.5 billion people.[11] This will require countless new cities to house hundreds of millions of yet unborn urban dwellers. And across most of the world, life expectancy is on the rise. The aging population is already challenging countries like Japan, which expects 40 percent of its population to be 65 or older by 2050.

Then, tectonic shifts in power production and consumption, from decentralized renewable energy production on rooftops to overnight electric vehicle charging, are pushing the power distribution infrastructure to its limits.

Combined, these trends have placed buildings squarely at the crossroads of many of the challenges we face as a society. Municipal, regional, and national governments have already responded with the development of smart city projects around the world, which, as McKinsey puts it, use digital intelligence to solve public problems and increase the quality of life of their citizens.[12]

[9] How much of the world's land has been urbanized, really? A hierarchical framework for avoiding confusion, Zhifeng Liu et al., Landscape Ecology, 2014
[10] 2018 Global Status Report, Global Alliance for Buildings and Construction, UN Environment, 2018
[11] https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html
[12] Smart Cities Full Report, McKinsey, 2018

Early smart city projects have tended to focus on targeted solutions, such as expanding public Wi-Fi or enabling smart lighting, parking, and waste management. As time goes on, they will become increasingly ambitious, scooping up more and more applications that will have impacts well beyond their urban perimeter. At the same time, the role of buildings, arguably their atomic unit, will become more important, as smart building and smart city projects become more closely aligned.

"Smart city projects around the world use digital intelligence to solve public problems and increase the quality of life of their citizens."

This is increasingly the case in energy management. For home owners, smart home technology has primarily been about increasing comfort and convenience, but reducing electricity bills and environmental impact has also been a part of their calculus. The result has been an uptick in rooftop solar power production over the past decades, and the more recent popularization of electric and hybrid vehicles.

Utilities have a strong incentive to get involved in smart city projects through smart metering initiatives and smart thermostats that allow them to better monitor and control domestic power consumption. Smart meters and smart thermostats are key to enabling the smart grid, which will become vital to accommodate a growing proportion of variable (because weather-dependent) decentralized power on the power grid.

An approach utilities are trialing is managing electricity demand, be it indirectly through dynamic pricing schemes, or directly, using electrical load control – briefly switching off smart appliances such as air-conditioning devices, heat pumps, or electric vehicle charging stations. Because these measures will become vital to ensure the resilience of the power grids they rely on, some utilities companies have begun offering premiums to customers that purchase smart meters, smart thermostats, or opt into flexible pricing schemes, and are forming partnerships with smart home device vendors to enroll smart domestic appliances into their demand response programs.[13]

Home healthcare and assisted living is another area in which we're likely to see similar dynamics. So far, solutions have been proving their validity on a subset of the population with a strong personal incentive to make them part of their lives. But healthcare providers and government authorities are already recognizing the improvements they can bring in terms of saving their own costs, offering more affordable healthcare to their citizens, and optimizing the allocation of limited resources. As a consequence, initial adoption from the ground up will be bolstered by a push to increase adoption from the top down.

Ultimately, it's likely that climate change, along with its disastrous consequences, and environmental legislation enacted in response will become a key driver for the widespread adoption of smart building technology. Because buildings make up such a large share of global power consumption and greenhouse gas emissions, governments and supranational bodies will seek to lay out directives geared at curbing energy waste in the building sector.

The EU's nearly Zero-Energy Buildings (NZEBs) Directive is a case in point. The directive requires all new buildings in the EU to source most of the energy they require from renewable sources by 2020, significantly lowering CO_2 emissions and saving up to 80% operational cost.[14] Similar initiatives have been put in place around the world, as have private renovations. The successful retrofit of the Empire State building in New York, which saved more than 38 percent of

[13] The emerging role for smart homes in the smart city, ABI Research, 2018
[14] Principles for nearly zero-energy buildings, Buildings Performance Institute Europe (BPIE), 2011

the building's energy consumption, earning it a LEED Gold certification, showed just what can be achieved.[15]

Building IoT is shaking up the industry
For a long time, building management systems were only economically viable in large buildings due to installation and maintenance costs and the high level of expertise required to plan and maintain them. As we report in the remainder of this magazine, today's building automation systems increasingly build on wireless IoT based technology that is easy to deploy, operate, and modify. New low power wide area cellular networks (LPWAN) are laying the foundation for a new generation of use cases, as are innovations in short range communication technology, such as Bluetooth 5.0 and Bluetooth mesh.

"The successful retrofit of the Empire State building in New York, which saved more than 38% of the building's energy consumption and earned it a LEED Gold certification showed just what can be achieved."

Today's connected buildings combine a variety of solutions, from power management to Heating, Ventilation, and Air Conditioning (HVAC), lighting, air quality monitoring, security, access control, smart parking, and more, into a single platform. In addition to data sensing, wireless communications, and data analytics that are behind most IoT applications, a new wave of emerging technologies is being applied to smart, connected buildings to make them even smarter, such as artificial intelligence (AI), edge intelligence, accurate indoor positioning, biometric sensing, and digital twins. And while they still can't read your mind, AI is getting better at picking up on your behavioral patterns. If it doesn't, you can always talk to it, as voice control is emerging as a popular solution to pull it all together as a controlling hub.

So what does the future hold?
It seems that there's little doubt that connectivity, and with it, smart building technology, will become increasingly all-pervasive, in the same way that Wi-Fi has become a fixture in most homes today. Of course, this will require managing the risks that come with the technology, in particular cybersecurity and data privacy. The first wave of technological adoption has been from the ground up, in homes, businesses, and commercial buildings. Now, the combined challenges of increasing urbanization, transitions to new forms of mobility and power production, and efforts to mitigate and adapt to climate change are likely to drive innovation into new, more sustainable and resource efficient ways of living. ■

[15] https://www.memoori.com/empire-smart-building-making-case-retrofitting-historic-buildings/

Why smart cities need smart buildings

As the two ecosystems evolve, they will have ample opportunity to feed off each other.

The smart home is growing from the bottom up, with consumers upgrading their homes using an ecosystem of increasingly affordable technologies. Smart buildings, such as shopping malls and offices, are following a similar path, motivated by business incentives. Smart cities, by contrast, tend to be managed from the top down by municipal or national authorities in partnership with public and private utilities. Their drivers: making cities more efficient, sustainable, and better places to live.

But so far, as ABI reports[1], top-down coordinated smart city projects have only been partly successful in their mission. Yes, they've been quite good at deploying smart street lights and opening doors to things like car and bike sharing schemes. But when it comes to broader integrated projects, such as transforming a city's healthcare offering or upgrading its power distribution infrastructure, complexity and cost quickly become barriers. Connecting smart home and smart cities projects, could therefore be beneficial to both.

Environmental legislation – the EU's Energy Performance of Buildings Directive (EPBD) and the US Commercial Building Initiative (CBI) are examples – is forcing public authorities and businesses to step up their efforts to limit greenhouse gas emissions and energy consumption at the community level. Commercial buildings, which in the US consume 36 percent of the electricity, are an important part of this equation.[2]

From energy and health to security and transportation, a push from the companies and public authorities with a stake in increasing data exchange to monitor and control the built infrastructure at the urban level will boost smart building adoption while furthering the goals of smart cities.

Power from the people

While good for the planet, there's more to increasing the share of solar energy fed into the grid than setting up vast expanses of solar panels. If our grids are not modernized, it could lead to an uptick in power outages as utilities struggle to balance power production and consumption.

When every passing cloud or gust of wind causes power production to fluctuate, matching power supply and demand across the grid becomes much more challenging.

The decentralization of production is a major paradigm shift in power management. Today's power grids are built around a relatively simple network architecture designed to distribute power from power plants to cities, then neighborhoods, then individual buildings through a branching network of powerlines. To keep the grid up and running, utilities ramp up and down production to match consumption as demand varies throughout the day.

Now imagine how feeding energy into the grid from individual buildings increases the complexity of the system. It's one thing to predict the power output of conventional thermal or hydroelectric power plants. But when every passing cloud or gust of wind causes power production to fluctuate, matching power supply and demand across the grid becomes much more challenging. Existing infrastructure can handle low shares of variable renewable energy sources. But when variable renewable input grows, utilities need to expand the bag of tricks they have at their disposal to stabilize the grid.

Part of the problem … and of the solution

So what does this have to do with smart buildings? As more and more of them are going solar, power utilities are being forced to devise new schemes to manage the highly variable renewable energy produced. And while they are at the root of the challenge, smart homes – and smart buildings in general – will also be key in providing a solution, combining energy storage, electric vehicle charging, smart appliances, and demand response management using smart thermostats.

Initially these solutions might mean savings for consumers and facility managers. But eventually they'll become vital to power companies. That is why utilities could become the driving force behind the proliferation of smart building technology, by offering reduced rates for customers that let utilities take over some control of their connected appliances, decide when their electric vehicles should be charged, and manage excess solar energy stored in domestic battery units.

Who's afraid of the nursing home?

The overlap between the goals of smart cities and smart buildings isn't limited to the power grid. Smart health brings it into the home. The

[1] The emerging role for smart homes in the smart city, ABI Research, 2018

[2] The Internet of Things in Smart Commercial Buildings 2018 to 2022, Memoori, 2018

topic is high on the agenda of many smart cities, in particular as a ballooning population of baby-boomers needing care is on track to collide with the current shortage of vacancies in residential care homes and dedicated medical facilities.

There are plenty of reasons for cities to promote e-health and domestic assisted living solutions. Typically, cities pick up a significant part of the – rapidly growing – tab for senior care projects: ong-term care costs are projected to increase by 80 percent between 2015 and 2060 in the EU.[3] Offering better alternatives to residential care homes, dreaded by many, is low hanging fruit for smart cities, which also aim to improve the life quality of their residents. For many applications, connected homes are the ideal touchpoint.

This begins with promoting easy-to-access e-health services that don't scare away the less tech-savvy populace. Giving caregivers access to the status of connected appliances, such as lights, washing machines, and the fridge can be one way to monitor the mobility of the elderly, in addition to fall-monitoring wearables. Smart locks that let caregivers enter the home make it easier for those with restricted mobility to receive care. Combined with new forms of telemedicine, these technologies can enable elderly individuals to stay at home longer. It's only a matter of time before city authorities find ways of proactively setting up platforms and subsidizing hardware rather than financing an expansion of the network of residential care facilities.

All for one and one for all

Banding together has a range of other advantages beyond one's own four walls that ultimately benefit smart cities. Take security, yet another smart city component that can be built from the bottom up. The smart home security company Vivint recent launched its Streety app, which extends home security to the neighborhood by providing a platform for members to share access to their residential cameras. Amazon-owned Ring provides a similar service, which extends to local police departments that can share their data through the platform as well.[4]

The same logic applies to other areas as well. For example, one way to make mobility smarter is to cut down on the time spent driving around in search of parking – roughly four days a year in the UK.[5] Apps like Pavemind offer a smart solution, letting people rent out their residential parking to others during defined timeslots.

Seeding smart cities one smart building at a time

According to a Smart Buildings Magazine article[6] cited by Forbes[7], buildings are an ideal starting point from which to grow smart cities. In the same way that a building is a microcosm of a city, smart buildings are a microcosm of smart cities, with needs that overlap broadly, from managing energy, water, and lighting, to delivering security and emergency services. "By adding and integrating certified smart buildings," the article concludes," local officials and technology leaders can quickly form smart campuses, smart communities, and scale all the way to smart cities." ■

[3] Relationship-based home care: A Sustainable Solution For Europe's Elder Care Crisis, Global Coalition on Aging, 2018

[4] https://venturebeat.com/2018/05/08/amazon-owned-ring-embraces-neighborhood-watch-with-home-security-networking-app/

[5] https://www.britishparking.co.uk/News/motorists-spend-nearly-four-days-a-year-looking-for-a-parking-space

[6] http://www.smartbuildingsmagazine.com/features/the-smart-way-to-smart-cities-begins-with-buildings

[7] https://www.forbes.com/sites/insights-inteliot/2018/10/24/smart-buildings-forming-the-foundation-of-smart-cities/

New apps let neighbors share access to their surveillance cameras to extend home security to the neighborhood.

Assisted living solutions can help address shortage of vacancies in residential care homes and dedicated medical facilities.

Home, smart home

Tech enthusiasts will hardly need convincing. Reaching the rest will take more effort.

Almost a quarter of a century after Microsoft founder Bill Gates unveiled his connected Xanadu mansion, smart homes are going mainstream. Granted, we might not be able to afford its countless wall-mounted screens, let alone its floor space. But the cost of hardware, cloud storage and computing, and connectivity have made smart home appliances, networks, and services affordable to a broad swath of the population, piggybacking on the democratization of Internet of Things technology.

Adoption rates of smart home technologies are on the rise, as consumers seek to increase their comfort, convenience, and security. The Boston Consulting Group found that customers are beginning to see smart home technology as "standard household items, rather than unnecessary luxuries."[1] ABI Research predicts 282 million smart homes globally by 2022, 230 million more than in 2017. This growth will be fueled by the shipment of 2.2 billion smart home devices, including connected sensors, actuators, and interfaces to monitor and control them.[2]

How smart is your home?
There is no simple definition of a smart home; instead, smart homes form a continuum, from single purpose to fully integrated installations. A simple setup might feature remote controlled electric blinds or a voice activated speaker. More sophisticated solutions might encompass everything from energy management, entertainment, and assisted living solutions to enhancing the physical comfort and the security of their inhabitants. What they all share is that they let their users control or automate a constantly growing list of functions using technology.

The range of smart building applications keeps expanding. Now you can pull out your phone to remotely control your lighting and blinds, your heating, ventilation and air conditioning (HVAC), your surveillance cameras and door locks. Tap on an app to switch on your backyard sprinklers, check the status of your robotic lawnmower, or set the mood by controlling your outdoor lights. Set up your home so that it looks out for you, connecting you to your healthcare provider, your loved ones, local emergency services, or your home security provider. Or use it to help you remotely manage renewable power production, storage, and resale to the grid.

And as smart home systems mature, they are actually getting smarter. Monitoring and control is increasingly being enhanced by machine learning and pattern recognition of sensor data – collected, for example, by an in-house wireless sensor network or via smart meters. They might even use robotic lawnmowers as mobile sensors that feed in data from around the garden. By tracking their users' habits and monitoring the indoor and outdoor environment, the systems are learning to anticipate their owners' needs, increasing comfort and convenience by adjusting the indoor climate and watering the tulips. By automatically running the dishwasher and charging their electric vehicles when electricity costs are low, they also help them save up for their next smart home investment.

Voice continues to drive adoption
Voice activated speakers, the quickest way to imbue your home with a dash of digital intelligence, have become an overnight success, with over 41 percent of US consumers owning one.[3] And their use extends beyond reserving a table for dinner or calling an Uber. Some smart speakers such as the Amazon Echo can be used to control a growing ecosystem of smart home devices – lights, smart plugs, TVs, thermostats, door locks, and even your oven – either out of the box or using third party integrations.[4]

This surge in popularity is good for the ecosystem. Just like the Echo, Google's Home Hub and Apple's HomeKit can take much of the credit of making smart homes "a thing" for mainstream consumers. Once consumers open their doors (and their hearts) to the services they offer, they are much more likely to invest in compatible devices to further expand the range of applications they can control by command. And as the still largely Anglocentric technology knocks down

[1] https://www.bcg.com/en-ch/publications/2018/mapping-smart-home-market.aspx.
[2] Driving growth in the European Smart Home, ABI Research, 2017

[3] https://techcrunch.com/2018/12/28/smart-speakers-hit-critical-mass-in-2018/
[4] https://www.tomsguide.com/us/pictures-story/880-best-alexa-compatible-devices.html

one language barrier after the next, their growth will accelerate as they conquer the linguistic patchwork that is the rest of the world.

Ways in for incumbents
The smart home market is currently dominated by Amazon, Google, and Apple. But established service providers – security, utilities, mobile network operators (MNOs) – and startups are vying to get a piece of the pie as well. Startups can gain access to the market by nimbly integrating their products into the existing ecosystem. And an existing relationship of trust gives established players a strong platform to build on.

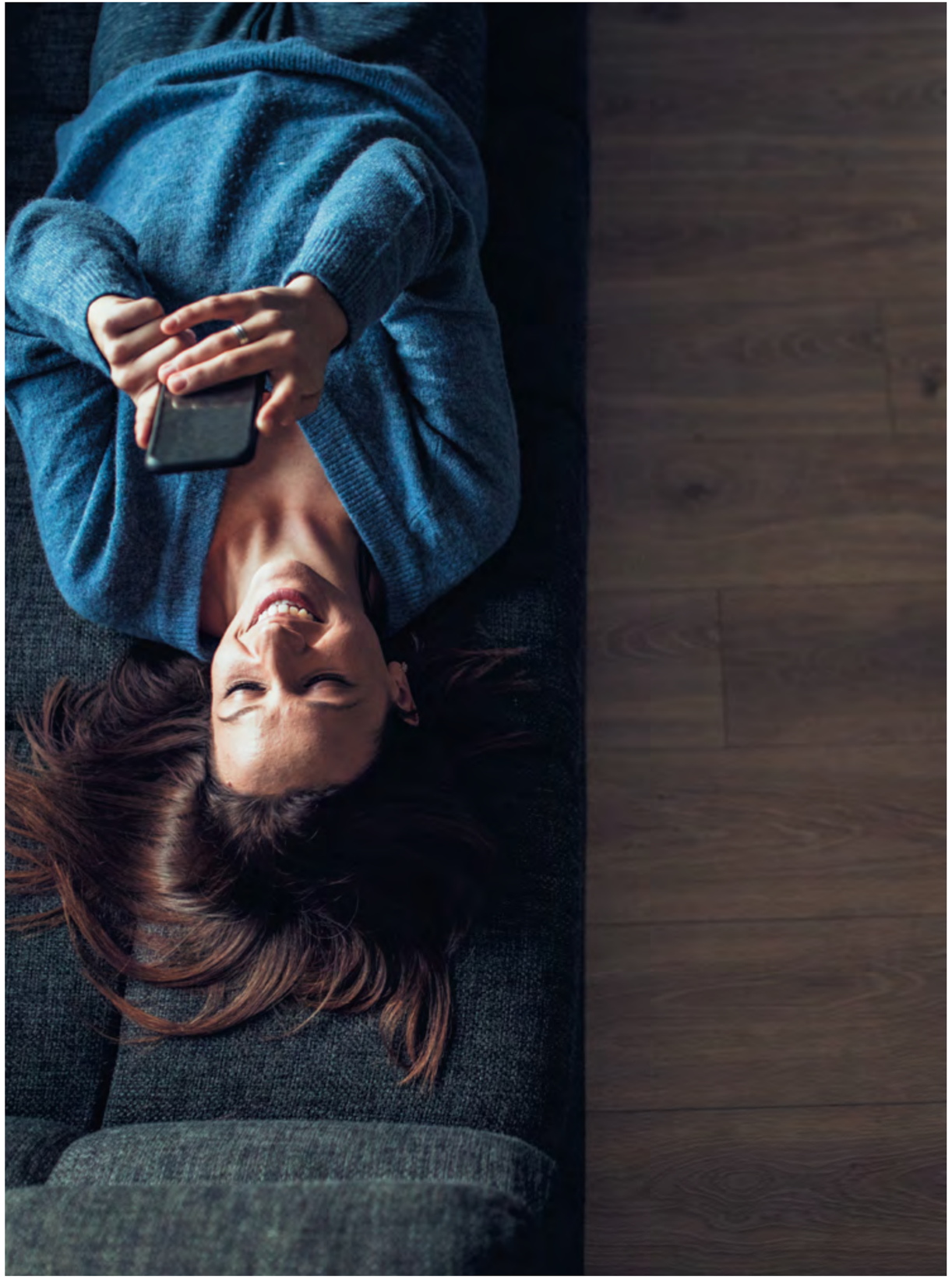
Take home security, a popular service in the US. Over the past years, it has become a strong driver of smart home market adoption.[5] The benefits of cloud-connectivity are obvious: it's comforting to be able to check in on your home or secondary residence every now and then. Because they are often already present in the home, it's much easier for security providers to market and sell smart services on top of their existing infrastructure. And by exposing home owners to benefits of the connected home, it makes skeptics more likely to adopt the smart devices in other aspects of their home.

Communications service providers (CSPs) also have an opportunity to take advantage of established trust to expand their service offering to their client base. In 2017, Accenture argued that they were in a strong, yet fragile position to become preferred providers of smart home platforms.[6] Competition is fierce, yet AT&T, Vodafone, and Swisscom are just some of a long list of CSPs that have come out with platforms to protect and manage home security, power consumption, and smart appliances remotely via an app.

Opening the door with innovation
And there's still plenty of room for innovation, and lots of market share to conquer. Consider assisted living: nursing homes are both expensive and unpopular, and many elderly individuals welcome tools that allow them to spend more time in the comfort of their own home. From smart door locks and video doorbells that increase security to smart ovens that reduce the risk of kitchen fires, all the way through to voice controlled TVs, elderly individuals and smart home technology providers are likely to benefit immensely from each other

Then there's the rising popularity of electric vehicles, roof-top solar panels, and domestic power storage. Established power utilities and up-and-coming startups will be able to compete for customers by offering services to monitor and manage their power production, sourcing, storage, and consumption. With smart thermostats, for instance, utilities can bid for some control of when customers consume power in exchange for rebates of discounts. Tesla's Powerwall battery packs deliver homes up to a week of power on a single charge and let users monitor their performance via a smartphone app.[7] Sonnen, based in Germany, lets users charge their electric vehicles using solar-panel sourced electricity stored by members of the community.[8] And the list of innovative startups in this space goes on.

Ultimately, customers will be won over by smart home technologies when the upsides – comfort, convenience, cost savings, security, and status – outweigh the downsides – cost of ownership, complexity, maintenance, and privacy. And there's some good and some bad news to the smart home technology offering that keeps on growing. First the bad news: the choice can be overwhelming. But, hey, at least you don't need to be a billionaire anymore to live in a smart home! ■



[5] https://globenewswire.com/news-release/2018/08/03/1547019/0/en/Market-Size-of-Global-Smart-Home-Industry-Predicted-to-Reach-USD-53-45-Billion-by-2022.html
[6] The Race to the Smart Home, Accenture, 2017
[7] https://www.tesla.com/powerwall
[8] https://sonnengroup.com/sonnenbatterie/

Connecting the workplace – tomorrow?

The final word on the connected workplace has yet to be spoken. So when is the right time to start digitizing the workplace?

66%

Of global organizations see energy as the main driver for smart buildings.

Source: Harvard Business Review

There's a lot of hype surrounding smart workplaces. In fact, Gartner, a research and advisory consultancy, currently has them at peak hype in their Hype Cycle model. From there, it's a long drop into the Trough of Disillusionment, during which those producing the technology and their users scramble to find applications that pay for themselves. Meanwhile, smart workplaces potentially expose themselves to security threats. Users risk sacrificing personal privacy for the greater good of room occupancy monitoring and streamlined access management. And navigating the jungle of solutions, connectivity protocols, and integrations can be daunting.

So who's right? The staunch defenders of today's typical mix of email, Skype, and brick and mortar structures devoid of deeper connectivity? Or the connectivity pioneers that have already taken the leap after assessing the risks? Let's take a look at the promise and the potential pitfalls of digitalizing the workplace before the technology reaches Gartner's Plateau of Productivity.

Energy savings are a win

Energy savings is always high on the agenda when considering whether or not to digitalize the workplace. In fact, a survey carried out by Harvard Business Review Analytic Services found that for 66 percent of global organizations energy is the main driver for smart buildings.[1]

And experience bears this out. Using sensing and analytics to optimize the indoor climate from the bottom up can reduce energy demand and cost by 20 to 40 percent.[2] Simply controlling lights automatically using a connected lighting system can shave around 40 percent off of lighting costs on top of the 27-29 percent savings that are up for grabs by transitioning to highly power-efficient LED lighting.[3]

Far and away the most effective way to cut power consumption is to reduce office surface area. Less square meterage translates to less rent, lighting, climate control, and maintenance. Occupancy monitoring using distributed sensors is one way to diagnose and free up under-utilized space. And flexible seating can dramatically reduce square meterage, and, thus, costs. Some will love the daily shake-up. Whether you can win over those in your workforce that thrive on routine, e.g. using tools that take their demands into account, is another question.

And, experience shows that smart building investments pay back too - eventually. Of those asked in the Harvard survey, roughly a third reported that they achieved their ROI in the second year after completing their digital makeover. Another third said it took longer than two years. But, as the study concludes, rewards are not guaranteed. Both a willingness to change the company culture and the courage to invest without a neatly defined justification are prerequisites to getting into the game.

Improved convenience? Check!

By monitoring the status of shared infrastructure and sending alerts to those in charge of maintenance, repairs can be carried out promptly, making the office a more pleasant place to work.

Access management solutions increase the capacity of the elevators and guide employees and guests along the quickest way from A to B, while ensuring that only those authorized get access to restricted areas and resources. Indoor tracking using Bluetooth beacons, for example, can help manage and track the status of shared resources, from remote controls to lab equipment.

Distributed sensors can be used to control the blinds, windows, lighting, and heating of rooms and open spaces in response to the environmental surroundings, the weather, or the number of occupants in the room at any given time. Where's the nearest free meeting room? How long is the lunch line in the canteen? And how busy is the gym? Practical questions like these find a solution in the connected workplace.

Higher levels of engagement? Maybe...

Studies have repeatedly found today's overall workforce engagement to be at low levels worldwide, leading to high employee turnover and sub-optimal value creation.[4] There might be a

[1] Pulse Survey, Data-driven workspaces, Harvard Business Review Analytics Service, 2018
[2] https://facilityexecutive.com/2018/04/hvac-efficiency-optimizing-hvac-systems/
[3] The Internet of Things in smart commercial buildings 2018-2022, Memoori, Q2 2018
[4] Connected, committed, and collaborative: How an engaged workforce drives success, IBM, 2017

digital fix for that, combining social media-like interfaces with artificial intelligence to provide workers with the content that is relevant to them.[5] The digital workplace could be pivotal in breaking out of siloed and hierarchical forms of collaboration, facilitating the exchange of knowledge throughout a company, both horizontally and vertically.

There is evidence that investments in digitalization pay off in terms of productivity. According to Memoori[6], a study by Deloitte found that 52 percent of companies examined that had invested in the technology outgrew the market, compared to only 20 percent of those didn't go digital. And Aruba, a provider of IoT solutions for the digital workplace, found that 75 percent of companies that embraced IoT increased their profitability.

So where's the catch?

Securing a connected enterprise is a can of worms that many companies are unprepared to deal with. Especially in today's Bring-Your-Device-To-Work culture, it requires considerable upstream efforts in risk management.

The point of entry into the network is one place that warrants attention, says a report authored by Aruba on IoT and the Smart Digital Workplace.[7] Additionally, devices need to be actively monitored once connected to the network, using what they call a "security-centric network built with a mobile-first approach," such as their 360 Secure Fabric network. It involves some extra effort, but let's keep in mind that relying on outdated and poorly maintained technologies to connect a company can also open the door to hackers.

The other pitfall, if that's what we can call it, is that it involves change. First, there's the infrastructure, then there are the processes, but at a deeper level, there's the culture. McKinsey reported that cultural and behavioral challenges are the most significant barriers keeping companies from meeting their digital priorities.[8] The main causes behind this are risk aversion, siloed mindsets, and an overall non-digital culture.

Invest now to win

All things considered, taking bold action and embracing a digital culture now gives companies a head start in a transformation that is already well underway. The gains in competence that early adopters take away from the experience will benefit them as they hone their digital skills, as will the employees attracted and retained, the operational costs saved, and the operational risks mitigated. So if you're on the way home from the office, sure, start thinking about the digital transformation of your business tomorrow. Otherwise, the best time to start is probably today. ■

[5] https://www2.deloitte.com/insights/us/en/focus/human-capital-trends/2018/network-of-teams-connected-workplace.html
[6] The Internet of Things in Smart Commercial Buildings 2018 to 2022, Memoori, 2018

[7] Solution Overview, The Smart Digital Workplace, Aruba, 2018

[8] https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/culture-for-a-digital-age

The BIoT: from pipes to protocols

Thanks to its smaller footprint, lower costs, and simpler maintenance, the Building IoT is opening markets that previously couldn't afford full-fledged building management systems.

The first building automation systems were pneumatic. From a control center at their heart, buildings ran a complex web of copper conduits that could be used to switch the state of pneumatic actuators and valves controlling each room's heating and cooling based on input from pneumatic sensors.[1]

Eventually, pneumatic systems were outperformed by electronic switches, which, later still, were replaced by digital controllers. Throughout the process, the range of systems that could be centrally controlled expanded beyond heating, ventilation, and air conditioning (HVAC) systems. Today, leveraging the endless possibilities brought forth by the Building Internet of Things (BIoT), these include anything from thermostats, lighting, and security infrastructure to windows, blinds, door locks, and indoor and outdoor signage.

But while building automation systems of yore were economically viable in limited settings – in large-scale deployments, such as commercial high-rise buildings with dedicated building management facilities – the emerging Building Internet of Things now promises solutions that are affordable even to medium and small companies. It leverages the very same cheap connectivity, sensing, cloud-based processing power, and seemingly infinite data storage that has propelled the Internet of Things to one of the fastest growing sectors of our day.

The challenge of integration

While modern buildings are built to last half a century or more, the technologies they incorporate are often obsolete within a decade, two at best. Because you can't simply tear down and build a new building every time a new technology comes around, real estate managers typically fitted their buildings with new technologies when the need arose.

To the first installation, perhaps a digitally controlled HVAC system, they might have added a network of security cameras, then centrally controlled lightings and blinds, electric locks, and, why not some digital signage to manage emergency situations. Each successive installation would typically have been sourced separately, as few companies were competent multiple areas of expertise.

The result was a complex patchwork of incompatible systems built on a variety of networks and technologies. While each system accomplished its purpose, managing them in concert and getting them to sing to the same beat became increasingly difficult. Eventually, open standard protocols such as BACnet, LonWorks, and, later, Tridium's Niagara framework became established, replacing their predecessors.

While these offered a higher degree of integration, they too have their failings in terms of interoperability, cost, openness, and technical limitations. Crucially, no single system fully meets the needs of the most common standards used in building automation.[2] In an academic review of building automation systems, the authors conclude that this has led to the development of non-standardized solutions to patch over deficiencies, further hampering interoperability.[3]

Tailored to the needs of smaller players

The Building IoT massively changes the game by expanding the scope of building monitoring and management and bringing down the cost of ownership. As a result, small and medium enterprises, which in the US make up 98 percent of commercial buildings and 65 percent of their floorspace, are able to get on board as well.[4] The lack of cables goes a long way in simplifying deployment and maintenance, and today's low cost of wireless sensing devices, often fusing together multiple sensors into a single package, also impact the purchasing price.

But BIoT systems are about more than deployed hardware. The gathered data is only worth as much as the insights that are gained from it. That's where the analytical brain of the system comes in. New business models, such as Infrastructure-as-a-Service, Platform-as-a-Service, and Software-as-a-Service, which all offer different flavors of easily scalable access to cloud services for data analytics and storage, give companies easy to administrate access to the necessary cloud technology.

"The Building Internet of Things leverages the same connectivity, sensing, cloud-based processing power, and infinite data storage that propelled the IoT to one of the fastest growing sectors of our day."

An added benefit of these systems is their seamless integration into our smartphones, which gives us direct access to our home or property. Offering monitoring, analysis, and control via user-friendly interfaces, BIoT systems greatly reduce the need for expertise and training to optimize your in-building experience, maintain your infrastructure, and save energy costs in the process.

The benefits of open technologies

Historically, the automation of each building function was developed in a separate silo. As a consequence, today's smart building hardware ecosystem continues to be largely fragmented, in terms of technologies, platforms, and architectures. The desire to integrate multiple functions into an all-compassing solution has led to the emergence of multiple trends.

On the one hand, companies have recognized the need to form strong alliances to align and streamline their offerings. In their report on the Internet of Things in Smart Commercial Buildings, Memoori outlined the expansion of partnerships and strategic alliances among building system manufacturers, major ICT vendors' IoT platform solutions, and the software, application, and platform segments. They are often joined by representatives of these niches, including smart lighting, HVAC, and elevator companies.[5]

[1] https://www.csemag.com/articles/high-rise-hvac/

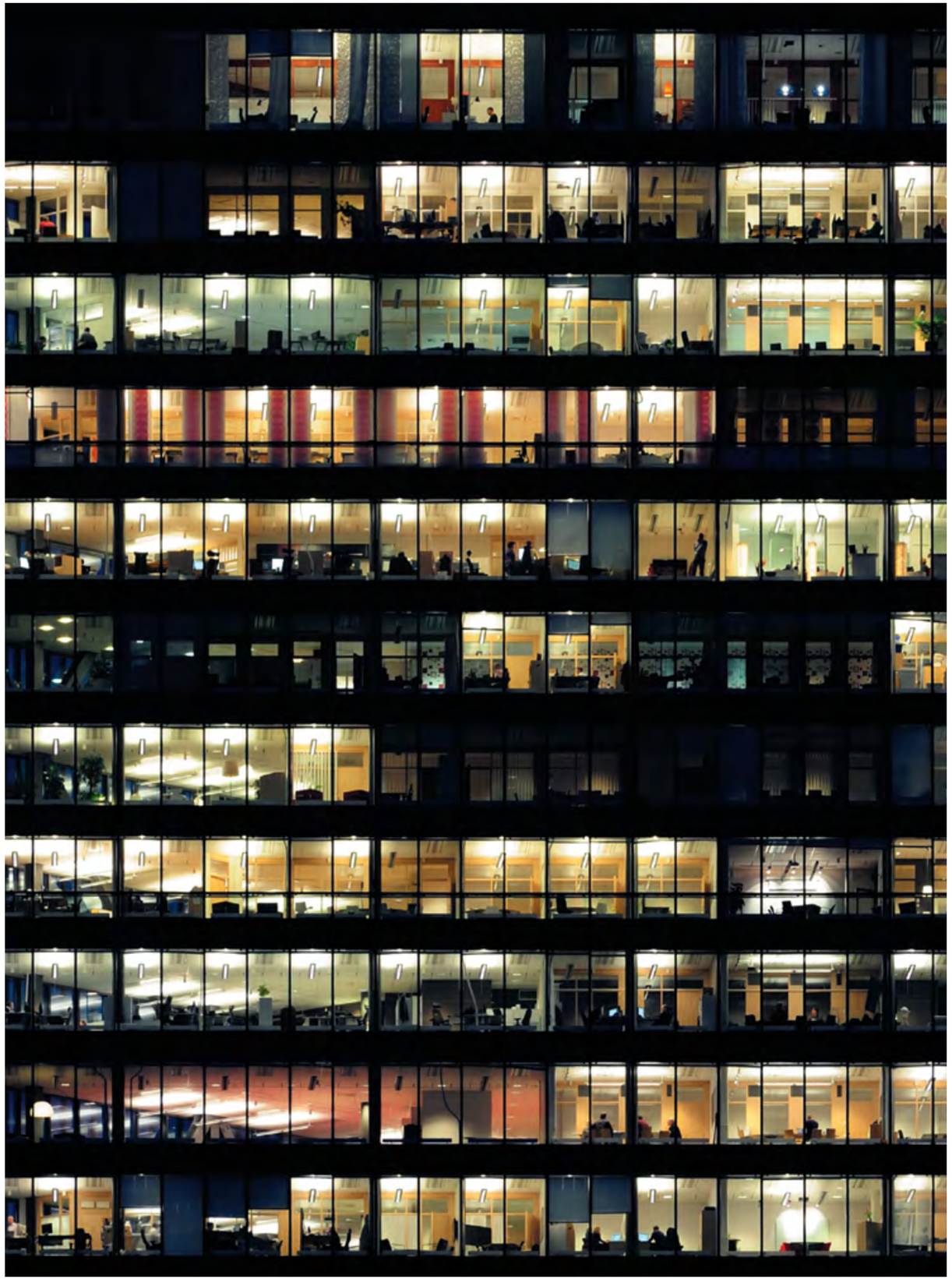
[2] ISO 16484-3, EN 15232
[3] Building automation systems: Concepts and technology review, P. Domingues et al. Computer Standards & Interfaces 45, 2016
[4] The Internet of Things in Smart Commercial Buildings 2018-2022, Memoori, Q2 2018

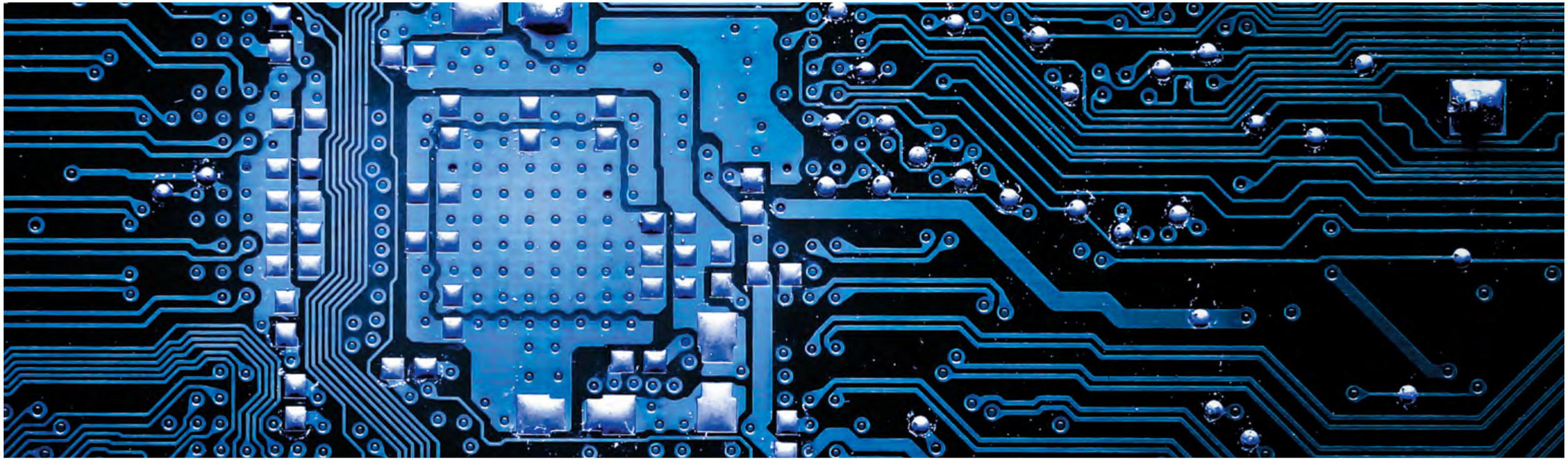
[5] ibid

Management service frameworks or service-oriented architectures are another approach being pursued to make the variety of solutions that are not interoperable by design work together. Service-oriented architectures, such as BACnet web services and oBIX, work by adding an abstraction layer in between the deployed building automation technologies and the client IoT applications.

Remaining barriers to overcome
Cybersecurity and data privacy are challenges across IoT applications, and the Building IoT is no exception. A system is only as secure as its weakest element, and as more and more components are connected into increasingly complex solutions, the threat of cybersecurity is becoming more and more challenging.

The emerging cybersecurity market for smart commercial buildings – estimated by Memoori to grow at CAGR of over 15 percent by 2022 – is a natural consequence of these developments. Legislation pertaining to cybersecurity, such as the Cyber Vulnerability Disclosure and Reporting Act, and the EU's data privacy legislation, will only increase companies' demand for outside expertise to address these challenges. ■





Emerging technologies for connected buildings

With the fast pace of innovation, tomorrow's smart buildings will benefit from a patchwork of established, emerging, and (from today's perspective) futuristic technologies.

There are many technologies targeting smart building IoT applications, but a one-size-fits-all solution has yet to emerge. Even small connected buildings with a few dozen to a hundred sensors use an average of three communication protocols. That number increases as buildings get larger and their systems more complex. As proprietary and open technologies compete, efforts are underway to tie them together under a single united standard.[1]

But innovation isn't limited to communication technologies. New network architectures based on mesh and capillary networks are further optimizing bandwidth use and the cost of ownership and maintenance. Emerging indoor positioning technologies and innovative sensing solutions are also enabling new use cases in smart buildings, from asset tracking to accurate occupancy counting.[2] Artificial intelligence is cutting the need for bandwidth by moving more and more analytics out of the cloud and into the devices themselves.

While the backbone of the in-building communication network is likely to remain wired, using TCP/IP or Ethernet networks,[3] wireless protocols will continue to grow their presence in smart buildings. Short range wireless technologies are already commonplace in most buildings, providing Internet access and enabling wireless sensor networks. Bluetooth, universally present in smartphones and tablets, is a natural choice for controlling smart home devices.

Because they require zero configuration, cellular technologies have become popular in alarm panels – with LTE Cat 1 offering sufficient bandwidth to stream voice and video – and smart meters. The introduction of 4G low power wide

[1] https://www.ericsson.com/en/patents/5g-will-be-the-platform-for-tomorrows-smart-cities

[2] Review: Energy-Efficient Smart Building Driven by Emerging Sensing, Communication, and Machine Learning Technologies, Qian Huang, 2018

[3] The Internet of Things in Smart Commercial Buildings 2018-2022, Memoori, Q2 2018

area (LPWA) technologies – LTE-M and NB-IoT – are making cellular technologies even more attractive for smart metering applications and their extremely low bandwidth requirements. These connectivity solutions will continue to evolve in the 5G era under the mMTC (massive machine type communications) umbrella.

Ultimately, the optimal choice of communication technology depends on the specific use case at hand. While cellular-enabled devices offer easy installation, the fact that they all need a mobile data plan makes them costly for multi-device installations. Higher density deployments, e.g. for smart lighting, heat cost allocators, and wireless in-building sensor networks, play precisely to the strengths of short range solutions such as Bluetooth mesh. Connected to a gateway, a Bluetooth mesh network can wirelessly connect distributed devices to the internal building automation system or to the cloud.

“LPWA solutions will continue to evolve in the 5G era under the mMTC umbrella. ”

At some point, bandwidth will become a bottleneck as the density of deployed devices and the amount of data they communicate increases. One way to free up the airwaves is to push some of the data analysis from the cloud to the device itself, located at the edge of the network. Devices that leverage edge intelligence can track typical usage patterns and detect outliers, communicating only relevant data to the central server or the cloud. Alternatively, analysis can be carried out midway between the edge and the cloud, on the gateway – in the so-called fog. Reduced latencies are an additional benefit of edge and fog intelligence.

In early 2019, the Bluetooth Special Interest Group (SIG) announced an enhancement to its suite of location service solutions.[4] Bluetooth-based positioning has long been used to let users find misplaced items using Bluetooth tags. By equipping a building with Bluetooth receivers at fixed locations, building owners can offer real time location services to help track people, assets, and other goods. And beacon-enabled setups are popular solutions to help people navigate large buildings. To these use cases, the enhancement adds direction finding, enabling down to decimeter-level indoor location services and other use cases. Direction finding requires that fixed Bluetooth anchor points be fitted with multi-antenna arrays.

Sometimes a single sensor is just not enough to provide sufficiently reliable information. In such cases, sensor fusion, or the combination of different sensor inputs into one reading, can be a solution. Detecting the presence of people in a building in order to optimize heating and cooling, saving resources, and increasing comfort and wellbeing is one example of such a challenging use case. To do so, researchers fed CO_2 readings and other environmental data into a neural network and achieved accurate results.

And then there’s Li-Fi. The technology, which transmits data by imperceptibly flickering LED lights, easily outperforms Wi-Fi in terms of transfer rate, achieving up to 10 gigabits per second in the lab. The technology, which has been piloted by Philips and Icade, has the potential to enable ultra-high speed data transfer in electromagnetically sensitive environments or when security is paramount, given that the light cannot traverse walls and generally requires line-of-sight.[5]

“Short range wireless technologies are already commonplace in most buildings, providing Internet access and enabling wireless sensor networks. ”

Closing on another futuristic theme, biometrics are going mainstream. In smart buildings, biometric approaches are finding applications that we are all well familiar with from science fiction movies: identifying individuals and granting them access to restricted areas. Now that fingerprinting, widely used on smartphones, has become common, iris scanning is coming into its own. The EyeLock Nano NXT can reliably use the technology to identify up to 20 people in a minute from a distance.[6] And there’s more in the pipeline. Facial recognition has found its way into the latest generation of smartphones. It’s probably only a question of time before the technology is commercialized for use in smart homes. ■

[4] Enhancing Bluetooth Location Services with Direction Finding, Bluetooth SIG, 2019

[5] https://www.signify.com/global/our-company/news/press-release-archive/2018/20180316-philips-lighting-introduces-lifi-broadband-data-through-light

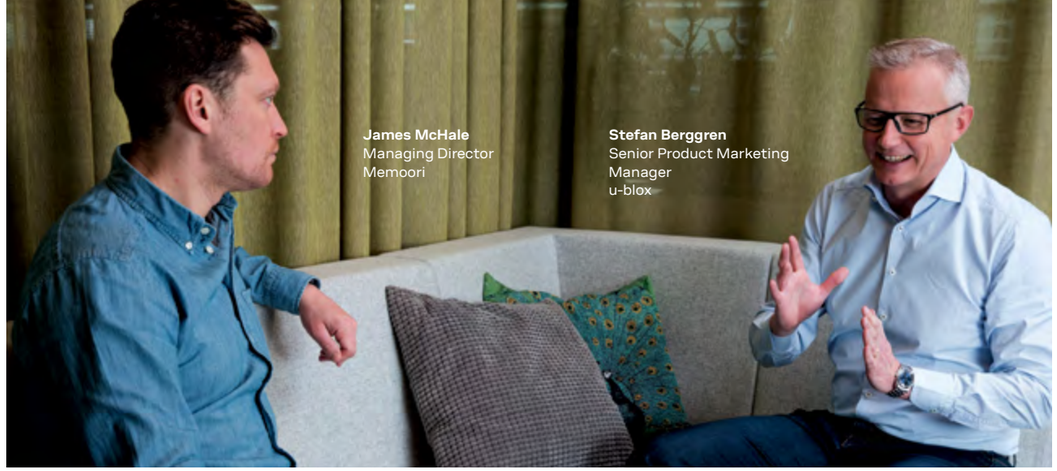
[6] https://www.eyelock.com/index.php/access-control/nano-nxt

Expert opinion

Making our buildings smarter

Interview between Stefan Berggren, Senior Product Marketing Manager, Product Center Short Range Radio, u-blox, and James McHale, Managing Director, Owner and Founder of Memoori Research AB

From energy and urbanization to demographics and health, major forces transforming our society are shaping the buildings we inhabit. Connected building technology will be central to addressing many of these challenges, but we always need to keep in mind the people and the purposes that the buildings are meant to serve.



Why do we need smart buildings?

Stefan Berggren – For me, a smart building is very much about the energy consumption within the building that needs to be optimized. It is about making sure that the light is on when it's needed, controlling the heating, ventilation and air conditioning (HVAC) equipment, and making the elevators as efficient as possible. All this is about saving energy.

James McHale – Absolutely. If we look at some of the milestones in the development of technology in buildings, one of the big things that happened in the eighties was the introduction of direct digital controllers (DDC), which was the first attempt at electronically controlling HVAC devices, and putting them on a bus network. From that point we've seen the industry take off. Another big advancement was the introduction of open protocol languages like BACnet and more recently of IP networking, which has had a really profound impact. It has allowed us to connect more things than ever before, and I think we're really just starting now to see that come to fruition.

S.B. – Of course it's also about the well-being of the people in the building, making sure that the conditions are right at every moment, and also adapted to each user and resident.

J.McH. – When we write about the industry, we always try to highlight the importance of the user experience. The people who are creating products and services should have that at the front of their minds when they are trying to optimize environments.

S.B. – By having the right lighting, we can really improve the efficiency of the people. We then become more alert, reduce the number of sick days, and so on. It's about optimizing conditions so you have the perfect environment for the people.

J.McH. – Definitely. I always try to talk about outcomes, not output. I think one of the issues with the construction or building industry is that previously it's been focused more on output, producing more buildings. But really what we should be doing is asking what it is that the building is supposed to achieve. And technology definitely has a part to play in that.

How would you define a smart building?

J.McH. – I tend to think of a smart building as, basically, a building that isn't dumb! I guess that means the building should have some understanding of the environment, of where it is and what it's supposed to do. Beyond that, it should also have some ability to learn.

S.B. – I was googling around for a definition of the smart building. I found one very good explanation from Buildings Performance Institute Europe (BPIE)[1]. It focused on the smart building's

[1] A vision for smart buildings in Europe, BPIE, Marteen De Groote, April 2017. (URL: http://bpie.eu/wp-content/uploads/2017/04/smart-building-ws-April-2017_BPIE.pdf)

high energy efficiency and its reliance on local renewable energy sources, integrating energy storage and demand-side flexibility. It went on to say that a smart building empowers its users with control over energy flows and recognizes and reacts to their needs – comfort, health, and well-being, as well as operational requirements.

J.McH. – It mentions users, which I think is important. As I said, that, to me, is at the core of what we do, optimizing for users.

S.B. – Also about the energy efficiency of the building, we see that, today, according to the European Commission, buildings are responsible for approximately 40% of energy consumption and 36% of CO_2 emissions in the EU[2]. So, we need to work on that, to make them more efficient.

J.McH. – I've seen that statistic as well. If we are going to reach the targets we've set, for example for CO_2 emissions, buildings are going to have to be a huge part of that.

Beyond this, this focus on output is again important. From my perspective, there is, as well, a difference between types of commercial buildings and what they are, what they are supposed to do, and what their output should be. We mentioned productivity. I think that's important, in offices. But equally, in hospitals it should be about patient outcomes; in schools, about trying to provide a better education. Even in prisons, it should be about helping to reduce re-offending rates. These are the things that buildings should be able to contribute to.

S.B. – A smart building is about understanding what's going on inside. If we take the example of the hospital, one important thing is to be able to keep track of the different types of hospital equipment, and to locate them. Also, to monitor patient flow through the hospital and optimize it in an effective way.

J.McH. – Absolutely. Tracking assets, tracking people, making sure that we are being as efficient as possible with resources. Ultimately someone has to pay for all of this, so we have to be as efficient as possible.

S.B. – In office buildings, one must utilize the building as much as possible and optimize the use of the space to avoid empty rooms.

J.McH. – There's a big trend at the moment towards optimization of space in offices and commercial real estate. A lot of providers are coming up with solutions, either new companies or established ones, and also from different technological perspectives. For instance, there are lighting or access control companies looking at this as an opportunity. And in the corporate environment, companies are coming up with their own solutions. The amount of money they spend on commercial real estate can be a big cost to the business, so anything they can do to optimize that is a big win for them.

S.B. – Yes, and also for retail to understand how consumers are moving around in the stores via a heat map.

J.McH. – Yes, exactly. Being able to have a really granular understanding of not just where consumers go in the store, but of what they're looking at, even what they're thinking about buying. Tying that in with the marketing of products or being able to give them the information to help make the buying decision – there is a lot of work going into that. A lot of what they are doing now in terms of enhancing the shopping experience is very sophisticated.

What are the major enabling technologies for smart buildings, now and in the future?

S.B. – For u-blox, it's very much about wireless technology. I read a report from ABI research that the ratio of wireless equipment in smart building will rise from 20 percent in 2018 up to 35 percent in 2022. And we see that upward trend for wireless. We also believe that the smart building is very much about collecting sensor data from a large sensor network, sending the aggregate data up to a cloud service, and, for these types of applications, a mesh

[2] https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

network is incorporated to connect node to node. Bluetooth just announced their Bluetooth mesh half a year ago, which we believe in very much. You also need a gateway to aggregate the data from the connected sensors and send it through a cellular connection, for instance, up to the cloud. We believe that we can contribute to both the meshing and the gateway.

J.McH. – I think you have hit on some big trends. If I'm perfectly honest, the construction or building industry is not always at the forefront of technology. I think it takes a lot of cues from what happens in IT. And clearly what we are seeing now, as you alluded to, is the fact that a big trend in buildings is getting data out of them. Sensors are a big part of that. But it's also about what we do with the data. We have to be able to use it to optimize the environment, and that's where intelligent software comes in. Using the cloud to be able to process that data, display it intelligently, give the people who are making decisions, such as facilities managers, the tools they need to optimize what they are trying to do. Whether it be to save energy or increase productivity.

"A big trend in buildings is getting data out of them and to be able to use it to optimize the environment. That's where intelligent software comes in."

S.B. – Another aspect is indoor positioning. There are different methods available, but most recently Bluetooth announced the addition of the Bluetooth 5 direction finding feature to their Bluetooth location services solutions. They claim to be able to get down to the centimeter level indoors as well, with a real-time positioning technology using the angle of arrival (AoA) and angle of departure (AoD) of signals. We talked about lighting, and that is a perfect position to place these types of sensors.

J.McH. – Yes, absolutely. Previously when we've spoken about space and occupancy, like working out where people are, we've seen quite a few companies using the lighting infrastructure to do just that. It is an exciting time for the business, in the sense that I feel there is an increase in digitization and definitely a proliferation of sensors as they become a little bit cheaper, and as our way to connect them wirelessly or using wires is getting better as well.

I would add that there can often be too much focus on technology, rather than what we are really trying to achieve. I see technology as being the tool to achieve what we want to do; it's a means to an end, not an end in itself. In some respects, the relatively conservative construction industry can look at what's going on at the bleeding edge in IT and digitization, and say, "OK we can use this technology", and pick and choose what they need to achieve, whatever the objective may be for that building.

“It can't be an afterthought anymore. Security needs to be at the forefront of everyone's mind.”

What are the barriers to implementing smart buildings?

J.McH. – I think construction is quite conservative, as well as fragmented. You can have different stakeholders with competing interests. It's not just about building a building, it's about designing it, putting infrastructure in it, engineering it. It's definitely a multi-layered, complex industry. And rightly so – buildings are complex things that don’t lend themselves very well to providing the best technologies.

Take, for example, a new building. The construction company can be under a lot of pressure to avoid late fees that can often be passed down the chain. If they don't meet their deadline, they start losing money – and margins in construction are already very thin, often only two to three percent. So a lot of times, technology can get engineered out. If you want to embrace technology and build a smart building, get a technology advocate in as early as possible, even in the design phase.

S.B. – It's even harder when you are trying to make an existing building smarter. Especially when there are multiple solutions: one for lighting, one for HVAC, and so on, and getting them to integrate.

J.McH. – You've hit on a great point. Data can often be siloed in these different systems, so we really need to be able to connect things more efficiently. We've seen some interesting communication protocols, such as BACnet of course, that do a good job of allowing things to talk the same language. I am quite optimistic that we're going in the right direction.

S.B. – The problem is that with so many different technologies, interoperability between

different standards and wireless technologies can become an issue. Buildings are around for a long time, so you need to be sure that you have a future-proof solution.

J.McH. – I think anyone who is building a building or retrofitting one is cautious. If they are going to make an investment, they need to know that it's going to bring them a return, or at least do what it's supposed to. And, as you said, most of the buildings we see around us will still be here in thirty or forty years, while technology moves at a different pace. That is an issue that people need to think about.

S.B. – Even if you would like to have as much data as possible for smart services, the facilities management, IT department, etc. are all totally separated, creating yet another barrier. And you need to have them talk to each other to develop a great solution incorporating both information technology and operational technology.

J.McH. – IT versus OT. I think as this matures – as IT departments become more comfortable with the idea of actually incorporating building information and data – it will be easier. But it's going to take time.

How should security issues, in particular cybersecurity, be tackled, with so many points of entry to the data flow and the hardware?

J.McH. – It's a serious problem, and it requires a serious response from the industry. And it's, as you said, a layered problem. I think it's about everyone from the manufacturers all the way through to the end users coming up with end to end solutions. If something is connected to the network, it's more than likely that someone will try and attack it and find out where the vulnerabilities are.

From the manufacturer perspective, I'd like to see products with security baked into them, through to good education for systems integrators. They need to install systems that focus on security and do so in the correct way. It isn’t always clear exactly what is on the network. It's crazy, but there are people who have this kit in buildings and don't know what's on their network. So end users need to know what's connected and to make sure that the right people have the right access.

S.B. – You read a lot of stories in media about how they managed to put malware on different things in the IoT, which can cause a lot of damage. I’ve read that researchers were able to take control of the lighting in a building using a drone and have it blink an SOS using Morse code. In another example they managed to get into a temperature sensor of a casino lobby’s fish tank and collect sensitive data from the casino. At u-blox, as we are involved with short range, cellular, and positioning components, we have developed our five principles of security.

First, we ensure that only authorized software is running on the module. Then, you need a mechanism to update the software on different nodes in the networks using secure Firmware Updates Over The Air (FOTA), and to ensure that the API's in the links of the module or device are secure. And then, connections or transport layers need to be secure and linked end-to-end. We also need to be able to detect spoofing and jamming of the device and perform countermeasures. These are our five principles but, as you said, we need control over the complete building system, end-to-end.

J.McH. – I think what you guys are doing with securing the hardware is fantastic. We need more of that. From the building perspective, we need to combine that with educating the right people. It can't be an afterthought anymore. Security needs to be at the forefront of everyone's mind.

S.B. – We talked about the technology, but security is not only about features and functionalities. You need to manage the entire process, creating a secure environment to store the secure keys and a robust procedure to manage production and later on software updates in the field.

Do you see any geographic trends?

J.McH. – Building regulations can change from region to region or country to country, for example in fire detection systems, which is quite a regulated business. There are different standards in different regions. However in general, I think buildings and building automation is quite a global business. You do see the same suppliers in a lot of different countries, which is good.

From a technology perspective, the uptake of IoT does vary by region, and there may be a lot of different reasons for that, economic and governmental. But in general we are seeing technology being implemented across the world.

S.B. – Your report says that the potential is biggest in the APAC region. We see that as well. The economy is growing, more buildings are being built, and urbanization is becoming faster.

On a technology level, from a short range perspective, standards are quite the same globally.

“We believe that Bluetooth will have a considerable impact on smart buildings, with recent developments in long range capability.”

From a cellular standpoint, we see differences in the different markets. It depends when and whether new technologies are adopted, for example NB-IoT or LTE-M , and when systems like 2G or 3G are closed down. We need to follow these trends carefully, and different markets also require different combinations. We mentioned 5G, which also differs across regions. Yes, it’s a global standard, but the frequency bands are defined more locally and are auctioned off to different telecommunications companies. That makes things quite complicated.

J.McH. – What are we going to see in terms of transitioning from 4G to 5G? From what I’ve been reading it will be a real step change in bandwidth.

S.B. – 5G comprises three different core technologies. The first offers a much broader bandwidth, hence higher speed, than existing technology which could enable, for example, very high definition surveillance applications (eMBB – enhanced Mobile Broadband). The second one is Ultra Reliable Low Latency Communications (URLLC) for mission critical communications. There is also an evolution for smart IoT devices in very dense networks – what they call massive Machine Type Communications (mMTC). These are for energy and form-factor conscious devices such as sensor nodes. They will continue driving the IoT ecosystem and its evolution and are our primary focus.

How do you see the future five years from now?

J.McH. – The trends that we're seeing right at this moment, for example more connectivity, more devices being connected, more data being produced and aggregated from different sources, will continue. I think we'll also see a maturing of how data is used and refined to make sure that we know what data can be used to optimize the building in the right way. Actually, five years isn't that long.

Back to my other point mentioned earlier: I don't expect construction and buildings to move at the same pace as IT technology – they just won't.

S.B. – I think it's an evolution. It will take small steps at a time as we integrate more and more sources into the data collection. Overall, it will move towards more open standards. From a commercial perspective, we’ll probably see much more M&A in the market.

From a technology perspective, we believe that Bluetooth will have a considerable impact on smart buildings with recent developments in long range capability. We’ve actually measured 1.5 kilometers between two Bluetooth nodes – it's really a game changer. Bluetooth SIG predicts that there will be 360 million Bluetooth devices in smart building by 2022, so that's quite impressive.[3]

J.McH. – We have talked about 3 billion connected devices in commercial real estate[4] by a similar date, so to say that Bluetooth might have around 300 million is not out of this world. I think one of the other things I've seen looking at some of the macro trends like urbanization and work is that we're becoming more flexible as a workforce. I wonder what impact that's going to have on commercial office space. There is a sense that the cyber and physical worlds are merging, for example, in identity management. We have access control systems in buildings that manage our physical identity in the building. We also have identity access management enterprise software that manages it on enterprise software. I see no reason why they won't be merged. What does that mean going forward with perhaps more remote working and how we connect with each other online?

You look at some of the video game technology now. Multiplayer, quite realistic worlds that are completely virtual. It makes you wonder whether they'll start to create virtual work environments that are this realistic as well. ■

[3] Bluetooth Market Update, Bluetooth SIG, 2018 (URL: https://www.bluetooth.com/markets/market-report)
[4] https://www.memoori.com/portfolio/ internet-things-smart-commercial-buildings-2018-2022/

What drives the Building Internet of Things?

Here are some facts & figures.

38bn

US$ growth of the IoT market for commercial buildings by 2022

Source: Memoori Research

16.8bn

connected devices in operation in smart cities by 2022

Source: Memoori Research

4.1bn

connected devices in smart homes by 2022

Source: Memoori Research

788m

buildings worldwide with at least one connected meter by 2025

Source: ABI Research

631m

smart building connected IoT devices in APAC as of now

Source: Memoori Research

500m

lighting systems & controls devices installed in commercial buildings by 2020

Source: Memoori Research

378m

security cameras in commercial buildings by 2020

Source: Memoori Research

360m

annual Bluetooth smart building device shipments by 2022

Source: Bluetooth SIG

87m

smart thermostats integrating smart homes into smart grid demand response systems by 2022

Source: ABI Research

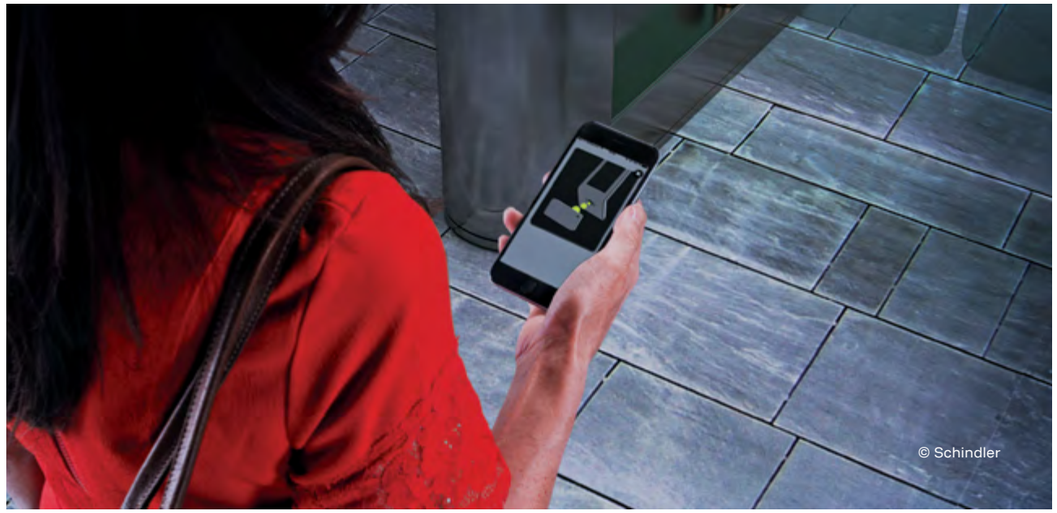
350%

growth in annual volume of Bluetooth automation and control devices by 2022

Source: ABI Research

Schindler's myPORT elevates indoor transit management to new heights

From the moment they step indoors, myPORT seamlessly identifies, guides, and transports building residents and visitors to their destination.



The myPORT app uses Bluetooth technology and the u-blox NINA-B1 Bluetooth module to enable user identification, authentication, and authorization.

A decade ago, Schindler's PORT Technology redefined the way we interact with elevators. Instead of being offered the binary choice of up or down, the PORT transit management system started asking users to enter their destination floor when calling the elevator. It was a paradigm-changing idea that opened the doors to algorithmically optimized elevator allocation. Especially in busy buildings such as residential high-rises, offices, or hotels, PORT Technology can improve handling capacity and waiting and destination times by up to 50 percent.

Recently, Schindler took these improvements one step further with the commercial launch of myPORT. Using smartphones to identify and authenticate people as they enter a building, the system seamlessly guides individuals through the floors and doors of the building to where they want to go. Tenants can be informed that guests, customers, or clients are on their way and remotely control their door locks to let them in. Moreover, the technology enables countless other applications, such as giving tenants keyless access to their mailbox and parking garage and making it easier for people with special needs to use the building's elevator and other infrastructure.

Convenience brings security

Access control solutions are often developed to keep the wrong people out of restricted areas. myPORT tackles the problem differently, focusing instead on improving how people transit through the building. The solution combines a deep understanding of the way people interact with the spaces they inhabit with decades of elevator technology leadership, wireless connectivity, and e-banking-level security. Building owners get enhanced security and increased real estate value. Users gain from a more fluid indoor experience.

The myPORT app uses Bluetooth technology and the u-blox NINA-B1 Bluetooth module to enable user identification, authentication, and authorization, offering a high level of convenience to the user. "Our solution needed a Bluetooth module providing reliable performance regardless of the orientation of its antenna. We found our fit in the u-blox NINA-B1 module," says Nicolas Gremaud, Vice President and Head of the Transit Management Group at Schindler Elevator Ltd.

From an occupied tower to the OmniTurm

The development of the myPORT system was guided by lessons learned studying the Torre David, a skyscraper in the Venezuelan capital of Caracas that was left unfinished and then occupied by inhabitants of a nearby slum. Carried out in collaboration with architects from ETH Zurich, the research delivered insights into how a building's verticality impacts the societal organization of its residents that were unique precisely because the tower lacked elevators and amenities such as electricity, running water, and largely, walls.

"myPORT wouldn't be what it is today were it not for the Torre David study," says Nicholas Gremaud. "The research – being awarded with the Golden Lion at the 2012 Architecture Biennale di Venezia – profoundly shaped our thinking on how to leverage technology to make future urban spaces more livable – by influencing how a building's users interact with each other and the building they occupy."

Soon, the technology will be deployed in an ambitious and highly complex real estate project. myPORT was selected to implement access control throughout one of Europe's tallest buildings, currently under construction in Frankfurt, Germany. The 45-story mixed-use OmniTurm sky rise will combine offices, 147 apartments, and various public spaces. Designed by the Bjarke Ingels Group, the 183-meter high landmark building will be the first commercial implementation of myPORT technology in Germany. ■

Learn more:
www.schindler.com
www.theporttechnology.com
www.u-blox.com/product/nina-b1-series

A flexible wireless sensor network to connect buildings to the cloud

Treon combines the technical excellence gained at Microsoft and Nokia with Nordic design into an elegant wireless connectivity platform for smart buildings and more.

"Everything is getting connected, and we want to be part of enabling that," says Joni Korppi, the CEO of Treon. With headquarters in Tampere, Finland, the birthplace of Nokia, and founded in 2016 by former Microsoft smartphone engineers, Treon commercialized their disruptive Treon Node and Gateway platform for smart building applications earlier this year.

Their platform uses the u-blox NINA Bluetooth module series to connect nodes distributed across a building in a wireless mesh network. An IoT Edge Gateway featuring a u-blox SARA-R4 cellular module and a u-blox NINA-B1 Bluetooth low energy module links the network to the cloud. Both the Treon Node and Gateway run Wirepas Mesh and are prepared for Bluetooth mesh as well.

The Treon Node features sensors measuring temperature, pressure, light, humidity, motion, magnetic field strength, and a gas sensor for indoor air quality monitoring. Additional sensors can be added to the platform as a custom project. This flexibility makes the Treon Node ideal for a broad range of smart building use cases that are commonly addressed by an ensemble of separate solutions, thereby simplifying deployment, maintenance, and data analysis.

The system enables traditional use cases such as monitoring and controlling HVAC and other building infrastructure without having to draw cables to a central control panel. And the system's mesh-gateway architecture does away with the need to equip each individual sensor node with a SIM card. Data simply hops from node to node until it reaches the gateway, from where it is channeled to the cloud or an in-house building management system.

Other emerging use cases can be found in commercial buildings. Shopping malls could, for example, offer marketing services as part of their rental package. Shopper heat maps generated using the Treon Nodes would then track the effectiveness of the marketing campaigns – providing insights beyond sales numbers. In a smart washroom context, towel dispensers can be monitored in real time to improve customer satisfaction and save in maintenance costs.

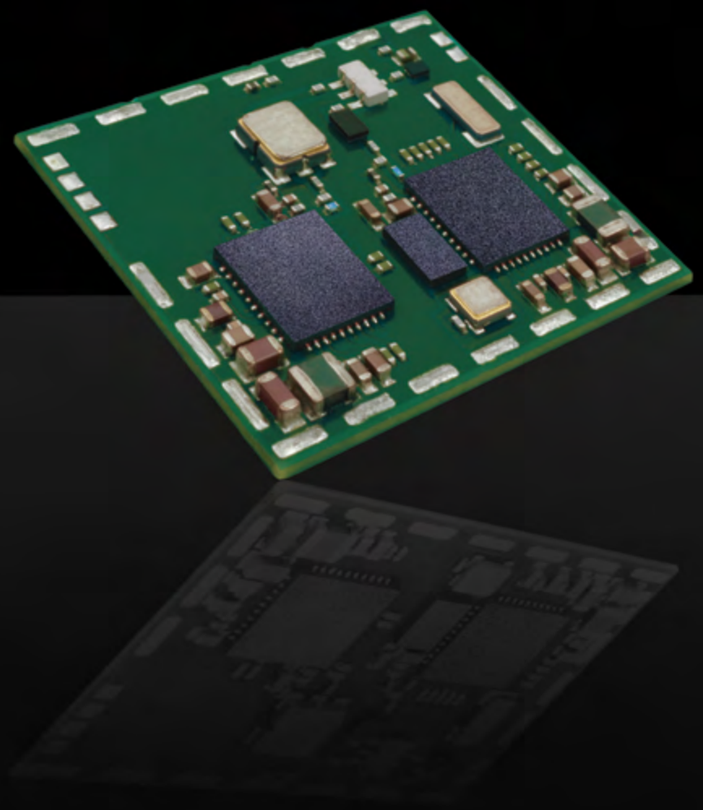
Now, the company is broadening its focus to cover industrial applications, using their nodes to control industrial pumps and analyze vibrations of motors for predictive maintenance. Algorithms running on the individual nodes provide the edge intelligence needed to keep the amount of data sent across the network in check. And with distributed nodes forming a network of anchor points, users can benefit from room-level indoor positioning as part of the platform.

Treon's embrace of openness only adds to the company's disruptive potential. "We see great value in working with our competitors," says Joni Korppi. "Cross-support between our nodes and gateways and those of other providers means that customers can source their nodes from a variety of companies and run them all on the same architecture. We're still only scratching the surface of a market that will soon become huge, and we see openness as a strength that will play to our benefit going forward." ■

Learn more:
www.treon.fi
www.u-blox.com/product/sara-r4n4-series
www.u-blox.com/product/nina-b1-series

The Treon Node features sensors measuring temperature, pressure, light, humidity, motion, magnetic field strength, and a gas sensor for indoor air quality monitoring.

In the spotlight



The latest in positioning and wireless communication technologies

Combining industry-leading quality, robustness, sensitivity, and performance with innovative features, u-blox delivers components and solutions that meet the needs of even the most demanding designs. We focus on business-critical applications where products need to perform 24/7 with maximum reliability, handling exceptions with minimal disruption to the overall system. Our customers expect improved productivity, quick turnaround, and a head start on their competition.

ZED-F9K

The ZED-F9K is the first dead reckoning module with integrated Real Time Kinematics (RTK) to deliver lane accurate positioning under the most challenging environments such as dense cities, tunnels or parking garages. Its multi-band L1/L2 GNSS receiver is based on u-blox F9 technology and enables rapid convergence within seconds. The module has an integrated inertial measurement unit that provides acceleration and angular velocity measurements to the sensor fusion algorithm. The algorithm further combines GNSS measurements and a vehicle dynamics model to provide decimeter-level performance where GNSS alone would fail. In modern automotive applications such as Advanced Driver Assistance Systems (ADAS), where alleviating driver fatigue can improve the safety of our roads, the ZED-F9K is the ultimate solution.

Learn more:
www.u-blox/product/zed-f9k-module

NINA-B3

The NINA-B3 series of stand-alone Bluetooth 5 low energy modules now also includes the NINA-B306/316 modules with an integrated PCB antenna. The trapezoidal printed antenna enables superior performance transmission and data reception in a small form factor.

The NINA-B306/316 modules are fully pin- and software-compatible with the entire NINA series, giving manufacturers a seamless upgrade path as well as design options.

The NINA-B3 series comes with u-connect software that makes it easy to integrate Bluetooth and Wi-Fi connectivity into new and existing products. Two variants are available: u-connectXpress, which is used together with a host, and u-connectScript, which enables embedding applications directly on the module.

Learn more:
www.u-blox.com/product/nina-b3-series
www.u-blox.com/product/u-connect

SARA-N3

The SARA-N3 series of multi-band NB-IoT modules supports a selected set of features based on 3GPP Release 14 and will be able to receive additional features to become 5G compliant via subsequent firmware upgrades without hardware changes.

Two product variants are available: SARA-N300 for the China market and SARA-N310, which supports multiple, configurable bands for operation under any NB-IoT network. Because of the deep in-building range of NB-IoT, SARA-N3 is ideally suited to support low data rate applications such as HVAC control, access management, smoke detectors, and other monitoring systems.

Learn more:
www.u-blox.com/product/sara-n3-series

Experimenting with Bluetooth mesh, inside and out

There's more to the technology than first meets the eye. That's why we're putting it to the test.

Released in 2017, Bluetooth mesh quickly established itself as a powerful enabler of smart lighting solutions, ushering in the new concept of lighting as a platform. But the technology's scope goes far beyond lighting, targeting smart building, smart industry, smart city, and smart home applications in which tens to thousands of devices need to communicate with each other. Last year, we plunged head-first into two experimental projects to gain hands-on experience for field-testing Bluetooth mesh networks to acquire valuable expertise that we can share with our customers.

You'd hardly know it, but when you walk into our Malmö office, you're actually entering a large-scale Bluetooth mesh testing site. Dozens of wireless nodes, spread across 45 meeting rooms, open spaces, restrooms, and recreational areas constantly monitor parameters related to the indoor environment, including temperature, humidity, occupancy, and lighting. The distributed network is powered by the Treon Node, and runs a Bluetooth mesh stack on its u-blox NINA-B1 and NINA-B3 Bluetooth low energy modules. The result is a unique sandbox in which we can explore the benefits of the network topologies that Bluetooth mesh enables in a dense indoor setting and learn how the technology behaves when it is pushed to its limits.

As part of the Lund Smart City project, we used Bluetooth mesh to connect power distribution cabinets spread across the municipality to its smart city network. It isn't the first smart city application that comes to mind, but it goes to show just how pervasive connectivity will become in future cities. The sensor network tracks temperature and acceleration on the cabinet doors to give city authorities an early warning when these vital components of the power grid are accidentally damaged or deliberately tampered with.

In the Lund Smart City project, data gathered using Bluetooth mesh enabled Treon Nodes are first sent to wireless gateway nodes, from where they are uploaded to the cloud using NB-IoT cellular connectivity via u-blox SARA R4 LTE Cat M1/NB1 modules. The project, carried out in collaboration with Schneider Electric, Ericsson, ABB, Telia, and other partners including the municipal authorities and startups from the Mobile Heights community, is already delivering insights into the performance of Bluetooth mesh in an outdoor environment in which nodes are several tens of meters apart. ■

Learn more:
www.futurebylund.se/en/home
www.u-blox.com/en/short-range-radio-chips-and-modules
www.u-blox.com/en/product/sara-r4n4-series