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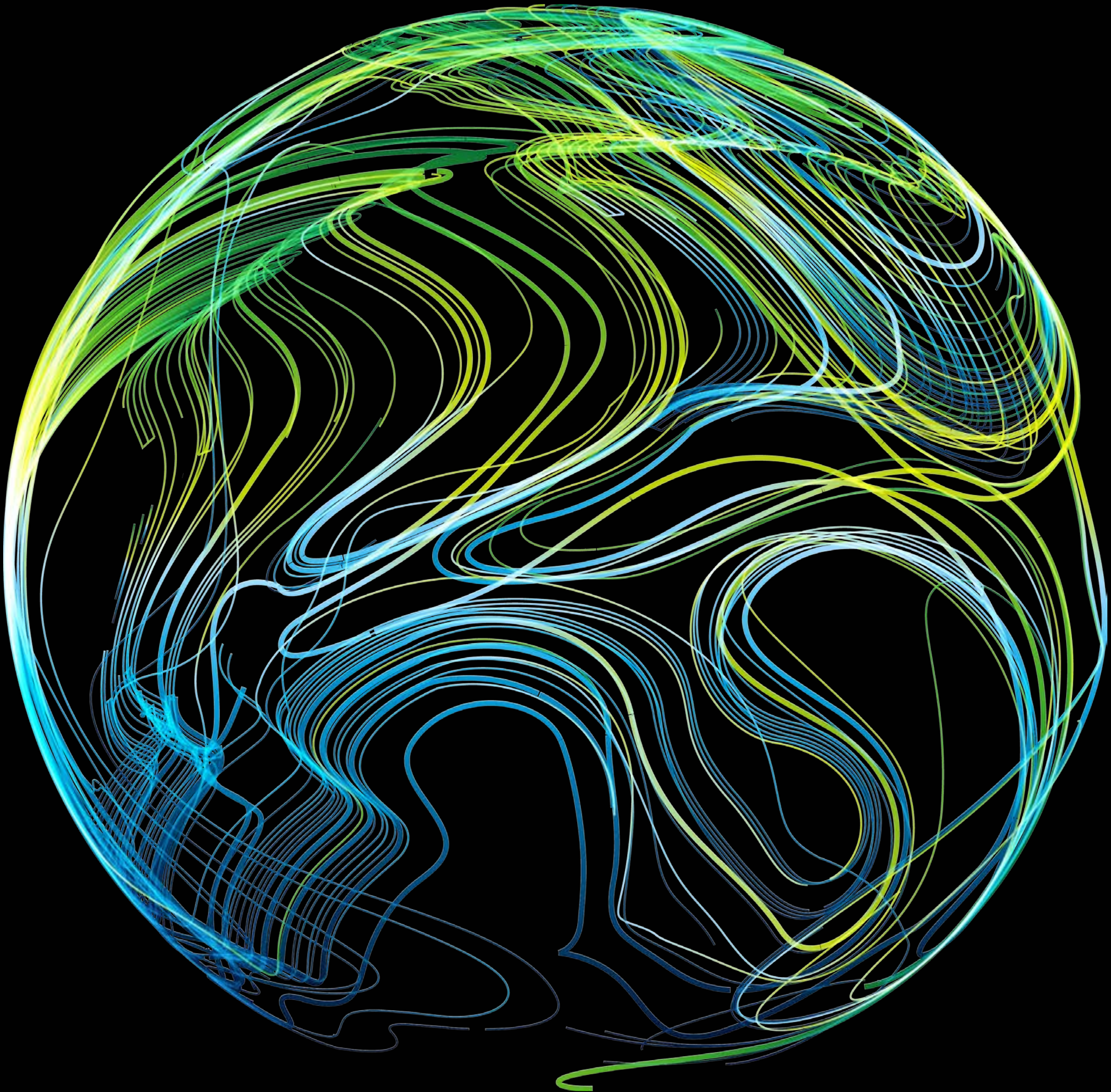

2017 Technology, Media and Telecommunications Predictions

Middle East edition

Foreword

Welcome to the 2017 edition of Deloitte's Predictions for the technology, media and telecommunications (TMT) sectors.

For the first time in our 5 years of releasing our Middle East edition, we are including predictions for all three sectors together, and not splitting them into different sub-industries. This, by itself, is a reflection of the exciting industry we are in. An industry that continues to blur the boundaries of innovation, and reshape how operators, media players and technology companies collaborate and interact in an increasingly integrated market place.

Across the global and regional predictions, we believe that the distinction between sectors is fast becoming obsolete. The introduction of dedicated machine learning capability to smartphones is relevant across all industry sectors, not just the technology or telecommunications verticals. The transition to 5G and resulting implications on machine to machine communication is a critical enabler to new technology adoption, starting with self-driving cars. IoT itself is the epitome of this borderless ecosystem with operators and technology companies working closely together to shape the cities and lives of tomorrow. Cybersecurity is an evergreen topic in the region raising threats to media companies and Telcos equally, and requiring cross sectorial regulations and safety measures.

With smart cities and nations so high in the agenda of the Middle East countries, our region is at the forefront of this borderless market place, with regional Telcos talking more about AI and IoT than network expansion. In this day and age, breaking borders, albeit at industry level, is a refreshing twist. 2017 promises to be yet another exciting year for the TMT sector. We wish you all the best for this year and trust that you and your colleagues will find this year's predictions a useful stimulant in your strategic thinking. We look forward to discussing them with you.

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5G: a revolution in evolution, even in 2017

Deloitte Global predicts that significant tangible steps towards the launch of 5G, the fifth generation of cellular networks, will take place in 2017.

First, enhanced 4G networks, namely LTE-Advanced (LTE-A) and LTE-Advanced Pro (LTE-A Pro), which incorporate many of the core 5G network components, will be commercially available: by end-2017, over 200 carriers are likely to be offering LTE-A across some of their network, and over 20 should have LTE-A Pro networks[102].

Second, there will be continuing development of the 5G standard[103]. While 5G is likely to be the most complex and challenging of all generations of cellular network launched so far – it is an integrated framework of multiple technologies – there is an agreed plan for the creation of the 5G standard[104]. Significant steps are scheduled for every year through 2020, by which point dozens of networks are likely to launch at least a limited service[105].

Third, a few dozen of the 800 operators around the world are likely to be actively involved in trials, development and in some cases commercial deployment of services marketed as 5G, in 2017[106]. The pace of activity is likely to be an acceleration relative to prior years.

The lack of a ratified standard (the first instalment of which is expected in 2018), the dearth of commercial launches (most launches not being anticipated until 2020), the lack of any 5G smartphones this year, and even the fact that hundreds of cellular operators have yet to launch even 4G, should not be interpreted as evidence that the effort to launch 5G at the start of the next decade lacks momentum[107].

5G's enhanced performance will be pre-released in stages via two iterations of the 4G network, namely LTE-A and LTE-A Pro. Both standards will be in commercial deployment in 2017 around the world. The extent of coverage for each network upgrade is likely to vary by market, with LTE-A Pro coverage likely to be in cities only as of the start of 2017, but rolling out steadily through 2020 and beyond.

Both standards contain components of 5G networks and as such should provide an indication of what 5G may offer, for users, carriers and enterprises: significantly higher speeds, lower latency and support for low-power low-bitrate Internet of Things (IoT) devices and sensors. The experience gained from deployments of LTE-A and LTE-A Pro, as well as 5G trials, should provide much useful data that can be fed into the launch of 5G networks and applications, as most of the key technology enablers of 5G are the same. If, for example, carrier aggregation works as expected for LTE-A, it will also work for 5G.

Gigabit speeds over cellular networks

LTE-A is designed to offer maximum downlink speeds of up to 3 Gbit/s (gigabit per second) and maximum uplink speeds of up to 1.5 Gbit/s[108], while LTE-A Pro offers even faster maximum speeds of over 3 Gbit/s, and 5G should offer yet higher multi-gigabit speeds[109]. Real world speeds are likely to be about 10-20 percent of maximum speeds.

By end-2017, Deloitte Global expects tens and possibly hundreds of millions of LTE-A users to be able to access maximum speeds in the hundreds of Mbit/s (megabit per second), although in some 'real world' environments, the speed attained might be in the tens of Mbit/s: still fast, and equivalent to speeds attainable over many fixed broadband connections[110].

As of the start of 2017, Deloitte Global expects a large number of smartphones to be capable of exploiting these greater speeds. As at end-2016, over half of all models of 4G phones were LTE-A capable, permitting maximum downlink speeds of up to 150-600 Mbit/s[111]. The first mobile router capable of Gbit/s speeds over an LTE-A network was launched in late 2016[112]. This compares to initial 4G downstream speeds in the low tens of Mbit/s[113].

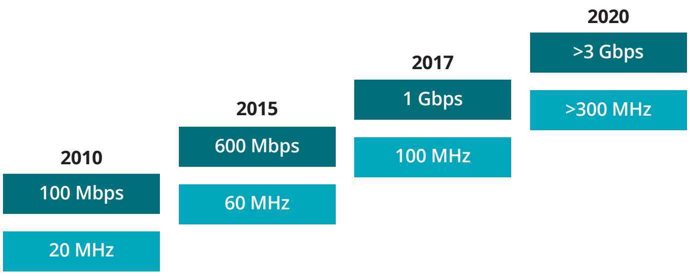
By the time wider 5G launches around 2020, a significant proportion of users should have become accustomed to obtaining and expecting connectivity speeds of over 100 Mbit/s, and in some cases significantly higher (see Figure 3[114]).

Deloitte Global predicts that significant tangible steps towards the launch of 5G, the fifth generation of cellular networks, will take place in 2017.

The higher speeds that LTE-A and LTE-A Pro are expected to support in 2017 are based on various network methodologies (see sidebar on network methodologies for more detail) that will be fundamental components of 5G, including:

- carrier aggregation, which increases the speed (as well as capacity) by combining multiple fragmented spectrum resources
- Licensed Assisted Access (LAA), which leverages disjoint bands across licensed and unlicensed spectrum
- MIMO (multiple-input multiple-output), which uses more antennas per device to be able to send and receive at faster speeds
- QAM (quadrature amplitude modulation), which improves spectral efficiency to obtain higher speeds
- relay nodes, which improve performance at the edge of each cell in a network
- beamforming, which directs a signal from a cellular base station more precisely towards each device, to deliver higher speeds.

Figure 3. LTE-Advanced Pro data rate and bandwidth



Source: Deloitte Global analysis

Higher capacity

Iterations of LTE have been designed to be able to support a significantly higher number of connected devices relative to the first release of the standard.

LTE-A Pro offers 10 times the capacity of the first 4G standard, which was 'frozen' in 2008. There are multiple approaches to increasing capacity, including:

- using significantly smaller cells. Cell size has been declining with each generation of cellular technology; LTE-A and LTE-A Pro allow for base stations to be placed in locations such as stores in shopping malls and lamp posts so as to provide local coverage[115]. Experience of deploying dense networks based on small cells is likely to be invaluable for 5G deployments which require hyper-dense networks[116]
- carrier aggregation, which increases capacity (as well as speed) by combining multiple fragmented spectrum resources. This approach can also incorporate unlicensed spectrum
- MIMO (multiple-input multiple-output), which enables greater capacity by deploying more than one antenna on the same device
- relay nodes, which provide greater capacity at cell edges and in hot-spots
- using higher frequency bands.

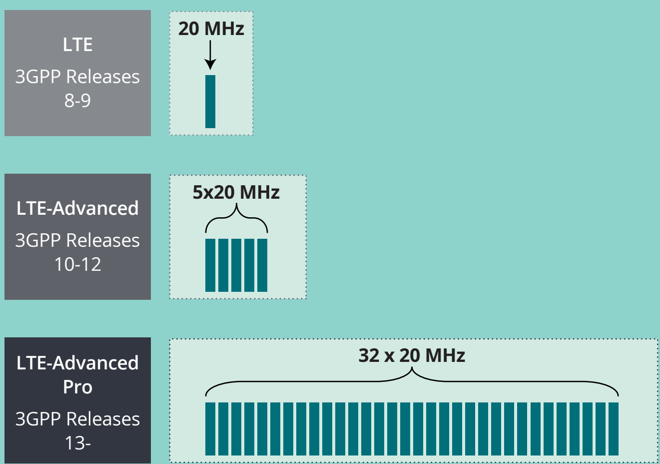
All these approaches are likely to be deployed for 5G, whose capacity is intended to be sufficient to support 100 billion devices.

Network methodologies that deliver higher speeds and offer greater capacity

Carrier aggregation: this enables higher bandwidth by aggregating multiple carriers (or channels) each of which is between 1.4 and 20 MHz wide, likely most commonly the latter in 2017[117]. The more spectrum available, the faster the speed. LTE-A supports up to five carriers; LTE-A Pro supports up to 32 (see Figure 4)[118]. LTE-A also enables the use of unlicensed spectrum, including frequencies (in the 5 GHz range) which are normally used for Wi-Fi. Combining licensed and unlicensed spectrum enables a faster connection.

LAA (Licensed Assisted Access): this enables higher bandwidth by joining together licensed spectrum with unlicensed higher frequency (5 GHz) spectrum, such as that typically used for Wi-Fi. The combination of these resources enables faster speeds.

Figure 4. Aggregation of up to 32 component carriers



Source: Deloitte Global analysis

MIMO (multiple-input multiple-output): this method enables greater spectral efficiency (getting greater usage out of the same amount of frequency), and greater capacity by deploying more than one antenna on the same device[119]. The more antennas, the faster the speed, when connecting with a MIMO-equipped access point. LTE-A Pro offers initially between 8-16 antennas, and a planned upgrade to LTE-A Pro will support up to 64. This is an evolution of the Massive MIMO capability planned for 5G and is likely to be tested in 2017 with 128 antennas[120].

QAM (quadrature amplitude modulation): this approach also enables improved spectral efficiency[121]. The higher the QAM, the greater the efficiency, the more bits per transmission and the higher the peak data rate[122]. For example, 256 QAM sends 8 bits per transmission, which is 33 percent more efficient than 64 QAM (6 bits). The latest version of LTE-A introduced 256 QAM[123]; 5G may offer yet higher bit QAM.

Relay nodes: these network components, which are new to LTE-A, are low-powered base stations which provide greater coverage and capacity at cell edges and in hot-spots. These enable networks to be based on a mix of large and small cells[124].

Beamforming: this technique, which was included in the first release of LTE, directs a signal from a cellular base station more precisely towards each device, rather than spreading it across a fixed angle[125]. 2G and 3G cell towers split coverage into sectors, so six sectors would imply 60 degrees per sector. With beamforming, the angle is 1-2 degrees wide, which enables a higher speed and longer 'beam' of signal to be directed towards a device. Beamforming is delivered via software; the antenna has no moving parts. LTE uses two-dimensional beamforming; LTE-A Pro incorporates 3D-beam forming, the net result of which is higher speeds[126].

Lower latency
LTE-A Pro additionally offers vastly lower latency (the time taken for a data packet to travel from one point in a network to another). LTE-A Pro has 600 microsecond latency compared to eight milliseconds (8,000 microseconds) for standard LTE[127].

Lower latency enables more responsive applications, but more critically makes machine control, such as of fast-moving machines, far more viable.

Lower latency is likely to be critical to any application for vehicles that uses cellular networks as part of autonomous or partially-autonomous control. In a typical application, a car would need to ping the local cell tower, be acknowledged, send a packet or packets, adjust for possible errors, and then receive the correct response. All in, on a standard 4G network, this process would take between 30 and 80 milliseconds. A car travelling at 130 kilometers per hour (36 meters per second) would travel over 2.9 meters due to latency. With 5G, for which latency is measured in microseconds, the car would move just a few centimeters. The faster that vehicles can communicate with cell towers, traffic signals, other infrastructure and other vehicles, the lesser the impact of an accident, and the greater the likelihood of an accident being averted.

The few dozen very low latency LTE-A Pro networks that will be deployed in 2017 should be able to serve as test beds for applications that are made viable thanks to much lower response times.

Lower latency enables more responsive applications, but more critically makes machine control, such as of fast-moving machines, far more viable.

Dedicated support for IoT
A further innovation that is central to 5G and introduced by LTE-A Pro is specific support for IoT devices[128]. LTE-A Pro incorporates a Low-Power Wide Area Network (LPWAN) specification that enables low bandwidth (up to 250 Kbit/s) connections to a large number of connected devices, many of which may be battery powered. This part of the network is designed to enable low power transmission (20-23 decibel-milliwatts, or dBm) so that devices should be able to last several years before batteries require replacement.

Furthermore, LPWAN is designed to operate in low frequencies (180 KHz, where the current low end of cellular network frequencies is 600 MHz) which would enable the signals to reach basement floors and deep inside buildings, permitting the connection of utility meters, boilers and other machines that are typically located below ground level.

IoT is expected to be one of the most significant new applications for 5G and one of the major drivers of new connections. The availability of LTE-A Pro networks should provide very useful feedback in 2017 and subsequent years on how best to utilize this innovation.

Backward compatibility
Global 5G deployment will likely take many years to complete fully: in some markets 5G may still be in roll-out at the end of the next decade. Different carriers in the same market may launch at different times, and each operator is likely to take several years to roll out 5G fully, beginning with cities and suburban areas and then to rural areas. Multiple iterations of 5G standards are likely to be rolled out throughout the next decades, with deployment timetables varying by market and by operator.

The highly variable pace of deployment is similar to what has happened for prior generations of cellular technology. The first 4G networks launched in 2009 but as of the start of 2017 hundreds of operators were yet to launch the service.

5G networks will be operational alongside and in conjunction with 2G, 3G and 4G networks; 5G handsets are likely to support these three generations of cellular technology. In 2017, the vast majority of countries are likely to have networks that blend 2G, 3G and 4G network technologies, as well as each of their upgrades (GPRS, EDGE, HSPA, LTE-A, LTE-A Pro). In 2017, the same user on the same network may have a 500 Mbit/s connection in some locations, and 50 Kbit/s (0.05 Mbit/s) in others. Network performance on fixed and mobile networks has become increasingly varied and this may continue into the next decade.

The bottom line

5G is likely to have a big bang impact. Its long fuse, which incorporates interim milestones in the forms of LTE-A and LTE-A Pro, has already been lit. While 5G is a significant, complex upgrade to 4G, it is not a single-step upgrade from the first release of 4G, but rather the culmination of many years of sustained upgrades to 4G networks.

Indeed, the technology building blocks for 5G readiness are being deployed in 2017, and in some markets are already in place. The foundational technologies required for 5G deployment are being widely adopted.

Building 5G networks
As operators plan for 5G and its associated road map, they should consider integrating these foundational technologies and pursue a 'core-outward' approach to ensure they are ready when 5G appears.

Carriers should be able to get a better idea of the economics and performance of deploying some of the network elements that LTE-A and LTE-A Pro share with 5G, such as 3D beamforming, carrier aggregation, and MIMO. They could gather useful empirical data on the technical challenges of using these new techniques, particularly with regard to indoor coverage.

Carriers should also be able to learn about some of the logistics for densification of the network, which requires acquiring more sites on which to place base stations. Site acquisition costs have always been significant; deploying potentially millions of cells requires a new approach to deployment that offers substantially lower cost per site[129]. Carriers and organizations should also get a better idea of the extent to which IoT demand can be stimulated by the offer of a dedicated low-power, low-frequency network.

Marketing 5G
Deploying 5G networks will be a major challenge; selling it will be another. Deploying faster networks is costly, estimated at $63.1 billion (€57 billion) for 5G roll-out in the EU alone[130]. However, the availability of higher speeds will likely reveal uses we cannot currently imagine and needs people did not realize they had. There will likely be multiple 'killer apps' for 5G. Consumer demand for all goods and services seems infinite, and connectivity is a subset of that.

5G entails multiple significant upgrades, rather than a single one. Much work will be required to map evolving network capabilities (in terms of performance, reach and price) with useful applications, with utility including that derived from entertainment. Cross-functional teams, comprising engineering, customer experience, marketing and other teams at carriers should be closely aligned, and should also work closely with a wide range of hardware, software and other vendors whose offerings would be enhanced by 5G.

The industry – vendors and carriers – needs to communicate widely the core benefits of a significantly improved cellular network.

Connectivity is a core enabler of the modern economy; enhanced connectivity is likely to nurture and disrupt a significant part of global economic output for decades to come. 4G is estimated to have accounted for up to $150 billion in economic growth and up to 771,000 jobs in the US alone[131].

The industry should also market the ingenuity of the technological breakthroughs that 5G represents: the fifth generation of cellular networks will be the most sophisticated ever. It is founded on multiple technological breakthroughs that, if explained using readily understandable language, would likely impress. The public has been fascinated by innovations such as virtual reality, smart watches and 3D printers. Arguably the personal, enterprise and societal benefits from faster connectivity are even more significant. The telecommunications industry may want to convey a simplified view of the underlying mechanisms by which a high definition, high frame rate video can be sent instantly around the world, seemingly via thin air. Consumers with a basic understanding of the wondrous mechanics of a 5G network might be more predisposed to pay for it, and less likely to regard it as a commoditized utility.

The evolution of mobile applications
Enterprises should start experimenting with new products and services based on higher speeds, greater capacity and a lower cost per gigabyte.

Companies should also consider how faster, lower-cost downloads, allied to larger capacity smartphones, might change usage habits.

For example, 4G's greater speeds relative to 3G unlocked latent demand for streaming music into cars and for watching video on public transport.

Still greater speeds may encourage more users to download more apps while out and about. App downloads that complete in seconds rather than minutes may encourage more people to use apps rather than mobile-optimized websites. For retailers, this would enable a higher functionality user experience, including the ability to offer indoor navigation or one-touch checkouts using fingerprint readers. On the other hand, the majority of users seem stuck at having up to 30 installed apps on their phones[132], only using a handful on a daily basis. Higher speeds from 5G may not alter that 'limited shelf space' attitude.

A major new capability unlocked by iterations of 4G and 5G will be in the enterprise IoT space, and much experimentation will be required in this space to identify the optimal applications.

Fixed line replacement
Operators may also want to evaluate whether some consumers might consider LTE-A Pro (and in a few years, 5G) as alternatives to fixed broadband connections into premises. Fixed networks are getting steadily faster but mobile networks are keeping pace. Using 5G could be significantly cheaper than installing fiber[133]. In some markets LTE speeds are now competitive with fixed line networks accessed via Wi-Fi.

At some point, LTE-A Pro and 5G could provide sufficient coverage, speed and capacity for some households such that fixed line broadband, in addition to mobile, becomes superfluous. Homes with multiple low- to medium-connectivity requirements may be able to 'get by' with just a LTE-A Pro or 5G connection. Such households may primarily consume video on laptops and smartphones, and perceive little difference between high definition and ultra-high definition (UHD, also known as 4K) speeds, and might even be content streaming video in standard definition. These homes may have dozens of connected devices, such as connected kitchen appliances and smart thermostats, each of which sip rather than gulp bandwidth, and as such may not require very high speed fixed connections. Households wanting multiple 4K connections to watch live sports may still need a fixed line connection, but otherwise a mobile (5G or LTE-A Pro) connection may do.

Implications for legacy networks
Carriers should also consider whether and when they may want to switch off some of their legacy networks. It may be preferable, for example, for some operators to turn off their 2G networks, and reallocate the spectrum. This may lead to a more efficient use of this spectrum. In 2017, a few operators are expected to turn off part or all of their 2G network, but the vast majority have not stated any plans[134].

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