



GSMA Intelligence

ANALYSIS

Mobile World Congress 2017 wrap-up

March 2017

The in words at MWC: investment, innovation and intelligence

The 2017 edition of Mobile World Congress welcomed more than 108,000 visitors to Barcelona for the biggest event in the mobile industry.

While we set out our key findings from the show over the next few pages, several broader themes run across much of this analysis and point the way for the industry as it continues to transform:

- **Investment:** 5G places the industry at something of a crossroads: while widely recognised as an evolutionary step, it could be revolutionary in impact – but only with the right levels of investment. There was much discussion on how to ensure the right regulatory environment and adopt more pro-investment stances around the world.
- **Innovation:** With innovation in smartphone form-factors clearly plateauing, this year there was a greater focus on chatbots and digital assistants (powered by AI), autonomous vehicles and IoT devices. And with 5G some way off launch, we also learnt of the innovative use cases already emerging for other technologies – from NB-IoT to LTE Advanced Pro.
- **Intelligence:** The networks of the future have the potential to deliver the intelligence that will transform the industry – including network, location and ambient intelligence. But with increased intelligence and vast amounts of data comes a growing appreciation of the imperative for robust end-to-end security.

Overall, the mood at Mobile World Congress was one of getting on with the practicalities of delivery – specific roadmaps, deployment models and investment challenges. The industry continues to transform for the opportunities and challenges ahead.

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5G: operators push for lighter-touch regulation to encourage investment

5G dominated MWC this year. While the exhibition halls were full of connected vehicles, robots and drones, all purporting to benefit from 5G speeds and latency, the conversations within the keynotes and 5G seminars focused on the need for a more pro-investment regulatory environment to help operators deploy 5G networks.

Key points

- A group of key mobile ecosystem players called for an acceleration of the 5G New Radio standardisation schedule to enable large-scale trials and deployments as early as 2019.
- FCC Chairman Ajit Pai reaffirmed his administration's proposed [light-touch approach](#) to regulation as a means of promoting investment and helping "the United States realise its 5G future".
- A number of operators across Europe and India also called for lighter regulation and the need for market consolidation to attract investment in 5G.
- Mobile operators presented their results at the Global 5G Test Summit. Some 25 mobile operators confirmed 5G lab testing, of which 12 have progressed to field testing (with most tests conducted in the 28 GHz band) and four have announced major 5G trials.

Viewpoint: 5G buzz tempered as operators point to investment challenges ahead

Operators are clearly wary of the scale of investment required for 5G, with Timotheus Höttges, CEO of Deutsche Telekom, projecting that the cost of covering Europe with 5G might total €300–500 billion. DT's CTO also highlighted the need for collaboration to reduce the cost of 5G networks, particularly around the radio network and to facilitate the network densification that is at the heart of 5G. FCC Chairman, Ajit Pai, signalled his administration's intent to pursue a light-touch, pro-investment regulatory stance as a means to drive investment, while European Commissioner for Digital Economy, Andrus Ansip, noted that the EU would do everything it could to ensure incentives and favourable regulation would be in place.

There were also some more cautionary comments on the near-term outlook. Liberty Global CEO Mike Fries stated that "the commercial deployment of 5G by 2020 is too aggressive and LTE still has significant headroom". This echoed comments from both T-Mobile US and Sprint that there is still life left in 4G, with Sprint highlighting the potential of Gigabit LTE (both Telstra and EE announced plans to launch this service in 2017).

Overall, there was a clear sense of progress around 5G at MWC, particularly on technology standards and use cases. However, it was equally clear that the significant capital investments for 5G will require close collaboration between mobile operators and governments, as well as vertical co-operation with other industries that will benefit from 5G deployment. More cost-effective deployment models and a supportive regulatory environment will be key, an area where the US appears to be ready to take the lead.

Smartphones go back to the future

As usual, Mobile World Congress was used as a launchpad for flagship devices from global manufacturers including Sony, Lenovo, LG and Huawei. However, it was the reboot of the Nokia 3310 – originally launched in 2000 – that stole the headlines, as the latest technology innovations continue to largely underwhelm.

Key points

- HMD Global resurrected the classic Nokia 3310 phone in a thinner and more colourful form. As with the original model, it retains a long battery life and comes pre-installed with the Snake game. The device is no more than a feature phone, constrained to 2.5G networks and with limited capacity for mobile apps.
- [Sony Xperia XZ Premium](#) was awarded the “best new smartphone” at MWC this year. The handset has the first 4K HDR screen in a smartphone, contains Qualcomm’s latest Snapdragon 835 processor and can capture video at up to 960 frames per second, enabling it to record smooth slow-motion video.
- ZTE demonstrated a prototype gigabit phone considered to be the world’s first 5G-ready smartphone. The handset relies on carrier aggregation technology that will eventually allow the device to reach a gigabit download speed.
- LG G6 dropped the modular design of the G5 and instead focused on screen quality and its camera technology. The device, which comes with a much thinner bezel, applies an 18:9 aspect ratio that matches a common standard in cinematography, while the G6 also adopts a dual camera at the back including a 120-degree wide-angle lens.

Viewpoint: Nokia nostalgia highlights perceived lack of innovation

The Nokia 3310 is by modern standards a ‘dumb’ phone, repurposed in an array of colours, whose main selling point is a one-month battery life and the ability to play Snake. Yet, as Nokia and BlackBerry (which launched the KeyOne) played on nostalgia to reinvigorate their brands, the developments highlight the industry’s perceived lack of innovation since the launch of the iPhone in 2007.

The absence of visible smartphone innovation remains a source of frustration for consumers. Yet, amidst the commoditisation of the industry, these frustrations should be seen in the context of a developing ecosystem of mobile products (tablets, wearables, 360 cameras) as well as a continually improved user experience. Smartphones are increasingly focussed on usability, enabling innovation in other areas such as virtual reality, the next iterative platform for consumers.

Improvements to smartphone computing power continue, with both ZTE’s prototype phone and Sony’s XZ Premium device containing the latest Qualcomm 835 processor. In a relatively short period of time, smartphones have become capable of playing and watching immersive VR games and video content, offering a much cheaper and more mobile solution to the dedicated VR products from Oculus, PlayStation and HTC.

Screen quality has also improved immensely in recent years, underscored by the 4K HDR display on Sony’s flagship device. This trend continues to be driven by the explosion in video consumption on handset devices, with most vendors adopting smaller bezels to increase screen size without increasing the overall phone size. And although the Nokia 3310’s one-month battery life may serve as a reminder of simpler days, the practical issue of short battery lives in smartphones is at least partially mitigated by the continued development of fast and wireless charging.

Connected and autonomous vehicles: progress a clear highlight

Developments and progress around autonomy (self-driving), electrification and connectivity-related innovations in the automotive industry were a highlight of many keynotes as well as displays at this year's MWC. There was a consensus that connectivity is now an important part of buyers' purchasing criteria and that higher levels of autonomy in vehicles are on track to be realised in the next decade, with 5G connectivity seen as important to their mass-market success.

Key points

- In a [keynote discussion](#), the founder of Otto (now owned by Uber), Anthony Levandowski, stressed the advances that self-driving autos can bring in terms of road safety, congestion, pollution and costs.
- Cybersecurity was highlighted by all, given the hacking threat surrounding connected and/or autonomous vehicles. While some participants believed that hacking is inevitable, the auto OEMs and tech companies believe that the risks can be mitigated with robust security and rapid and effective responses to any breaches.
- Automakers highlighted the value of connectivity both to current production and, in the future, to autonomy. As smart cities are developed in parallel to autonomous vehicles, communication with infrastructure is an important element in achieving the safety goals that autonomous driving aims to provide.
- Ford announced a partnership with Vodafone that will see 4G modems installed as standard in a select range of European vehicles. The modem will use 4G LTE connectivity to provide in-car Wi-Fi, with up to 10 devices able to connect at once. It will also hook up to Ford's Connect and FordPass services, allowing drivers to perform a range of functions remotely.

Viewpoint: Connectivity now accepted as required in new vehicles; autonomy on the way

Connectivity in vehicles is central to the evolution of smart cities, promising greater safety, efficiency in the use of transportation infrastructure, and lower carbon emissions. All of the automakers at MWC agreed that connectivity is now an essential part of consumers' thinking in purchasing new cars; manufacturers such as BMW, Ford, GM, Jaguar and Volkswagen indicated that onboard connectivity and digital services are now mass-market.

There is still debate in the industry around the level of connectivity needed in autonomous vehicles; Alphabet's Waymo autonomous driving unit believes connectivity in vehicles opens them up to cybersecurity threats. Connectivity in some form is, however, essential to the best functioning of vehicles in autonomous mode, particularly when vehicles capable of full autonomy reach the mass market. While it will be important to have excellent sensors and extremely precise mapping constantly available to the vehicles, their ability to communicate with one another as well as public infrastructure is essential to improving safety and efficiency. Low-latency 5G connectivity will be particularly important, as demonstrated by some auto OEMs and tech companies, although other forms of connectivity, such as V2V and mesh networks, may achieve similar results.

The issue of security is an extremely important one for the industry to address, regardless of the level of connectivity vehicles have. Robust security and rapid and effective responses to any breaches will be necessary to gain government and, particularly, public approval of high-level autonomous vehicles on public roads.

The introduction of fully autonomous vehicles on the market is likely to occur in the next decade, though there was no consensus on when this will be. Ford is the most aggressive automaker, expecting them to arrive by 2021, while most expect introduction by 2030.

Virtual reality: content key to driving mass-market adoption

Virtual reality (VR) was everywhere at MWC. With a wide range of headsets already available, many stands took the opportunity to showcase their VR and augmented reality (AR) technology and content. While gaming remains the primary use case for consumer VR/AR, there was a much greater amount of content related to commercial VR and industrial AR at the show. As we move beyond the hype cycle, a new range of exclusive content must be designed for VR and AR to achieve success.

Key points

- With no major headset announcements, vendors' attention focussed on the use of peripherals to enhance the VR experience. Samsung introduced a controller for its Gear VR headset, enabling a more intuitive user experience, particularly for gaming, and bringing it in line with other products that include one such as Google Daydream View and HTC Vive.
- Nokia and BT announced they will research how the use of 5G can support future VR services. The research will assess how the low latency and high bandwidths of 5G can enable new experiences such as fully immersive live sport or entertainment in high-definition VR. Meanwhile, Intel demonstrated the potential of VR in the 5G era by streaming 8K 360-degree video to two VR headsets via a fixed wireless connection.
- HTC showcased various VR concepts for its headset, including a model creator that allows a user to create a design in a VR environment and print it using a 3D printer. It also demonstrated a spray-painting simulator for training purposes.

Viewpoint: Virtual reality - moving beyond user-generated video content

VR and AR have the potential to be the next major computing platform. There are, however, a number of issues to deal with that will define whether this happens and, importantly, the pace of adoption. These include smaller and cheaper headsets, software adjustments to avoid nausea, ultra-high bandwidth connectivity (realistically above 1 Gbps) and content designed for the medium (as opposed to repurposing existing video content, a lesson from the failed 3D TV foray). The hardware component remains in the works and was de-emphasised relative to its front-and-centre role in 2016, with focus shifting to content at this year's event.

While gaming was the initial use case for VR, content is shifting towards broader video formats - both YouTube and Facebook launched live 360-degree video streaming during 2016. Short-form VR content in various forms is emerging including the creation of studio-backed VR mini-series (such as 'Invisible'), documentaries (produced by Ryot) and sports clips. Major media corporations are also starting to explore the viability of producing new VR content. Indeed, during a keynote speech at MWC, Netflix CEO Reed Hastings stated that if virtual reality is to take off, then the company will adapt to it.

Beyond home entertainment, companies were keen to highlight the VR/AR potential in industrial applications. In remote maintenance, for example, AR can enable real-time connection between remote experts and field service engineers. VR apps can and will increasingly be used to supplement education and training in a variety of fields including surgery (as demonstrated by FundamentalVR), engineering and aerospace. For industrial AR to take off, it must address challenges around content, hardware and particularly interaction. A smartphone or tablet will have limited use in an engineering world where use of touch interfaces is restricted by wearing industrial gloves.

Chatbots and digital personal assistants take centre stage

Chatbots and voice-activated personal assistants were key topics over the course of 2016, and for the first time emerged as key focus areas at Mobile World Congress.

Several operators announced chatbot customer-service assistants, with other players announcing their own Alexa-style personal assistants accessed through apps or home speaker devices. Chatbots and digital assistants are clearly set to be a key technology battleground for 2017.

Key points

- Google looked to boost the profile of its Google Assistant, announcing that English and German versions of the assistant would soon be available on all phones running versions 6 or 7 of the Android operating system.
- SK Telecom showcased its NUGU virtual assistant, an Alexa-style home assistant that supports a range of third-party service and hardware providers.
- Both Telefonica and Deutsche Telekom announced chatbot-based customer-service agents, named Aura and Tinka respectively. Telefonica has positioned its assistant as a way for consumers to pool their personal data and control how this is used by third-party services.
- Korean messaging operator Line is to launch [Clova](#), another Alexa-like voice assistant with interfaces through an app and a speaker called Wave.

Viewpoint: Will a single platform emerge to dominate the chatbot and personal assistant ecosystem?

Voice interfaces attracted less discussion at MWC than chatbots, reflecting the reality that voice is simply one user interface (alongside text) through which to access the underlying technology – namely, AI-powered by machine learning and natural language processing. Personal assistants are emerging as a key use case of this technology, with the landscape looking increasingly crowded. Players from across the ecosystem are looking to compete for the coordinating role at the heart of the consumer experience.

There was overwhelming acceptance at the event of the inevitable shift of focus for brands and corporates to chatbots (often referred to as ‘conversational commerce’), reflecting the need for brands to go where consumers are, even if many companies remain uncertain at this stage of the eventual outcome. Many of the use cases will be well known, such as around customer service and commerce; one commentator suggested that chatbots are merely a “new front end on existing back ends”. However, the true potential of chatbots will require further advances in AI and machine learning. Industry experts acknowledged the challenges still to be overcome for machines to understand human conversation, particularly via a voice interface.

As in other areas of the digital economy, a major discussion topic at MWC was the extent to which one platform will emerge as the dominant platform for chatbots, personal assistants and other consumer engagements. The value of messaging bots and digital assistants will increasingly lie in their integration with a broader platform and access to user data, so that the bot can easily access information around the user’s identity, past behaviour and payment details in order to provide informed and relevant ‘answers’. Several Asian markets such as China are already seeing dominant platforms emerge for chatbots, while Facebook and its Messenger platform is already gaining critical scale in many western markets.

Digital payments expand in reach and innovation

Mobile and digital payments were an important theme at MWC, with established players and start-ups announcing new services to improve consumer experience and continue the growth of digital payments and mobile money. There have now been over 500 million mobile money account registrations in 92 countries, with almost 174 million active users over a 90-day period (GSMA). Several announcements focused on the expansion of existing payment services into more markets, while others highlighted new concepts and partnerships to enhance mobile payments capabilities.

Key points

- Visa is widening its global payments capabilities, announcing that its mVisa QR-based payment service will be available in more countries to provide simple, secure point-of-sale and e-commerce transactions. The company also announced the expansion of its Everywhere initiative, which challenges start-ups to bring digital payments to IoT.
- MasterCard has teamed up with Oracle to offer a streamlined digital payments service for the retail and hospitality sectors.
- Mahindra Comviva is helping mobile money operators increase user engagement with a new service that enables relevant offers and promotions to be delivered automatically to users' mobile devices.
- Messaging is poised to become the new foundation for building platforms and ecosystems, with several players including Google adding new features to their messaging apps and enabling conversational commerce and/or e-commerce via messaging apps.

Viewpoint: Greater availability and innovation to deepen engagement

Making digital payment services more widely available to users and more convenient for merchants to deploy is an obvious but vital strategy to sustain the growth of mobile payments. The expansion of the mVisa payment service to 10 new countries, including Egypt, Indonesia, Pakistan and other developing countries, is a good example. The service still uses QR code technology, which is old but flexible, meaning merchants do not need to invest in costly point-of-sale infrastructure. Meanwhile, Visa's expansion of its Everywhere initiative into Europe plays into the company's R&D in IoT payment applications and further underlines the importance of innovation in providing strong user experiences.

The overarching theme of seamless digital payment experiences was accentuated by MasterCard's partnership with Oracle. The tie-up allows for improved features on MasterCard's retail and restaurant apps, improving the user payment experience. Other key announcements, such as Mahindra Comviva's launch of its Mobilytix Customer Engagement for Digital Platforms, continued the theme of deepening engagement levels among those using mobile money by providing relevant incentives.

Several chatbot demonstrations and concepts utilising contextual and intuitive conversation (such as OpenMarket with Virgin Trains) reflect the growing influence of commerce in messaging platforms. Messaging players are executing on their strategy of creating a new platform for e-commerce and monetising their user bases. Companies and brands are looking at messaging platforms as a primary platform for 24x7 customer relationships. However, most companies have yet to move towards messaging and conversational commerce. Advancements in chatbots will help, but easy and secure integration of payments is the missing ingredient required for conversational commerce to flourish. Mobile payments and financial services will then be set to become new sources of revenue generation for messaging apps in the coming years.

AI: use cases grow but mass adoption still to come

For the first time machine learning and artificial intelligence (AI) were both strongly represented at Mobile World Congress, with AI an enabling technology supporting a range of new use cases across industries. These included messaging platforms, digital personal assistants, robotics, health, entertainment, smart cities and networks.

The primary focus areas for AI and machine learning were improving user engagement, humanising interactions with machines, gaining efficiencies through self-optimisation and enhancing human productivity through cognitive computing. Nevertheless, hurdles remain along the path to mass adoption of AI.

Key points

- SoftBank Chairman and CEO Masayoshi Son highlighted the concept of singularity, when artificial intelligence will surpass the intelligence of humans. He suggested that in 20 years' time, 'the chips in our shoes will be smarter than our brains'
- There were a host of announcements around new digital assistants and chatbots (see *Page 7*). Telefonica's Aura assistant was among the most ambitious of the operator moves. Aura is part of the company's efforts to develop what it calls a 'fourth platform' based on AI.
- Roborace unveiled the Robocar, an electric race car that is driven autonomously by AI software, with teams competing to develop the best machine learning algorithms.
- Eirteic, Cardinality, Telefonica and ZTE are all using machine learning algorithms to improve network efficiency.
- Orange Healthcare emphasised how software-based medical diagnostic tools can be more accurate than human diagnosis, and offer support in patient treatment.

Viewpoint: Key limitations are restricting mass adoption of AI

We are already familiar with machine learning algorithms analysing and describing images, detecting and describing motion, and differentiating between individual faces and voices. Artificial intelligence is able to combine all of these cognitive services and more, highlighting the significant potential and range of use cases. AI and big data can change not just how people use mobile technology but how machines and companies interact with people.

A prime example of how AI can improve people's lives is its application in the health industry. AI will enhance patient engagement through personalisation of services and will efficiently deliver actionable insights through the use of machine learning algorithms for the automatic classification of diagnostic images. Intelligent wearables will make it easier to prevent pandemic diseases by analysing the travel histories of patients, providing them with useful information to minimise the risk of exposure to local diseases, and alerting doctors where there are signs of illness for prompt, personalised medical treatment.

Despite the progress to date, there are still obstacles to the wider adoption of AI-driven technology and services. The first issue concerns the current capabilities of the underlying AI itself, with many applications still requiring human intervention or supervision to work effectively. Secondly, in order to attract interaction and win consumers' trust, AI-powered machines and personal assistants will have to develop their human side - to be entertaining, sociable and conversational. Finally, data privacy remains a big concern because such algorithms, in order to be effective, will need access to very granular personal information.

Edge computing and slicing – are networks sexy again?

Network virtualisation was again a major topic at MWC. In 2016, discussion was more high level and exploratory but this has shifted to hard implementation and roadmaps. The issue is essentially about bringing cloud principles to mobile networks, enabling a decentralised architecture operating on a lower, long-run cost base and with the potential for incremental monetisation of the enterprise segment pre- and post-5G (so-called edge computing).

Key points

- All indications are of an acceleration along the evolution curve of NFV from discussion to hard implementation. Equipment vendors – Huawei, Ericsson/Cisco and Nokia – announced a range of operator wins and partnerships. Operator reporting also alludes to the transition; AT&T virtualised 34% of network functions in 2016 and plans to reach 55% in 2017, while SFR (France) has reached 50% and forecasts an increase to 80% by the end of 2017.
- Virtualisation has initiated broader discussion on redesigning entire network architectures. In a reverse of original build-outs in the 2G/3G era, this is software-driven (much of it open stack), with general consensus around standardising hardware from vendors to achieve scale economies and avoid fragmentation.
- Softwarisation has enabled operators to decouple the control (authentication) and user planes (data and voice streams). One major implication of decoupling is that network processing power and intelligence can be pushed out to the edge, improving speed and latency, and offering the possibility of new use cases (see *Viewpoint*).
- Several ecosystem alliances were announced or given airtime (including Facebook with TIP and Google with CORD), underlining the collective interest in improving network economics pre-5G.

Viewpoint: Four key observations on bringing cloud principles to networks

Firstly, edge computing should be seen more as a story of new use cases than cost reduction. In principle, by decoupling the control and user planes of the network, an operator can reserve network slices with higher speed and lower latency at guaranteed reliability levels given closer proximity to end users. Live demonstrations focused on autonomous vehicles, but more realistic use cases are in the enterprise segment, such as servicing robotics in factories and hospitals, and live sporting or music events with high audience densities. NFV in the core is not in itself a route to significant cost reduction. Deutsche Telekom highlighted that RANs are still 70% of network capex. Decentralising data centres to the edge and the integration of fixed and mobile network transmission are required for larger scale reductions, which will take years and in any case need to be weighed against incremental investments for 5G.

Secondly, edge computing helps lay the groundwork for 5G but it is not happening *because of* 5G. Long-term cost savings (from software innovation, cloud, open APIs) and new monetisation opportunities hold for 4G as much as 5G. This is particularly true for smaller operators that face the perennial challenge of having to make network investments on a par with incumbents but against a smaller revenue base; it is not surprising that Sprint was a major voice at MWC in this regard.

Thirdly, decentralised networks with functionality increasingly moving to the cloud create new security risks. This generated much discussion at MWC but with few answers.

Finally, ecosystem alliances underline a larger shift towards pooled R&D in the network space between internet companies (notably Facebook and Google) and operators. It is in their mutual interests for network economics to be improved given that video and eventually AR/VR in the 5G era will drive data loads ever higher.

Spectrum: augmenting 4G, prepping for 5G

The spectrum debate continues to be mostly based on raising capacity for LTE given inexorably rising data traffic, driven by video on smartphones. Licensed Assisted Access (LAA) is the latest way of using carrier aggregation to augment LTE speeds, with multiple operator-vendor partnerships using MWC to showcase this. 5G will likely require an even more varied and balanced use of spectrum. However, there is a general consensus that rather than 'big-bang' transformations, current LTE upgrades will serve as a pragmatic bridge to the Gigabit era. Unlicensed spectrum will assist the licensed bands as a supplementary capacity reliever for mobile operators at the final point of delivery, but it is the exclusive bands that will remain key for 5G deployment.

Key points

- Several operator-vendor partnerships were on display to showcase LAA: one of the most notable involved AT&T, Ericsson, Orange and Qualcomm, aggregating 80 MHz of spectrum and claiming to be the first capable of reaching 1 Gbps (in situ).
- Spectral requirements for 5G will be more onerous still given the Gigabit baseline and ultra-low latency. There is consensus that multiple and varied use of spectrum bands will be required, with sub-6 GHz and several bands within the 24–86 GHz range. There is far less agreement, however, on which those will be, with formal designations to be established at WRC in 2019.
- Part of this comes down to the (likely) increased cost structure of small cell networks in dense city centres to support high-frequency mmWave spectrum. Cross-sector initiatives that effectively pool R&D to rethink network architecture are increasingly seen as part of the solution. Facebook's TIP is probably the most developed, and revealed 11 new members at MWC (including BT, Millicom, Zain, Microsoft and Dish), as well as two acceleration centres in the UK.

Viewpoint: Pragmatic bridge building rather than 'big bang'

Like its LTE-U predecessor, LAA pairs licensed with unlicensed spectrum carriers to increase bandwidth and speed. But LAA works in most regions as opposed to LTE-U's limited footprint. Operators have used carrier aggregation before, but it has become more pressing given exponential data traffic growth and the awkward position of being between the LTE spectrum releases of 2011-14 and 5G standards that will not be in place until 2019. The AT&T-Orange LAA trial purports to reach a theoretical speed of 1 Gbps in the lab, with SKT not far off at a 900 Mbps peak in its demo of tri-band carrier aggregation LTE with Ericsson. This is music to the ears of marketing departments, but the significance of LAA is more pragmatic: even if realised speeds are 50% of trials, operators can conceivably deploy 5G-like experiences for 'enhanced' mobile broadband using existing LTE spectrum reserves before 5G becomes a reality.

There is consensus that more spectrum bands will be needed for 5G, but less so on which ones are optimal. Lower range spectrum supports longer range transmission but with less capacity, and vice versa at higher frequencies. The foray into high-frequency mmW spectrum is likely to entail a significant cost rise to support densified small cell networks in urban areas. The most likely scenario is a mix of sub-1 GHz and 1-6 GHz for longer range transmission, and above 24 GHz frequencies for higher density urban settings. This entails a mix of licensed and unlicensed, with particular implementations different for each region depending on allocation plans and commercial decisions of operators. For the purpose of 5G in the US, for example, the FCC has adopted licensed frequencies in the 28, 37 and 39 GHz bands, along with the 54-71 GHz range of contiguous unlicensed spectrum. Both AT&T and Verizon have or plan to trial fixed/wireless solutions at 28 and 39 GHz but this is likely only to work over relatively short distances. Vodafone, by contrast, regards sub-6 GHz as optimal. Similarly in Japan, NTT Docomo confirmed its plans to deploy 5G in the 3.4-3.8 GHz and 4.4-4.99 GHz bands in addition to the higher frequency 27.5-29.5 GHz range.

IoT: focus shifts to industrial, but challenges remain

In previous years, the IoT focus at MWC has been on consumer applications. This year, the narrative shifted to showcasing enterprise and industrial use cases, as vendors sought to promote IoT's role in industrial transformation. As the industry is on the cusp of converging enterprise IT and operational technology systems, a myriad of challenges remain around fragmentation; a lack of interoperability across multiple standards and platforms; high deployment costs and concerns over replicability; identifying business models and ROI; and security.

Key points

- Ericsson, Intel and China Mobile showcased an NB-IoT-enabled smart factory.
- AT&T has collaborated with Current (GE's start-up business), combining LED and solar energy technologies with networked sensors and the Predix IoT platform to bring efficiency and productivity gains to commercial buildings and industrial facilities.
- Harman and VMware have partnered to deliver IoT solutions for enterprise customers in industrial, retail, building management, automotive and energy efficiency industries.
- Robots were present across the show flow, including Nokia and ABB robot-learning demos but also Daqri's Smart Helmet, an AR helmet that can be deployed in industrial settings.
- Qualcomm, Nokia and General Electric demonstrated a private LTE network in unlicensed spectrum for industrial IoT use.
- Ericsson and Intel launched the 5G Innovators Initiative (5GI2) to explore, test and innovate with 5G network and distributed edge technologies. It was joined by GE, Honeywell and UC Berkeley as the first participants; 5GI2's initial focus is industrial IoT.
- Dell introduced the new Edge Gateway 3000 series for industrial use cases.

Viewpoint: Challenges must be overcome to achieve industrial internet vision

The opening keynote this year outlined a vision of how ubiquitous connectivity, data and AI can drive the Fourth Industrial Revolution. This will see business model innovation in manufacturing by combining advanced robotics, AI, sensors, cloud computing, IoT, 3D printing, data analytics, platforms and connected devices to increase productivity and reduce time wastage. More broadly, the industrial internet refers to connecting objects in the industrial context across more sectors, and promises new economic growth by reinventing key industry sectors.

During the show, ecosystem players discussed a number of challenges to achieving this vision, signalling that we are still in the inception phase. Long replacement cycles, difficulties integrating new technologies with existing legacy systems, and a lack of interoperability across business lines/units and IoT platforms remain key issues limiting deployment. There also has to be a clearer return on investment to justify the high upfront costs required, especially as many solutions are sold to address specific vertical needs, which reduces their replicability and therefore increases cost. Enterprises must also improve how they analyse, drive business decisions from and monetise the data they collect.

There are clear benefits to bringing IoT into an industrial setting, including increased business efficiency, greater innovation and improved visibility across the organisation. Meanwhile, GE estimates that a 1% improvement in industrial productivity could add \$10-15 trillion to global GDP over the next 15 years. This all points to the potential of industrial IoT; however, ecosystem players must address the wider issues around security, data privacy and interoperability before the industrial Internet can become a reality.

IoT: LPWA standardisation spurs commercial launches

With standards finalised by 3GPP for NB-IoT (Narrowband IoT), LTE-M (LTE for Machines) and EC-GSM-IoT (Extended Coverage GSM IoT), operators and vendors at MWC took the opportunity to showcase licenced LPWA applications. While last year the focus was on proof of concept, engaging the ecosystem and educating the market on the benefits of LPWA, this year the emphasis shifted to use cases spanning multiple industries.

Key points

- There are already more than 30 licenced LPWA commercial pilots either underway or completed, with commercial launches in over 20 countries already planned for 2017.
- Various LPWA solutions were on display across the conference halls, highlighting industry support for these technologies. GSMA's Innovation City hosted a dozen demos alone, from NB-IoT smart parking to LTE-M connected waste management and EC-GSM-IoT environmental measurements for agriculture and insurance, including an NB-IoT tagged seal, which is currently prototyping the technology in Scotland as parts of efforts to conserve wildlife.
- Several operators across Europe and Asia are focusing on NB-IoT. Meanwhile, nine large MNOs including AT&T, Orange and Telefonica announced plans for LTE-M networks. Some operators are taking a multi-technology approach. For example, Orange plans to use LTE-M in Europe while rolling out EC-GSM-IoT in Africa; China Mobile intends to roll out both LTE-M and NB-IoT; and a number of operators are supporting both LTE-M/NB-IoT (licensed) and LoRa/SigFox (LPWA using unlicensed spectrum), such as Telefonica and Telstra.

Viewpoint: NB-IoT and LTE-M gain momentum in 2017

As operators look to diversify into IoT to stay relevant and increase revenues, MWC saw a flurry of NB-IoT/LTE-M activities. Luke Ibbetson of Vodafone, who chairs the NB-IoT Forum, encouraged the industry to look beyond initial smart metering use cases. Indeed, this year the LPWA demonstrations spanned multiple industries; for example, Ericsson and China Mobile demonstrated smart screwdrivers for factories. AT&T, which plans to cover the US with its LTE-M network within the next few months, is looking to address multiple vertical needs using LTE-M, in the areas of security, health and wearables. Chris Penrose AT&T's president of IoT said "We see LTE-M as a game-changer (...) We will get much deeper in-building coverage with LTE-M, so we can connect things that never were connected before".

2G/3G/4G networks are already connecting M2M devices; there are 430 million cellular M2M connections globally. 3GPP standardised (licenced) LPWA provides a solution for operators to connect machines that require limited data transmission, long battery lives and indoor coverage while reusing their existing networks. Although standards have been agreed, there are still challenges ahead that need to be addressed. To truly realise its potential, the technology should support very low-cost deployments both in terms of module cost and network upgrades. In addition, full interoperability, security and roaming agreements for location-tracking devices are essential.

According to industry estimates, there will be close to 3 billion LPWA connections in 2025. Although unlicensed LPWA players such as SigFox and LoRa have had a head-start, should the challenges above be overcome, licensed LPWA could be the winning standard.

IoT: a joined up approach to security

Security was a prominent theme at MWC this year, particularly in the area of consumer IoT. The IoT ecosystem is growing rapidly but growth in the industry has led to increased malicious attention, resulting in a 450% rise in attacks on IoT devices over the last year alone, according to SoftBank. Such attacks cause economic damage and harm public perceptions of the industry. As a result, IoT security solutions were conspicuous throughout the event.

Key points

- SoftBank CEO Masayoshi Son outlined how the ARMv8-M architecture will increase security in its IoT solutions and help counter the rise in cyberattacks.
- AT&T discussed the IoT Cybersecurity Alliance announced earlier in February. The partnership between AT&T, IBM, Nokia, Palo Alto Networks, Symantec and Trustonic aims to drive awareness of ways to better secure the IoT ecosystem.
- Soracom announced the launch of its IoT connectivity platform in Europe with a strong focus on its security capabilities, claiming securing devices and data is the most critical role of a platform.
- Several operators including SK Telecom and T-Mobile exhibited secure IoT gateway solutions for the connected home.



Viewpoint: Industry bodies are key to securing the IoT ecosystem

The IoT sector is increasingly threatened by the risk of cyberattacks. AT&T has reported a 3198% rise in connected device vulnerability scans in the last three years, while it is estimated that the cost of cyber-crime will rise to \$2 trillion by 2019 (Juniper Research). In addition, IoT devices are increasingly being used in DDoS attacks such as those against Netflix and Twitter in 2016.

At the same time, the majority of connected devices have inadequate security. One study by Symantec analysed 50 smart home devices and found that none of them enforced strong passwords, used mutual authentication, or protected accounts against brute-force attacks.

Securing the IoT ecosystem is challenging. It requires end-to-end protection; a single weak point will render an entire system susceptible to attack. Research carried out by Avast found that of 132 million routers tested, 41% could easily be hacked. Once infiltrated, many of the devices attached to the routers can be manipulated.

In addition security solutions must be interoperable so that elements from different providers can be integrated seamlessly and across the value chain. To achieve this the industry has to co-operate, as Macario Namie, Head of IoT Strategy at Cisco Jasper said: “IoT security takes a village. No one provider covers everything.”

Several organisations are working on implementing cross-industry standards and promoting collaboration in the IoT space, such as the AllSeen Alliance and Open Connectivity Foundation. However, the launch of the IoT Cybersecurity Alliance represents a focus on cross-industry collaboration. In addition, the GSMA has already published the IoT Security Guidelines document, a set of best practices for the IoT industry. As IoT connections proliferate and security grows in importance, a coordinated approach from across the industry will be essential.

Big data: at risk of becoming bloated data

Big data was a key theme at MWC, underpinning smart cities, IoT and AI. With 90% of all global data generated in just the last two years and IoT devices expected to grow to 27 billion connected devices by 2020, big data opportunities are rife. The key challenge is to ensure data harmony – measuring data points from similarly purposed devices via a single model, regardless of manufacturer – vertically and horizontally across sectors, to support the platformisation and growth of big data use cases.

Key points

- The GSMA announced the release of the *Big Data for Social Good* initiative, leveraging big data from 16 of the world's leading operators, to provide the ecosystem with tools to help tackle epidemics and national disasters.
- Experts pressed the importance of data harmony for future IoT innovations. Orange and the GSMA demonstrated their standards for data harmony and common APIs to enable future IoT big data innovations, while DataTorrent discussed data harmony and seamless systems integration to support services reliant on big data.
- Operators envision a data-centric future, leveraging big data aggregations to enable IoT, AI and data-driven innovations. Telefonica announced its vision for a data-enabled cognitive user product and service experience, Aura. AT&T has teamed up with local governments to create an ecosystem smart city that enables real-time decisions relating to mobility management, infrastructure servicing and defence coordination.
- As demonstrated by Tele2, KT and Orange, there were a number of pilots exploring IoT and connectivity to optimise consumption of public services, improve mobility and manage the impact cities have on the environment.

Viewpoint: Putting together the pieces of the big data puzzle

Big data has been a major topic of discussion in recent years as organisations prioritise digital transformation, digitise customer experiences and farm data to deliver deeper customer relationships. With big data increasingly at the core of organisational customer relationship management (CRM) processes, a new challenge arises: big data is moving from individual organisations to the wider ecosystem. IoT devices will drive exponential data production, open APIs will promote data innovation, and organisations will leverage the early success of AI to drive increasingly more organic customer interaction. The challenge is the integration of huge quantities of different types of information. To do this, the industry has to ensure harmony in data standards to enable big data to scale successfully in bigger ecosystems such as the smart city.

While MWC demonstrated the successful use of big data within AI ecosystems and data-capture devices, the latter were based on harmonious data standards. Clearly defined models and templates were in place prior to data being stored and analysed on organised platforms – with common standards, APIs and endpoints. This allows data to be efficiently processed by developers and service providers, removing technical barriers (e.g. data aggregation, cleansing) and speeding up the development of services relying on big data processing.

Though there are advocates, such as Orange, Telefonica and DataTorrent, pushing for data harmonisation, the discussion needs to be accelerated if standards and solutions for harmonisation are going to cope with the exponential rise in the quantity of data from a plethora of IoT endpoints.

Personal data: users set to get a slice of value from their data?

Users are beginning to understand the importance and value their personal data holds in the digital economy, but what they probably don't get is any part of the \$1 trillion personal data market estimated by the industry. However, this appears to be changing as innovative personal information management systems (PIMS) grow and attempt to bring consumers a slice of that value. PIMS companies have been around for a few years but are gaining a higher profile as they help users to centralise and analyse their personal data from utility bills to posted photos, and even control which companies gain access to different categories of their information.

Key points

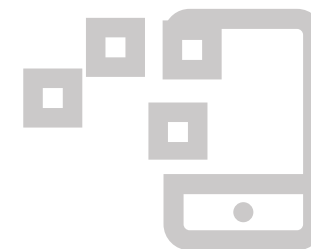
Three PIMS companies were on stage at MWC 2017:

- Jon Fisse, founder of data-for-reward-points company, Atomite, emphasised the opportunity mobile operators have if they champion users' control of their own data for consented use by ad networks. Jon pointed out: "to ad networks that do digital targeting, operator subscriber data that is verified and permissioned is Nirvana, exponentially more valuable".
- Julian Ranger is founder of Digi.me, a company that repatriates personal data to a secure personal library enabling the user to search, curate and exchange it with businesses in return for offers. He suggests companies might prefer to go direct to the user: "data that companies get from third parties can be up to 50% wrong, may not meet data protection rules, and is expensive".
- Katryna Dow is founder of Meeco, a company that enables users to manage their personal data and share it on their terms with trusted third parties in exchange for tailored offers. According to Katryna, "87% of participants in Meeco lab panels were interested in using their data as an asset for value exchange with businesses".

Viewpoint: Privacy and personal information tools drive data sharing and opt-in

Orange's Ludovic Lévy believes "the more subscribers trust, the more they share" - a belief that is behind a number of Orange's initiatives including: a 'trust badge' that flags trusted applications; a personal data management tool for users; and a piloted security suite to assist users in combatting malware. But if increasingly privacy-aware users are going to act on their concerns, they need more of these readily available and easy-to-use privacy tools.

The arrival of the EU General Data Privacy Regulation (GDPR) in May 2018 is likely to support the emergence of these tools while disrupting the data broker business model. The GDPR affects companies globally if they process data from EU residents. Laws restricting data collection to the use case for which consent has been requested could mean the ad tech and data broker industries may not be able to process and use personal information without explicit consent - or at least if challenged will need to prove they have 'compelling legitimate grounds'. This will give users a stronger right and easier way to opt out of data collection. The potential for PIMS to offer consented, self-curated and high-quality data sets may not go unnoticed by the ad tech and data broker industries, potentially forced by the GDPR to look for alternative data sources. The success of these systems will rely on clear identification of consumer use cases, an easy user experience and partnerships that can enhance their value and drive their distribution. Among other companies, mobile operators are sure to be interested in the potential for PIMS to add value to their existing authentication and attribute services.



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