

Rapidly Evolving Technologies

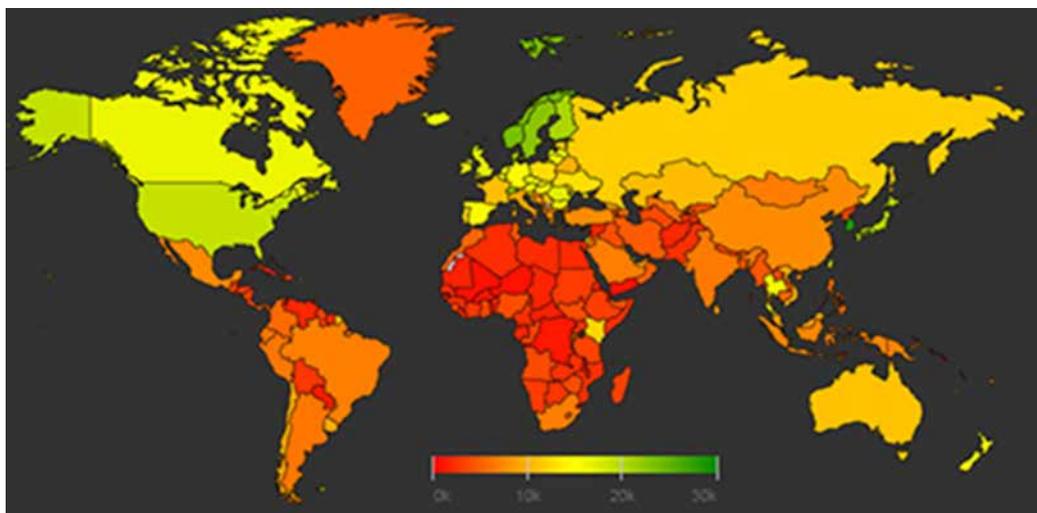


Due to rapidly evolving digital technologies and new business opportunities, the digital economy is growing rapidly, but unevenly. Despite some confusion due to marketing hype¹, new ITU estimates suggest that by the end of 2018, we will surpass the 50/50 milestone for Internet use.* Viewpoint 1 describes how access to broadband infrastructure can be extended to create an inclusive Information Society. At the same time, strong inequalities between countries persist in terms of speed of access (Figure 2), as well as differences in how connectivity is used (Viewpoint 2). Figure

2 shows average global connection speeds in early 2018, with significant differences in speed observed between the fastest regions (in North America and northern Europe) and regions with lower average connection speeds (Africa, and some countries in Latin America and Asia). Seven out of the top ten largest companies by capitalization in the world in Q3 2017 are digital companies with a strong digital component to their business².

**Text updated according to the ITU 2018 Global and Regional ICT estimates and the ITU's "Measuring the Information Society Report 2018".*

Figure 2: Average Connection Speeds Globally, by Country, 2018



Source: Akamai.



Table 1: Estimates of the Global Market: 2015, 2016, 2017, 2020 and 2021

	2015	2016	2017	2020	2021
Mobile cellular subscriptions	7.2 bn (ITU) 7.2 bn (GSMA) 7.2 bn (E)	7.4 bn (ITU) 7.5 bn (GSMA) 7.5 bn (E)	7.74 bn (ITU) 7.8 bn (E)	8.3 bn (GSMA) 8.4 bn (E)	8.4 bn (GSMA) 8.6 bn (E)
Unique mobile phone users	4.6 bn (GSMA) 5.0 bn (E)	4.8 bn (GSMA) 5.1 bn (E)	5 bn (GSMA) 5.3 bn (E)	5.4 bn (GSMA) 5.7 bn (E) 5.4 bn (Cisco) ³	5.5 bn (GSMA) 5.8 bn (E)
LTE subscriptions	1.1 bn (GSMA) 1.1 bn (E) 1.37 bn (ABI Research) ⁴ 1.068 bn (GSA)	1.8 bn (GSMA) 1.9 bn (E*) 2 bn (Strategy Analytics) ⁵	2.6 billion (GSMA) 2.8 bn (E*)	4.1 bn (GSMA) 3.5 bn (ABI) 4.8 bn (E) 3.6 bn (4G Am)	4.5 bn (GSMA) 5.3 bn (E)
5G subscriptions	-/-	-/-	-/-	70 m (GSMA) 55 million (E)	220 m (GSMA) 190 million (E)
Mobile broadband subscriptions	3.2 bn (ITU) 3.4 bn (GSMA) 3.6 bn (E)	3.65 bn (ITU); 4.1 bn (GSMA) 4.5 bn (E)	4.2 bn (ITU) 4.8 bn (GSMA) 5.3 bn (E*)	6.5 bn (GSMA) 7.0 bn (E)	6.9 bn (GSMA) 7.5 bn (E)
Smartphone subscriptions	3.3 bn (GSMA) 3.3 bn (E)	3.9 bn (GSMA) 3.8 bn (E)	4.5 bn (GSMA) 4.4 bn (E*)	5.9 bn (GSMA) 5.8 bn (E)	6.2 bn (GSMA) 6.3 bn (E*)
Fixed broadband (ITU)	820m (ITU)	884m (ITU)	979m (ITU) 1bn (E*)	1.1 bn (E*)	1.2 bn (E*)
Internet users (ITU)	3.21 bn (ITU)	3.49 bn (ITU)	3.58 bn (ITU)	4.16 bn (ITU)	-/-
Facebook users	1.59 bn MAU 1.04 bn DAU ⁶ (Dec 2015)	1.71 bn MAU 1.13 bn DAU	2.13 bn MAU 1.4 bn DAU	-/-	-/-
LINE users	215 million	217 million	207 million	203 million	-/-
Sina Weibo users	222 million	313 million	392 million	411 million	-/-
Vkontakte users	66.5 million	77.8 million	81.1 million	97 million	-/-
WeChat users	600 million*	806 million	963 million	1 billion	-/-
Smartphone stock	2.2 bn (Del)	-/-	-/-	2.1 bn (BI) ⁷	-/-

Source: Various. EST = Estimate. BI = Business Intelligence; Del = Deloitte; Facebook, E = Ericsson Mobility Report June 2018 at: <https://www.ericsson.com/assets/local/mobility-report/documents/2018/ericsson-mobility-report-june-2018.pdf> GSMA = GSMA database.

MAU = monthly active users; DAU = daily active users.

* Mid-year figures. <https://investor.fb.com/investor-news/press-release-details/2018/Facebook-Reports-Fourth-Quarter-and-Full-Year-2017-Results/default.aspx> and <https://zephoria.com/top-15-valuable-facebook-statistics/>

Viewpoint 1: Expanding Access to Broadband Infrastructure with the 4 Is

Our goal is to bring better technologies and services to those already connected, and to connect the unconnected. The latest ITU data reveal that some 52% or 3.7 billion of the world's population currently remain unconnected (ITU, 2018). We need to redouble our efforts to bring the power of ICTs to all nations, all people and all segments of society. Investment in ICT infrastructure is an absolute priority; we can never take investments in infrastructure for granted, and need to do more to create environments conducive to investment in ICTs. "4 I's" – Infrastructure, Investment, Innovation and Inclusivity – are central to ITU's strategy to leverage the power of ICTs to expand access to broadband services, and help accelerate the achievement of all the SDGs:

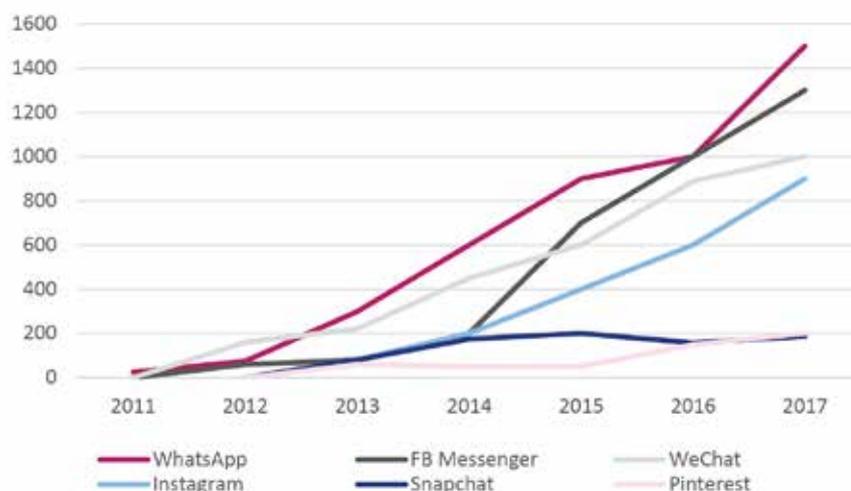
- **Infrastructure:** Today, broadband networks are critical infrastructure, as important as roads, railways, water and power networks. In LDCs, by end 2017, the number of mobile-cellular subscriptions reached about 700 million, with a penetration of 70%. Next-generation ICT infrastructure will power many digital solutions, from smart cities to public & financial services.
- **Investment:** Innovative financing mechanisms and PPPs are needed to create a better environment for investment (especially for hard-to-reach areas), which cut across industries and sectors. And policy-makers need assistance in strengthening digital development strategies and adopting an enabling environment. An ITU/UNCTAD survey found that less than 25% national broadband strategies include details on infrastructure investments⁸.
- **Innovation:** In emerging markets, ICTs are helping farmers to monitor prices, health workers to respond to emergencies, and borrowers to

connect with lenders. In developed and developing markets alike, entrepreneurs and tech MSMEs are at the forefront of industry disruption. Every year, at ITU Telecom World, ITU focuses on supporting the success of these innovators, who drive socio-economic growth and job creation in countries around the world.

- **Inclusivity:** The digital divide takes many forms. More than two billion adults still don't have a formal bank account, but 1.6 billion of these do have access to a mobile phone. Digital financial inclusion can help boost poverty eradication, job creation, gender equality and women's empowerment. ITU has teamed up with several partners to launch a new programme to accelerate digital financial inclusion. Digital inclusion also needs locally relevant content, and interfaces that feature text-to-speech and voice-recognition capabilities to enhance accessibility for people with specific needs, indigenous peoples and those with disabilities. Ensuring equal access to the information society is a moral imperative.

The scale of the infrastructure that must be built or upgraded to bridge the digital divide and deploy emerging technologies is huge and expensive – ITU estimates that connecting the next 1.5 billion people will cost USD 450 billion. ITU's World Radiocommunication Conference 2019 will determine the foundations for 5G and use of spectrum to meet the ever-growing demand for broadband services and applications. I'm happy to report that good progress was achieved in the set of technical requirements and criteria agreed for 5G by ITU-R Study Group 5 in November 2017. ITU has developed a set of 5G performance targets, preparing the ground for new applications such as automated driving, remote medical diagnosis and surgery, and advanced virtual reality (VR). In this way, we can close the gaps between the digital

Figure 3: Growth in Number of Users of Messaging and Hybrid Networks, 2011-2017



Source: Various, including Activate.com.

haves and have-nots, and help create an inclusive information society for all.

Source: Mr. Houlin Zhao, Secretary-General of ITU and co-Vice Chair of the UN Broadband Commission.

In addition to infrastructure and basic access, growth in data must also be considered. Estimates of data growth are generally difficult to come by, but Cisco estimates that traffic over the Internet will grow by over 20% a year between 2015-2020⁹, and that by 2021, global IP traffic will reach an annual run rate of 3.3 zettabytes. Cisco also projects that, by 2021, 80% of all Internet traffic will be video, up from 67% in 2016. OTT applications such as YouTube and Netflix are contributing to this growth in data flows and Internet traffic, with strong growth in subscriber and user numbers for several key services (Figure 3).

In terms of subscriber numbers, WhatsApp (owned by Facebook) now offers messaging and calling services to some 1.5 billion users in over 180 countries¹⁰. Viber (owned by Rakuten) currently offers calling, video and messaging services to over 800 million people¹¹. Facebook lists some 2.2 billion monthly active users (MAU) on Facebook for Q1 2018, a 13% increase year-on-year. Some 1.45 billion people on average log onto Facebook daily as Daily Active Users (DAU) for March 2018, matching the growth

in MAU with a 13% increase year-on-year. However, DAU and MAU are not measures of data traffic, and use of Facebook varies considerably in different regions of the world.

According to some estimates, some 2.5 quintillion bytes of information are generated daily, while Google alone is estimated to store over ten Exabytes of data on a daily basis¹². IDC/EMC (2014) reported that “the digital universe is doubling in size every two years and will multiply ten-fold between 2013 and 2020”¹³. More recent IDC estimates put the size of the digital universe at around 2.7 Zettabytes of data, but that by 2020, 30 Zettabytes of data will be generated annually. However, there are some indications that inequalities in access to and use of intelligent connectivity may be growing (Viewpoint 2).

Viewpoint 2: The Move from Traditional Connectivity to Intelligent Connectivity & Growing Inequality

Five years into tracking the correlation between ICT infrastructure maturity and GDP growth, the 2018 Global Connectivity Index (GCI) again finds that GDP returns among countries with concentrated adoption of ICT infrastructure. Countries with less proactive investment have seen less stellar results.

This year, the scope of the GCI was broadened from 50 to 79 economies and AI was added as a new element in the GCI equation, in addition to the five enabling technologies (broadband, data centres, cloud, big data and IoT). AI is the next major general-purpose technology driving paradigm shifts in economic and industrial activity. The influence of AI is trickling into all aspects of life.

Industries are embedding AI in all five enabling technologies, transforming traditional connectivity into Intelligent Connectivity to unleash new innovation and economic opportunities. New business models, products, processes and services are emerging every day, accelerating growth towards a digital economy worth some US\$23 trillion by 2025 and opening up a new economic growth cycle. Further, this digital economy has grown 2.5 times faster than global GDP over the past 15 years.

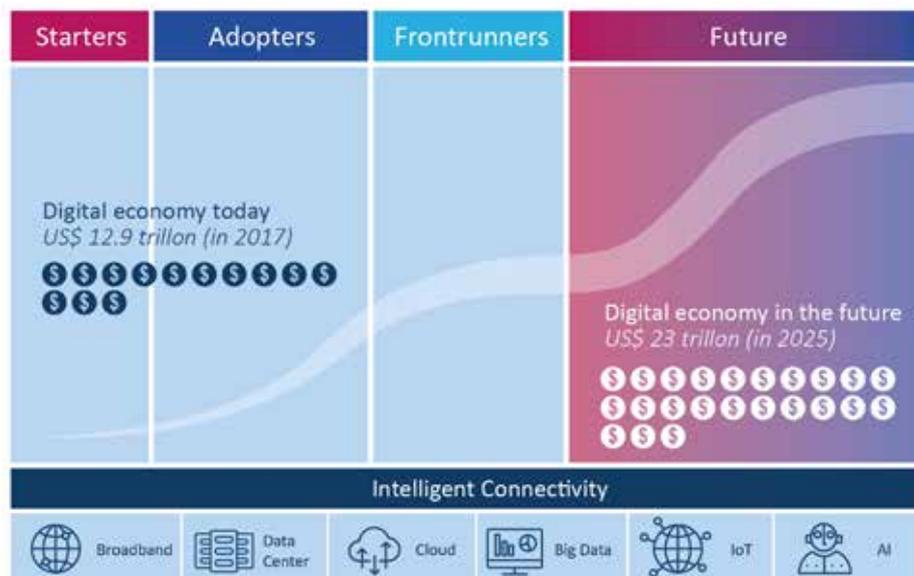
This year's GCI saw scores rise incrementally across all countries. 'Frontrunners' or advanced economies on the GCI S-curve are using Intelligent Connectivity to accelerate digital economy growth and unearth new opportunities. Advanced economies

are generally in better fiscal positions to make progress in ICT infrastructure development – and now AI – to climb the GCI S-curve and drive greater GDP returns.

Growth, however, has been uneven. The distance between countries at the top and bottom of the GCI S-curve continues to increase, indicating an amplification of existing inequality. Against this backdrop, it is vital that less developed economies in the GCI Adopter and Starter clusters prioritize ICT investment to stay competitive.

There is, however, good reason for optimism. In 2018, advanced economies find themselves on the cusp of new opportunities, while 'Adopters' and 'Starters' are laying foundations for leapfrog growth through well-planned and focused ICT investments. As GCI Frontrunners reach the limits of growth from current ICT investments, AI and Intelligent Connectivity are opening up a new economic growth cycle. While no one can be sure where AI will ultimately lead us, all can agree that its potential is enormous, and will impact every aspect of how we live, play, work and, potentially, even think.

Box Figure: Intelligent Connectivity – The USD 23 Trillion Opportunity by 2025



Source: Huawei.

2.1 Mobile Broadband

Strong growth in mobile broadband subscriber numbers continues, driven in part by consumer demand for applications. Point Topic reports that fixed wireless technologies are increasingly giving way to 4G LTE-based mobile broadband access, with 4G LTE now a major means of getting broadband at home in several regions – for example, Scandinavia and Eastern Europe¹⁴. The *Inclusive Internet Index (3i)*¹⁵, commissioned by Facebook and the Economist Intelligence Unit, shows that access to 4G networking services improved over the last year, particularly in low-income countries where coverage almost doubled, from 9.1% to 17.3%. ITU's Global ICT Development Index shows generally broad growth in ICT readiness, use and impact. Figure 4 shows the number of subscribers globally, by generation of mobile technology. LTE and higher generation 4G technologies now account for over half of all global mobile subscribers.

Speeds and coverage levels are increasing.

For example, Vodafone Italy has announced the launch of 1Gbps mobile service in Rome, Naples and Palermo, and has begun 5G trials in Milan¹⁶. In Singapore, the operators Singtel and StarHub have boosted mobile services to 1Gbps, following successful trials in 2017. Ooredoo Oman had covered 90% of the population with LTE network by mid-2018¹⁷. MTS Belarus has launched LTE services

in 80 towns over the first half of 2018 to push out 4G to 70% of the population, including 95% of people in urban areas¹⁸.

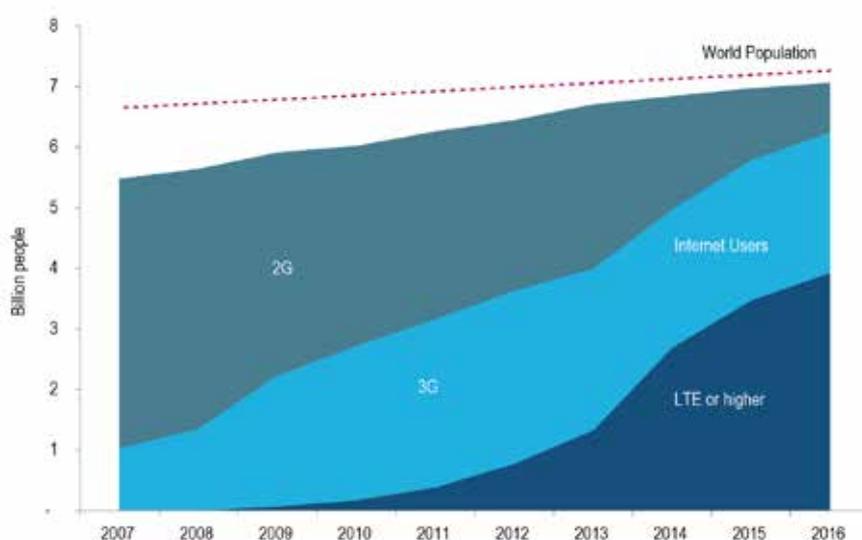
Barely a decade on from the first launch of 4G, the first 5G trials have already started.

As the industry heads towards the commercial introduction of 5G technology, investments in 5G-enabling and candidate technologies are growing. Several MENA operators have commenced trials of 5G and are beginning to map out spectrum strategies in conjunction with national regulatory authorities – for example, Zain and Etisalat have conducted 5G trials in Saudi Arabia, Kuwait and UAE.

The first commercial deployments are likely in 2019, following approval of the international standards for 5G at WRC-2019. 5G deployments will ramp up significantly after 2020, and most developed economies should enjoy the benefits of 5G by 2023 – for example, China is predicted to have anywhere between 200 million (GSMA) or one billion¹⁹ 5G users by 2023. Most other markets will still benefit from 4G networks, already available in 208 territories, according to the GSMA.

Verizon Communications is already trialling fixed-wireless '5G' residential broadband services in several markets in the US in 2018. Verizon had already trialled 5G residential applications in eleven markets in 2017²⁰.

Figure 4: Changing Mobile Coverage, by Type of Network, 2007-2016



Source: ITU.

Verizon plans a 5G trial for Sacramento, California, in late 2018, supported by millimetre wave (mmWave) spectrum.

Ooredoo and Nokia are collaborating on 5G early trials starting in 2018 in Qatar, aiming to accelerate roll-out. Ooredoo considers that 5G innovation will help “deliver superior mobile data experiences for our customers. 5G will catalyze mobility, industrial networking, remote healthcare, virtual reality, and ultra-high-definition video, and enhance our customers’ digital experience and help them enjoy the Internet in new and exciting ways”²¹. Viewpoint 3 emphasizes the importance of 5G, while Viewpoint 4 describes development of 5G in Saudi Arabia. Viewpoint 5 describes KT Corp’s GiGA Story Smart Village Project to boost regional economic growth in a province of the Rep. of Korea.

Viewpoint 3: The Importance of 5G

First- and second-generation wireless networks were focused on voice services and the focus of 3G and 4G shifted toward data and mobile broadband. While the focus on mobile broadband will continue with 5G, support for a much wider set of diverse usage scenarios is expected. 5G is positioned as an intelligent network that supports data and analytics use cases, helping it reach out to drive new industries in ways not previously possible. 5G enables developing countries to make full use of new technologies such as AI, cloud computing, M2M and data analytics²².

Over 90% of broadband subscribers in developing countries use mobile broadband and it is vital to migrate to 5G successfully to obtain the full benefits of mobile broadband. According to ITU-R Rec. M.2083, 3 major 5G/IMT-2020 use scenarios include: (1) enhanced mobile broadband; (2) ultra-reliable and low-latency communications; (3) massive machine-type communications.

5G/IMT-2020 will provide new applications and services for both developed and developing countries. Some of the 5G/IMT-2020 applications

will be much more important for the developing countries, such as smart transport systems, e-health, education, smart grid, agriculture and disaster relief. Developing and emerging economies are leapfrogging older technologies and becoming more mobile-oriented.

5G will have significant economic impact on these economies. According to IHS, 5G/IMT-2020 will enable USD 12.3 trillion of global economic output when its full impact is realized and developing countries can benefit from this opportunity without delay²³. Many countries have established 5G Taskforces to accelerate 5G, including India, UAE, Brazil, China, Turkey, Rep. of Korea, Japan, Indonesia, South Africa and Saudi Arabia. The EU has also developed a 5G Action Plan.

Source: Intel.

Viewpoint 4: The Kingdom of Saudi Arabia plans to test and roll out 5G services

Saudi Arabia is leading the way in the Middle East with the development of next-generation mobile broadband. Over 2017-2018, CITC, Saudi Arabia’s ICT regulator, awarded 160 MHz of additional IMT spectrum in 700 MHz, 800 MHz and 1800 MHz bands to mobile operators STC, Mobily and Zain. Saudi Arabia is a regional leader in terms of awarded IMT spectrum in sub-GHz IMT bands, which should help support the growth of mobile broadband network capacity, from 3G and 4G to 5G.

To aid evolution of mobile broadband towards the 5G and prepare the necessary foundations, the National 5G Task Force was established in early 2018. The Task Force unites all stakeholders with an interest in 5G, such as government, operators, equipment vendors and user groups. Specialized work is carried out in 3 subcommittees dealing with “5G Spectrum”, “5G Development” and “5G verticals”. All the necessary 5G policies and

supporting administrative provisions should be in place by end 2019.

The Saudi Government is taking an active role to create the best conditions for the private sector to invest in developing and deploying 5G, including measures for greater regulatory certainty vis-à-vis operators' business cases and technological flexibility through Unified Licences, implemented since 2017. These will be backed by timely availability of 5G spectrum and the promotion of a 5G services ecosystem in 5G verticals, such as eHealth, Industry 4.0 and Smart Cities, among others.

As one of the first steps towards achieving 5G, CITC issued Test & Trial licenses to all three mobile operators in early May 2018. These licenses allow the operators to pilot 5G technologies until end 2019 by utilizing 100 MHz channels in 3.6-3.8 GHz band, with individual test sites authorized in a speedy administrative procedure. STC was the first operator to start deploying 5G sites from early May 2018, starting in the Eastern Region and spreading to the rest of the country. These pilot deployments were implemented with 5G NR equipment utilizing 100 MHz TDD channel in Band 42 configuration. All three Saudi mobile operators are planning to gradually expand their 5G equipped sites in 2018 and 2019 in anticipation of full nationwide commercial launch, when fully 5G capable consumer devices hit the market by mid-2019.

The CITC is set to convert the test and trial licenses to full and exclusive 5G spectrum awards in 3.4-3.8 GHz by mid-2019. The awards of mm-wave spectrum may follow by beginning of 2020 taking into account the decisions of ITU's WRC-19 on the subject and availability of 5G equipment on the market.

Source: CITC, Saudi Arabia <http://news.itu.int/how-saudi-arabia-is-paving-the-way-to-be-a-regional-leader-in-5g/>.

Viewpoint 5: The GiGA Story Smart Village Project for Regional Economic Growth

Korea Telecom (KT) launched the GiGA Story project to help improve residential living environments and solve social problems by providing Internet and ICT solutions to address digital divides. The Rep. of Korea faces a serious population decline in rural areas, due to urbanization and demographic ageing. The GiGA Story Project started in 2014 in various locations in Rep. of Korea and Bangladesh, and Uiyaji Village project was launched in PyeongChang Province, Rep. of Korea, in 2017.

KT cooperated with the Government and local authorities in an early trial of 5G to stimulate the rural economy. Uiyaji Village is located near a local tourist spot with 600,000 visitors annually, but it did not have sufficient tourist attractions to attract visitors. KT developed tourist content using ICTs. An AR technology and Media Wall with motion recognition functionality can help visitors to obtain information on major attractions near Uiyaji Village. The AR service displays a 360-degree VR image of the town market and offers information on local products. It is hoped that this platform will change shopping habits and increase incomes through the sale of local specialties.

Since its launch in December 2017, Uiyaji Village has received over 1,000 visitors monthly and the profits of the local café have quintupled. In addition, the resident population has increased by 9.6%. KT and the local government will continue to cooperate to develop local products and improve living conditions using ICT solutions. In future, KT is planning to further develop the AR market and tourist content using its 5G early trial for community development and economic growth using ICTs.

Source: KT Corp.

In Singapore, Singtel collaborated with Ericsson in 2016 in a demonstration of live video streaming over 5G, which achieved a

peak throughput of 27.5Gbps and latency as low as 2 milliseconds. Early 5G trials by StarHub and M1 have achieved transmission speeds of 35Gbps. To encourage greater innovation and facilitate 5G trials, Infocomm Media Development Authority (IMDA) waived frequency fees for 5G trials from May 2017 to end 2019. Commercial deployments should happen from 2020 onwards, and IMDA has engaged the public in shaping 5G spectrum requirements and regulatory provisions.

In Europe, the EU 5G Action Plan targets an early market introduction for 5G in 2020 and a comprehensive roll-out up to 2025. Major opportunities for 5G in Europe lie in the digital transformation of major EU sectors (including automotive, manufacturing, energy, media and health sectors and other 'verticals'). EU operators are ready for the launch of 5G around 2020, but in mid-2018, the operator Elisa launched an early 5G trial in Finland using Nokia network equipment and Huawei devices, including a "narrowband" IoT service.

The difficulty is that the investment needs for 5G are enormous, at a time of thinning, if not declining, ARPUs for many operators in a number of countries, where operators are seeing shifts in capitalization (as well as revenues, in some cases) to Over-The-Top (OTT) players. According to the World Bank's forthcoming "*Data-Driven Development*" report, "telecom operators have developed several responses to OTT. They have argued for regulating OTTs that provide voice and text services in the same way they are. Some are developing their own OTT products. Others are including large bundles of their own offerings such as free calls or text in packages. Many are diversifying into opportunities in areas such as cloud computing, IoT and mobile money. Some are trying to do all of the above"²⁴.

However, the World Bank acknowledges that OTT players "not only compete with telecom operators that provide video services, but are also responsible for [generating] a substantial portion of traffic going over the networks". For example, a study of African mobile network operators by Research ICT Solutions showed that most operators have experienced strong revenue growth due to an OTT-induced increase in data demand, which

generally outpaced declines in voice and SMS revenues²⁵. The German research institute WIK notes, "consumers do not use Rich Interactive Applications and communication services as like-for-like substitutes; more often than not, consumers use them complementarily"²⁶. In this scenario, operators' broadband access infrastructure enables consumers to access online applications' innovative content, which in turn drives consumer demand for operators' broadband services.

For 5G, analysis by McKinsey (2018) suggests that operators have two options for investing in 5G²⁷:

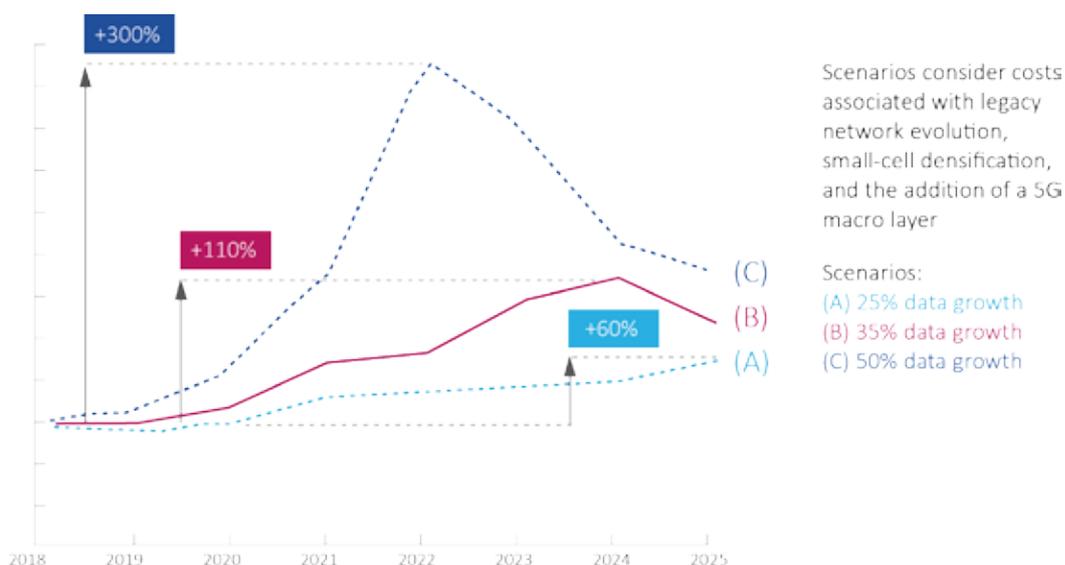
- A 'lean-in strategy' in which operators prioritize 5G investments with the hope of accelerating commercial prospects.
- A more conservative approach, in which operators delay 5G investments as long as possible, while existing networks are upgraded.

When network upgrades are no longer sufficient to support the increased traffic, operators will need to build new macro-sites or small cells to satisfy urban demand for capacity²⁸. McKinsey's analysis suggests that many operators will embark on significant new build-out between 2020-2025. Some operators in the US are already in the process of decommissioning 2G, while a number of European operators are planning to shut down their 3G networks around 2020.

McKinsey foresees that Total Cost of Ownership (TCO) for mobile access networks will increase (Figure 5), although the increase will depend on data growth and industry circumstances. Others argue that 5G technology may prove less expensive per bit than previous generations. A range of players are investing in network infrastructure, including data centers, submarine cables, fibre networks, servers and routers to help deliver content to end-users, including operators, content and application providers.

Despite this mobile success story, from the perspective of operators and other players in the industry, fibre-based backhaul is still vital for helping networks meet capacity and

Figure 5: The Total Cost of Ownership for Mobile Access Networks will Increase



Source: McKinsey (2018), available at: <https://www.mckinsey.com/industries/telecommunications/our-insights/the-road-to-5g-the-inevitable-growth-of-infrastructure-cost?cid=other-eml-alt-mip-mck-oth-1802&hlkid=4108a3016b4842dfac490f90465f61f4&hctky=9411404&hdpid=11560416-85ad-4de7-99a9-f0dc73b2ca57>

Note: Total Cost of Ownership (TCO) includes capex and opex for radio access network and transmission, but not core networks. Data are based on 3 operators in a European country; results are rounded.

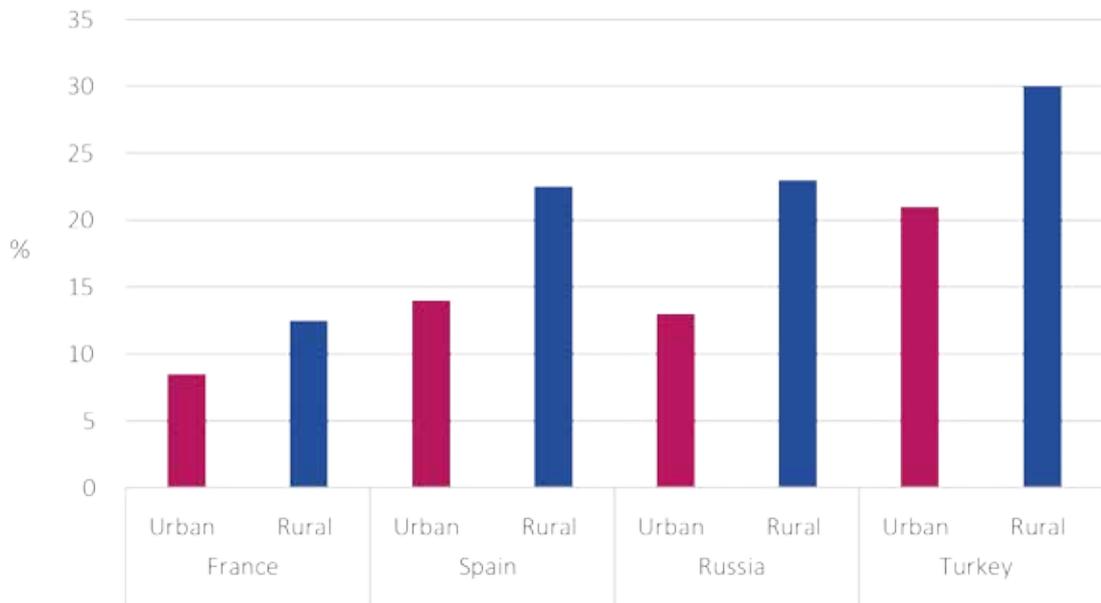
latency requirements for 5G, and supporting small-cell deployment in urban areas. In some countries, in recognition of their common interests, OTT players and telcos have partnered to expand broadband connectivity in previously underserved areas. For example, Facebook, Airtel, and BCS recently completed a 770 km fibre build in Uganda to provide backhaul to 3 million people and cross-border connectivity with neighboring countries.

From the edge of cities to remote farms, there are millions of people worldwide who live in areas with few or no fibre or cable connections. Although their homes may have copper phone lines, they may live too far from the local telephone exchange for DSL connections to work well. If their homes are over a mile from a central office but within four miles from a LTE cell phone tower, mobile may still offer the fastest Internet service available. Deloitte (2018) suggests that this may be quite rare in the UK, France and other Western European countries, but it may be more common in other countries²⁹. In some countries, rural residents are more likely than urban residents to have mobile-only service (Figure 6).

Smartphone penetration is also increasing in most markets. Deloitte predicts that, by the end of 2023, the penetration of smartphones among adults in developed countries will exceed 90%, up 5% on 2018, while smartphone sales will amount to USD 1.85 billion per year by 2023³⁰. Smartphones offer improved performance due to 5G connectivity, higher transmission speeds, improved processors, additional sensors and AI chips, software and memory. Data traffic from smartphones surpassed voice traffic in 2009, and has grown since then at a tremendous rate. Close to 85% of mobile data traffic is generated by smartphones today, expected to reach 95% by end of 2023 (Ericsson, 2018).

Approximately 40 million smartphones were sold in India in Q3 2017. With over 400 million Indians connected by 2G phones, India has passed the US to become the second-largest smartphone market and is even gaining in global share against China. With monthly service prices often under USD5 and many phones subsidized to USD25-35, Deloitte estimates 350 million more Indians will be connected by 2020³¹.

Figure 6: Data Mobile-Only Population for Urban and Rural Areas, Selected Countries, 2017



Source: Deloitte Global Survey of Mobile-Only Adults, August-October 2017. Deloitte TMT Predictions (2018), at: <https://www2.deloitte.com/global/en/pages/technology-media-and-telecommunications/articles/tmt-predictions.html>

2.2 Fixed Broadband

ITU records that there were 979 million fixed-broadband connections by end 2017. Point Topic (2018) estimates the global number of fixed broadband connections slightly lower, at 931.6 million by end 2017. The highest growth quarterly was recorded in Africa, Asia, and Oceania, as these regions with high growth potential continue to embrace new broadband technologies. Nearly three-quarters of net additions in fixed broadband subscribers came from East Asia, driven mainly by growth in China, which is adding some 15m broadband subscribers per quarter. China had already passed a quarter of a billion fixed broadband subscriber milestone in Q1 2016, and continues to grow at impressive speed, adding nearly 70 million FTTH connections over 2017.

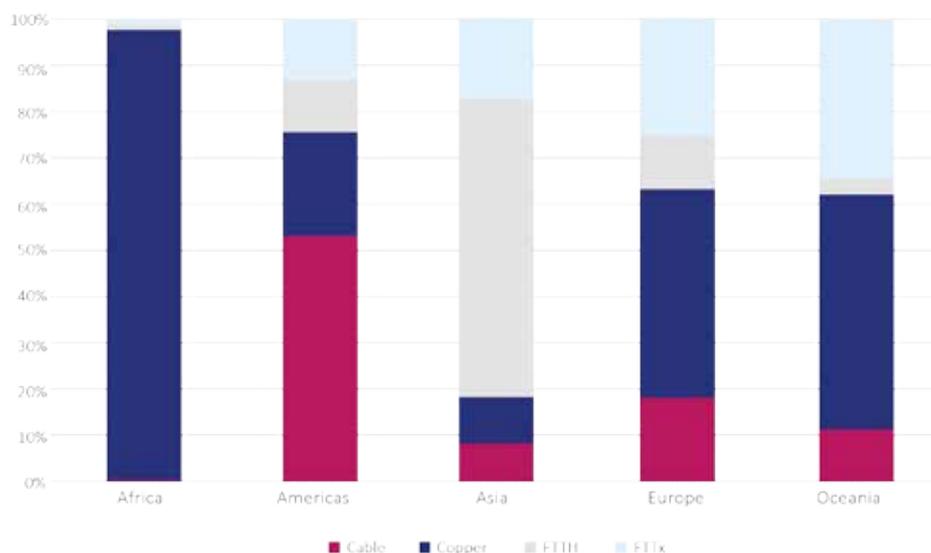
Point Topic reports that, in the year between Q4 2016 and Q4 2017, the number of copper lines fell by 6% globally, while FTTH connections increased by 28%. The share of fibre connections in total fixed broadband subscriptions continued to increase in all regions, with highest growth recorded in Asia and Americas³². Figure 7 shows the technology market share by region for the global regions for end 2017. Surprisingly, a drop in FTTx lines has been observed since 2016, due to this technology being

replaced with FTTH on a large scale in China, and to some extent in other countries.

For example, in early 2018, Algérie Telecom announced the commercial launch of FTTH broadband services in several provinces, with the Gigabit-capable direct fibre access network being deployed to the rest of the country through further regional launches expected through the year³³. In the UK, BT's Openreach's fibre connections reached a record high of 600,000 at end 2017, with plans to deliver FTTP to 3 million premises by the end of 2020, and 10 million homes and businesses by mid-2020s³⁴. In Brazil, TIM Brasil launched a 2Gbps FTTH service in October 2017 in Sao Paulo and Rio de Janeiro, passing some 200,000 households at a cost of USD 455 per month³⁵. In the US, Verizon has stated that their costs to pass a home with fibre have dropped significantly by 2017, down a large amount from USD 700 in 2007³⁶. Viewpoint 6 describes the development of broadband in Switzerland.

Meanwhile, one of the largest rural fibre connectivity projects in history is underway in India³⁷. Over 100 million Indians are ready to be connected with fibre, Wi-Fi and LTE. Phase 1 is finished of India's BharatNet. All 250,000 regional councils and 625,000 villages are expected to be reached by GPON fibre by March 2019. Most villages will have

Figure 7: Technology Market Share by Region, Q4 2017



Source: Point Topic, available at: <http://point-topic.com/free-analysis/world-broadband-statistics-q4-2017/>.

local Wi-Fi from the local Post Office and/or a program of local businesses. Backhaul for telcos is included; Indian operators may use BharatNet backhaul as they extend mobile broadband coverage to rural populations. The USD 15 billion project is primarily funded by the Indian Universal Service Fund (USF). Viewpoint 6 describes the development of broadband in Switzerland and the changes in the policy and regulatory environment needed to help stimulate its development.

Viewpoint 6: The Development of Broadband in Switzerland

Since liberalizing its telecom market in 1998, Switzerland has enjoyed a dynamic market conducive to promoting competition and the more extensive deployment of infrastructure. Over recent years, significant investment has been made in the expansion of both fixed and mobile networks. According to Akamai's "State of the Internet" report, Switzerland is one of the leading countries in the world in Internet connectivity with a next-generation access (NGA) population coverage rate of 94% and LTE population coverage rate of almost 99%. LTE advancements have been widely deployed and now offer bandwidths of up to 1 Gbit/s. Mobile operators have announced they will begin introducing

5G from end 2018. The fixed broadband subscription rate in Switzerland is nearly 46%, at the top of international comparisons, according to the OECD.

The Swiss Telecommunications Act of 1998 seeks to ensure that a range of cost-effective, high-quality and nationally and internationally competitive telecommunication services are available to individuals and the business community. It should also promote effective competition in the provision of telecom services and ensure a reliable universal service at affordable prices, for all sections of the population throughout the country. The fixed broadband market in Switzerland is characterized by a strong incumbent, high DOCSIS 3.0 cable population coverage and considerable FTTH investments by the incumbent and major local utilities. The incumbent is rolling out FTTH, FTTS and FTTC in connection with vectoring or G.fast, ensuring almost the entire population will soon have coverage with a modern fixed network. Some 200 cable operators cover 85% of the population with DOCSIS 3.0, and several have announced plans to deploy DOCSIS 3.1.

The entire population can access the universal broadband service, which currently offers 3 Mbit/s. Some 94% of

all dwellings and businesses can obtain fixed broadband services with at least 30 Mbit/s and 85% can access 100 Mbit/s or more. FTTH is currently deployed in more than 31% of households. However, the take-up of FTTH is still rather limited.

Initiatives by local utility companies to invest in FTTH in several major cities in 2008 seemed to act as a trigger for the incumbent operator to start investing in FTTH. To avoid duplication and to create a framework for FTTH roll-out, the telecom regulator OFCOM launched 'FTTH Round Table' discussions for market players. Following these round tables, the incumbent operator and major local utility companies agreed on infrastructure-sharing and co-investment schemes based on a multi-fibre model. Uniform technical standards (e.g. for the installation of fibre in individual dwellings) have been drawn up in various industry working groups. An intervention by the competition authority (COMCO) ensured that agreements between the incumbent operator and utilities would not impede competition.

Cooperation activities agreed to date between the incumbent and some 70 local utilities cover some 30% of all buildings in Switzerland. The implementation of a four-fibre-per-household network could increase roll-out costs by 10-20%, compared to a single-fibre point-to-point network architecture. In return, it creates two competing fibre networks, each with one spare fibre. The incumbent and all utilities offer wholesale access to their FTTH network on commercial terms.

In April 2016, the Swiss Federal Council adopted the "Digital Switzerland" strategy, whereby the Swiss Government seeks to support the digitization which affects all areas of life, for Switzerland to exploit opportunities and address associated challenges.

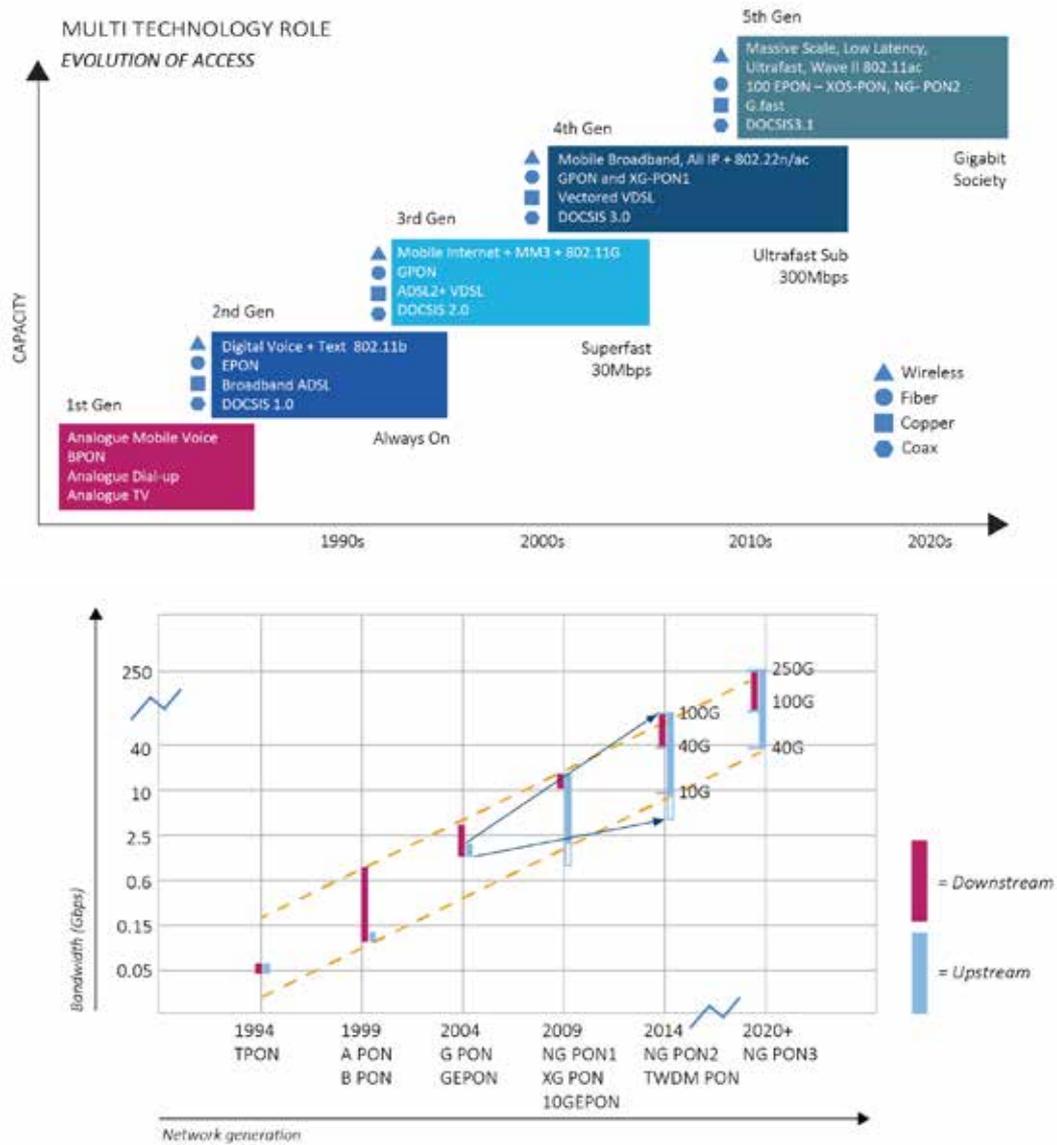
The "Digital Switzerland" strategy provides guidelines for government action and indicates where and how authorities, academia, the private sector and civil society must work together in order to shape the transformation process for the benefit of everyone. The government has set the goal of ensuring that ultra-high-speed broadband will be market-driven and available in all Swiss municipalities by 2020. The expansion of mobile networks (5G) and the frequency resources required for 5G, which are awarded by the State, will play an important role.

Maintaining an up-to-date regulatory framework, which promotes competition and investment in NGA technologies, is crucial in order to prepare for future challenges and to give Switzerland excellent foundations for developing a smart society. That is why in September 2017, the Swiss Federal Council adopted a revision of the Swiss Telecommunications Act (revised in 2007). The present revision seeks to adapt the law for new technological developments and market evolution, while improving transparency and consumer protection. The ultimate ambition remains unchanged – to adopt a market-driven approach, which fosters competition and thereby promotes investment and innovation.

Source: OFCOM, Switzerland.

Figure 8 shows the increases in bandwidth and traffic speeds made possible through advances in access networks (top chart) and PON (bottom chart), while Table 2 summarizes the key characteristics of the main xDSL technologies. The development and deployment of ultra-reliable, low-latency and high-capacity networks are essential for future developments in IoT applications (such as autonomous vehicles, which could require huge amounts of data³⁸). Viewpoint 7 describes Microsoft's innovative Project Natick to introduce an underwater data centre.

Figure 8: Bandwidth and Traffic Speeds for PON



Source: ADTRAN (top chart); ITU (bottom chart).

Table 2: The Main xDSL Technologies

	VDSL2	ADSL2+	SHDSL	HDSL
Transmission mode	Asymmetric & symmetric	Asymmetric	Symmetric	Symmetric
Pairs of Copper	1	1	1 & 2	1, 2 & 3
Frequency band	12MHz to 30 MHz (down & up data)	0.14MHz-2.2.MHz (down data)		196KHz
Modulation	DTM	QAM	TCPAM	CAP/2B1Q
Bitrate (down/up)	Up to 200 Mbit/s bidirectional	12 Mbit/s up to 24 Mbit/s & 1 Mbit/s up to 1.4 Mbit/s	Up to 5.7 Mbit/s (single pair)	2 Mbs bidirectional
Reach	<2.5km	<1.5km	<3km	<3.6km
ITU standard	ITU-T G.993.2 (Nov 2015)	ITU-T G.992.5 (Jan 2009)	ITU-T G.991.2 (Dec 2003)	ITU-T G.991.1 (Oct 1998)

Source: "Future of Cable TV": https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Events/2018/Future%20of%20Cable%20TV/The%20future%20of%20cable%20TV_preevent.pdf

Viewpoint 7: Underwater Datacentres in the Sea – Project Natick

We are firmly in the era of the fourth industrial revolution (4IR) marked by dramatic advances in computer science, data science, AI, cloud computing, and broadband that herald the transformation of societies. In less than forty years, the Internet is used by half the world's population. With these advances, we are increasingly reliant on data centres to process, store, and secure the huge volumes of data created every day.

Data centres are key to today's cloud services. To optimize performance, they need to be located where access to high-capacity fibre and ready power (ideally renewable) are available, with minimum transit distance to users. In 2014, Microsoft researchers began to explore the idea of underwater datacentres. Seawater could offer abundant cooling potential and reduce the need for power. Half the global population lives within 200 km of the ocean, so these data centres could also have low latency, as signals travel over the Internet at about 200km/millisecond.



Between August and December 2015, Microsoft launched Phase 1 of Project Natick, which demonstrated the feasibility of subsea datacentres, including the ability to operate a 'Lights-Out' datacentre (with reduced energy needs and human access), with efficient Power Usage Effectiveness (PUE) of 1.07, and a perfect Water Usage Effectiveness (WUE) of zero versus land datacentres (which consume up to 4.8 liters of water per kilowatt-hour).

Phase 2 of Project Natick is the creation and testing of a full-scale datacentre module powered by renewable energy off the coast of Scotland. Microsoft sought to demonstrate that full-scale undersea data centre modules can be manufactured and deployed in 90 days from 'power on'. The Phase 2 vessel was deployed from the Orkney Islands on 1 June 2018. It contained 864 standard Microsoft datacentre servers in 12 racks in a vessel the size

of a standard shipping container. It is as powerful as several thousand high-end consumer PCs with storage for the equivalent of 5 million movies. It is powered by renewable on-shore wind and solar energy, and off-shore tide and wave power. Phase 2 aims to:

- Develop a full-scale prototype subsea datacentre;
- Gain an understanding of the economics of undersea datacentre and TCO over its lifetime;
- Efficiently deploy the prototype within 12 nautical miles of the coast at a depth of 100 meters;
- Demonstrate ‘Lights Out’ operation over a deployment cycle of 5 years;
- Power the prototype from a nearby marine renewable energy sources; and
- Explore cloud datacentre solutions offering less resource-intensive options.

Ultimately, data from this project may lead to more efficient datacentres that can be operated at lower cost and less environmental impact than land datacentres. Land datacentres need clean tap water for cooling, and the evaporative cooling process leaves waste. Water is a precious resource. Undersea datacentres can have their own renewable power and no impact on water supply or electricity, or land itself, and have the potential to contribute to digital transformation and help realize the SDGs.

Source: Microsoft.

2.3 Internet of Things

The OECD has defined the IoT as “encompassing all devices and objects whose state can be read or altered via

the Internet, with or without the active involvement of individuals. This includes laptops, routers, servers, tablets and smartphones (often considered to form part of the “traditional Internet”), as these devices are integral to operating, reading and analyzing the state of IoT devices”³⁹.

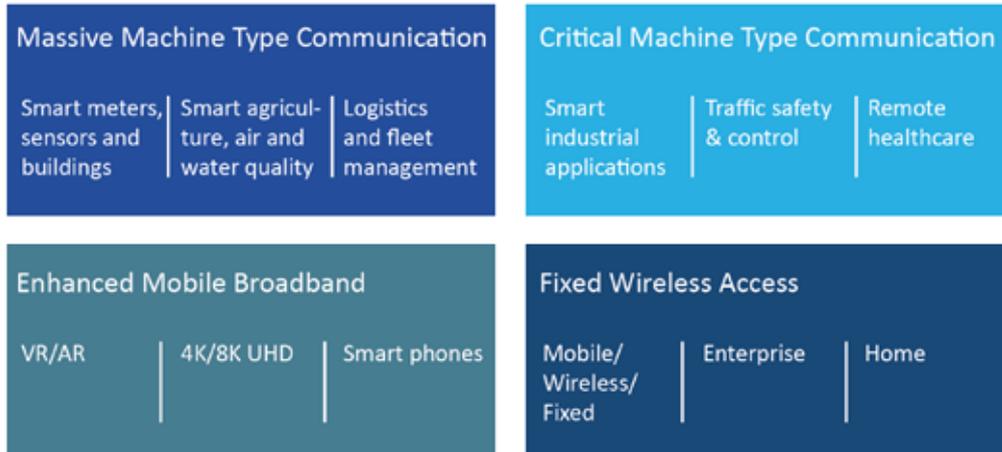
Gartner forecasts that 8.4 billion connected things were in use in 2017, up 31% from 2016, and growing to 20.4 billion by 2020. GSMA predictions are more conservative, forecasting that the number of IoT connected devices will increase from 8 billion in 2017 to 13 billion in 2020 to exceed 25 billion in 2025. IDC forecasts are considerably higher, forecasting that some 80 billion IoT devices will be online by 2025, creating 180 Zetabytes of data. According to Ericsson, the number of cellular IoT connections is expected to reach 3.5 billion in 2023, with an annual growth rate of 30%. Of the 3.5 billion cellular IoT connections forecast for 2023, North East Asia is anticipated to account for 2.2 billion⁴⁰.

Viewpoint 8: The IoT as a Cornerstone for Digitization

IoT is a cornerstone in the ongoing digitization of industries and society. The convergence of several technologies of the Fourth Industrial Revolution such as AI, cloud computing, drones, self-driving vehicles or robotics. The IoT market can be divided into two main types:

- **Massive IoT** – large number of devices, platform transmitting low bit-rates of data, long battery life in devices. Typical use cases are found in smart city solutions such as logistics, smart meters, sensors and buildings, as well as in agriculture, air and water quality management.
- **Critical IoT** – higher bit-rates of data, low-latency, and improved reliability, ultra-low latency and 5G technologies will support these requirements. Typical use cases are found in advanced industrial applications, traffic safety and control, remote healthcare.

5G expands the addressable market and offers new revenue streams



Source: Ericsson.

IoT aims to meet specific requirements. Basic, non-mobile, limited coverage cases may be served well by Wi-Fi and other technologies. IoT in networks implementing 3GPP technology is typically about wide area coverage, high-end applications based on 5G and applications where security is of high importance. When deploying IoT, enterprises and application providers can benefit from improved battery management and the device control that are offered by massive IoT networks.

Openness in interfaces, combined with open standardized device and application design, is key in allowing reliable and secure solutions. Security ranks highly in IoT surveys. With the growing number of connected devices, the number of attack points increase. As critical infrastructures become connected, the potential for damage and data misuse is huge. Protecting personal information, company data, and critical infrastructure are vital priorities, and security must span the IoT value chain.

A standardized approach can help unlock value. This complexity leads to the necessity of orchestration and collaboration to get to scale the true benefit of IoT. Interoperability can be facilitated by using key standards:

- Lightweight specifications can enable key device features (including bootstrapping, firmware updates, error reporting, etc.).
- Smart objects and reusable design can build more complex objects in different IoT segments.

By 2026, there could be a USD 619 billion revenue opportunity for telecom operators addressing industry digitalization with 5G technology, with the largest opportunities in manufacturing, energy and utilities, and public safety. As 5G IoT becomes integral to industry, 5G-enabled revenues for operators will grow. Investments in 5G networks, business models and organizational adaptation are also needed. Standards and alliances are the vehicle for scale in IoT.

The business case of industry digitalization fueled by IoT & 5G



Source: Ericsson. Ericsson's, *The guide to capturing the 5G-IoT business potential* <https://www.ericsson.com/en/networks/trending/insights-and-reports/5g-challenges-the-guide-to-capturing-5g-iot-business-potential>

In the UK, the regulator OFCOM conducted a study entitled “*Review of latest developments in the IoT*”, which identified applications with the largest number of connections, examined which technologies are likely to be adopted, and identified critical issues for regulation. It is hoped that this study can give some assurance to operators, prospective licence holders and IoT partners on the views of the regulator.

example, in 2017, the Telecommunications Regulatory Commission of Jordan launched a green paper on IoT with the goal of inviting comments from the industry and public at large on many facets of IoT deployment including spectrum, security, addressing, data analytics, permanent roaming, etc. Similarly, in Saudi Arabia, CITC has launched a public consultation to examine the impact of the launch of IoT, virtual network operator licences and issues around IoT.

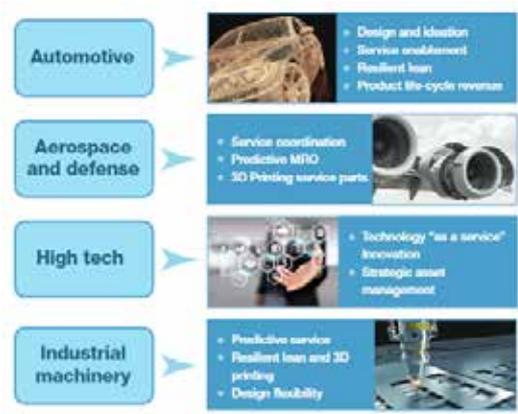
Governments in the Middle East are beginning to look closely at the impact of IoT. For

Figure 9: How IoT is Driving Change

IoT Changes the Paradigm across Businesses



Specific Manufacturing Sectors



Source: IDC, “*The IoT Imperative for Discrete Manufacturers: Automotive, Aerospace and Defense, High-Tech, and Industrial Machinery*”, 2017, available at: <https://www.sap.com/cmp/dg/sapleonardo-discrete-manufacturing-industries/typ.html>

Table 3: Different Technologies Used for IoT

	Government & Private Sector	Non-MNO Service Providers	Traditional Mobile Network Operators (MNOs)
High Mobility	PMR/TETRA Private LTE (rare) Private MVNO Satellite Vertical-specific (e.g. auto)	Satellite & HAPs MVNOs	4G & 5G Mobile Broadband LTE-Cat M1+ Legacy 2G and 3G Hybrids/multi-network
Low Mobility	Wi-Fi Bluetooth, ZigBee LoRa/LoRaWAN CBRS/Multefire NB-IoT unlicensed? Other LPWA & industrial	Wi-Fi SigFox, LoRa, other LPWA NB-IoT unlicensed MVNOs Multi-network	NB-IoT (especially China) 4G/5G Mobile BB + M1 Legacy 2G and 3G Wi-Fi Some LoRa, SigFox

Source: *Disruptive Analysis/Rethink Wireless*.

2.4 Towards the Next Generation of Satellite Broadband

There has been significant recent technological evolution in satellite technologies, which offer broadband capacity across the globe, bringing reliable connectivity to the hardest-to-reach corners of the Earth⁴¹. High-Throughput Satellite (HTS) systems can use multiple spot beams and sophisticated ground infrastructure to provide speed and capacity similar to terrestrial technologies in many cases. Recently deployed and upcoming non-geostationary satellite orbit (NGSO) systems in low-Earth orbits can now provide low-latency connectivity supporting a wide range of applications. And advances in satellite construction and competitive pressures are reducing the cost of services for users.

Satellite connectivity is starting to compare favourably with terrestrial wired solutions in terms of cost versus capacity in many developed and developing country scenarios. Advanced satellite systems have recently been launched or are planned for the near future. As the technology and market continue to evolve, satellite capabilities will continue to improve, while their cost will fall significantly, bringing satellite services in line with terrestrial solutions.

In terms of coverage, satellites are an effective means for reaching remote and rural areas, as well as passengers in

mobile environments, aircrafts and ships, as well as for use in emergency situations. Integrating satellite connectivity into terrestrial systems can help improve quality of experience (QoE) by intelligently routing traffic with different demands for speed and latency between delivery systems.

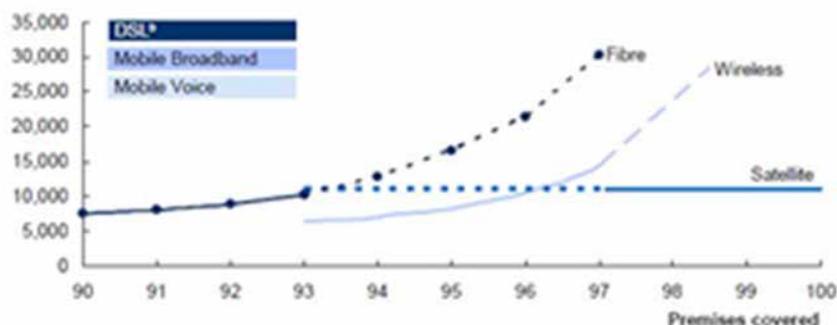
Satellite technology can also help relieve congestion and overloading of networks. In future, it will support 5G and ensure connectivity in times or areas where terrestrial networks are unavailable. Lower frequency band satellite services are ideal for high-reliability and mobility applications, including safety services.

Satellite systems should be given consideration as complementary solutions for next-generation broadband network deployments in rural and remote areas, as well as in diverse environments and deployment scenarios. Viewpoint 9 considers how partnerships can be used to advance satellite connectivity, while Viewpoint 10 explores the role of Governments in promoting connectivity using satellite broadband.

Viewpoint 9: Banding Together to Go Farther, Faster

The satellite industry has benefited from unprecedented innovation and technical improvements, enabling a revolution in the cost, quality and provisioning of broadband around the world. Smaller ground terminals are more affordable

Box Figure: Cost Comparison of Different Technologies for Connecting the Final 10% of Customers



Capital Cost AUD per Premises Activated (includes capitalised opex and the discounted value of replacement capex)
Source: State of Broadband 2013 report.

and easier to install than ever before, often allowing for self-installation in several hours and without trained technicians. Electronically steerable antennas are better suited to enable mobility services, allowing for satellites to communicate with terminals on vehicles, trains, vessels and airplanes. Smaller satellites in new orbits closer to Earth minimize latency issues. High-throughput satellites (HTS) with steerable spot beams can provide up to ten times the throughput of traditional satellites, and be configured to cover zones of high or imminent demand.

Software-defined payloads now allow for the purchase of “off-the-shelf” satellites which, once in space, can be modified to maximize their efficiency and output by altering frequencies, beams and throughput based on demand. There are now ways to “refuel” satellites in space, thus extending the in-orbit life span of a spacecraft by several years. Further, the current race to introduce reliable, affordable and reusable launch vehicles helps to make satellite services more economical.

Technological advances are improving the speed and quality of today’s satellite solutions, as well as decreasing costs and making satellite services more accessible for everyone. Satellite communications can be tailored according to user requirements and in many cases provide the best and most economical solution (see figure).

Satellite is an integral part of the universe of broadband solutions, even in relatively mature markets, as illustrated by the fact that the U.S. and Europe are amongst the largest global markets for satellite broadband connectivity.

Satellite provides many advantages for the deployment of broadband solutions:

Instant Infrastructure – Antennas can be installed in hours, enabling remote villages to be connected in a couple of days. Thanks to recent innovations, small and portable antennas can easily be transported (or even hand-carried) to even the most remote place and over rugged terrain.

Flexible/Re-usable – Satellites are ideal for terrestrial operators to extend their networks. Once the terrestrial network has reached a remote location, a satellite terminal can be re-installed at a different location, further away.

Scalable – Satellite solutions can be easily scaled up to demand, separately for upload and download speeds, to grow with the requirement of usage on an ‘as needed’ basis.

Solar-Powered – Today’s small antennas require less power and can use solar panels to compensate for the lack of reliable power in many locations and eliminate the need for diesel generators and fuel.

Mobility Capabilities – Steerable antennas can ‘lock’ onto the satellite and enable excellent mobility solutions to airplanes, trains, vessels and vehicles. For example, medical vehicles connected via satellite can serve as ‘mobile hospitals’, transferring test results and medical data to hospitals.

Resilient – Satellite solutions are resilient during natural disasters such as earthquakes or floods.

Source: Stephen Spengler, Intelsat.

Viewpoint 10: The Role of Satellite in National Broadband Plans (NBPs)

Governments should strive to foster markets that are accessible to all and allow the innovative use of technologies. For satellite operators to be able to enter the market, it is important that there is a legal and regulatory structure that is unboxed by legacy rules, or otherwise limit the number of independent service providers that are permitted to provide satellite services to consumers. Competition between a large number of market players encourages investment in infrastructure, the provision of new services, improvements in quality and availability of lower prices⁴².

Furthermore, governments should take satellite technologies into consideration in their NBPs. As such, it is essential to add a strategy or specific goal on satellite solutions for hard to reach areas. NBPs need to recognize satellite technology as an essential element to provide broadband access to rural, remote or geographically challenged areas of the country. Governments need to leverage the use of satellite technology in those areas where terrestrial broadband technologies are not feasible.

In the United States, the Federal Communication Commission (FCC) reformed and modernized their USF into the Connect America Fund (CAF) to maintain voice services

and extend broadband-capable infrastructure. Through the CAF, the FCC will use alternative approaches, such as satellite broadband, to address the costliest areas, minimizing the burden on consumers, and is also considering means-tested consumer subsidies for satellite service⁴³. In the Philippines, the Broadband Plan sets out future projects for broadband connectivity using satellite.

In conclusion, national governments can truly make a difference in bridging the broadband gap by taking advantage of technologies such as satellite to bring reliable connectivity to unconnected areas and create an effective solution to expand Internet reach. To support satellite connectivity initiatives, governments should ensure that they have an effective regulatory environment, are bolstering demand and lowering the cost of infrastructure. Governments are not alone in this endeavor, and can count on support and advice from international organizations and donor institutions to help broker partnerships with private sector actors and through combined efforts to enable the implementation of projects.

Checklist for Utilizing Broadband to Bridge the Digital Divide

The following checklist comprises the ten top policy elements as a starting point for countries willing to utilize satellite broadband to help bridge the digital divide:

- Acknowledge the urgent need to serve rural populations in government policies and regulations.
- Identify rural, remote, and low-population density communities needing broadband coverage, which cannot be served by terrestrial media.
- Include satellite broadband as an available alternative and integral part of any NBP.

- Identify region-wide needs and develop projects to cover countries on the same satellite coverage footprint so as to share capacity.
- Acquire unbiased, professional, technical, financial, and management expertise to develop optimal network design on a case-by-case basis, inclusive of rural customer requirements.
- Consider new technologies available for the future broadband markets, such as HTS and/or medium earth orbit (MEO) systems.
- Consider, define, and implement financing policies for broadband services in remote areas, including broadband, USFs, tax incentives and/or government funding for pilot projects.
- Identify potential partnerships with international organizations, multilateral development banks, and satellite operators for specific projects.
- Stimulate demand for broadband services by making services affordable, increasing digital literacy, and ensuring that there is relevant local content available.
- Conduct capacity-building workshops with stakeholders on technical and policy issues.

Source: Excerpt from ITSO-IADB (2016), "The Provision of Satellite Broadband Services in Latin America and the Caribbean", page 104, available at: <https://publications.iadb.org/bitstream/handle/11319/7843/The-Provision-of-Satellite-Broadband-Services-in-Latin-America-and-the-Caribbean.pdf?sequence=1&isAllowed=y>.

Source: Patrick Masambu and Piotr Dmochowski-Lipski, ITSO/EUTELSAT IGO.

Endnotes

- 1 “We Are Social Internet report”, January 2018, available at <https://wearesocial.com/blog/2018/01/global-digital-report-2018> based on data from Global Web Index.
- 2 “ICT4D Report 2018: Data-Driven Development”, World Bank, Washington, forthcoming.
- 3 www.digitaltvnews.net/?p=27026
- 4 “LTE Subscriber Base to Grow to 1.4 Billion Globally by Year-end 2015”, ABI Research, 12 June 2015, available from: <https://www.abiresearch.com/press/lte-subscriber-base-to-grow-to-14-billion-globally/>
- 5 www.totaltele.com/view.aspx?ID=493950
- 6 Figures for December 2015 and March 2016 available from: <http://newsroom.fb.com/company-info/>
- 7 “The Global Smartphone Report: The forces behind the global deceleration in smartphone sales”, Business Intelligence, 29 March 2016.
- 8 World Investment Report 2017, UNCTAD, Geneva.
- 9 Cisco Virtual Networking Index 2017.
- 10 <https://www.whatsapp.com/about/>
- 11 <https://www.viber.com/en/about>
- 12 “Artificial Intelligence: Re-Imagining Big Data's Applicability”, available at: www.cxotoday.com/story/artificial-intelligence-re-imagining-big-datas-applicability/
- 13 “Digital Universe Invaded By Sensors”, available at: <https://www.emc.com/about/news/press/2014/20140409-01.htm>
- 14 Point Topic, available at: <http://point-topic.com/free-analysis/world-broadband-statistics-q3-2017/>
- 15 <https://theinclusiveinternet.eiu.com/>
- 16 https://www.telegeography.com/products/commsupdate/articles/2018/03/02/vodafone-launches-1gbps-4g-in-italy/?utm_source=CommsUpdate&utm_campaign=801ea811df-CommsUpdate+02+March+2018&utm_medium=email&utm_term=0_0688983330-801ea811df-11619241
- 17 https://www.telegeography.com/products/commsupdate/articles/2018/03/02/ooredoo-lte-coverage-reaches-90-of-oman/?utm_source=CommsUpdate&utm_campaign=801ea811df-CommsUpdate+02+March+2018&utm_medium=email&utm_term=0_0688983330-801ea811df-11619241
- 18 https://www.telegeography.com/products/commsupdate/articles/2018/04/24/mts-expands-4g-lte-coverage-to-new-cities-in-minsk-region/?utm_source=CommsUpdate&utm_campaign=fc59a2c57e-CommsUpdate+24+April+2018&utm_medium=email&utm_term=0_0688983330-fc59a2c57e-11619241
- 19 “China to blaze Connectivity Trail with a Billion 5G users by 2023”, TechRadar, 18 October 2017, available at: www.techradar.com/news/china-to-blaze-connectivity-trail-with-a-billion-5g-users-by-2023
- 20 https://www.telegeography.com/products/commsupdate/articles/2017/11/30/verizon-launching-5g-fixed-wireless-residential-broadband-in-2h18/?utm_source=CommsUpdate&utm_campaign=e0d374e528-CommsUpdate+30+November+2017&utm_medium=email&utm_term=0_0688983330-e0d374e528-11619241
- 21 https://www.telegeography.com/products/commsupdate/articles/2018/02/27/ooredoo-strengthens-nokia-partnership-for-5g-rollout/?utm_source=CommsUpdate&utm_campaign=95977c6891-CommsUpdate+27+February+2018&utm_medium=email&utm_term=0_0688983330-95977c6891-11619241
- 22 <https://gsacom.com/building-5g-data-analytics-artificial-intelligence>
- 23 <https://www.ihf.com/Info/0117/5g-technology-global-economy.html>
- 24 Chapter 2, “Data-Driven Development”, Global ICT4D report, World Bank, forthcoming.
- 25 Research ICT Solutions, *OTTs: Impact on Operator Revenues*, 1 May 2018. See presentation of research findings at: <https://researchictsolutions.com/otts-threat-or-opportunity-for-african-telcos/>
- 26 Wissenschaftliches Institut für Infrastruktur und Kommunikationsdienste, *The Economic and Societal Value of Rich Interaction Applications (RIAs)*. http://www.wik.org/fileadmin/Studien/2017/CCIA_RIA_Report.pdf
- 27 <https://www.mckinsey.com/industries/telecommunications/our-insights/the-road-to-5g-the-inevitable-growth-of-infrastructure-cost?cid=other-eml-alt-mip-mck-oth-1802&hlkid=4108a3016b4842dfac490f90465f61f4&hctky=9411404&hdpid=11560416-85ad-4de7-99a9-f0dc73b2ca57>

- ²⁸ Due to the higher concentration of traffic (measured in traffic load per square kilometer) and the use of higher spectrum bands above 3 Gigahertz.
- ²⁹ Source: Deloitte Global Survey of Mobile-Only Adults, August-October 2017. Sample sizes: Turkey (290), France (103), Spain (168) and Russia (171). As reported in Deloitte TMT Predictions 2018, available from: <https://www2.deloitte.com/global/en/pages/technology-media-and-telecommunications/articles/tmt-predictions.html>
- ³⁰ Deloitte TMT Predictions 2018, available from: <https://www2.deloitte.com/global/en/pages/technology-media-and-telecommunications/articles/tmt-predictions.html>
- ³¹ Deloitte TMT Predictions 2018, available from: <https://www2.deloitte.com/global/en/pages/technology-media-and-telecommunications/articles/tmt-predictions.html>
- ³² Point Topic, available at: <http://point-topic.com/free-analysis/world-broadband-statistics-q4-2017/>
- ³³ “Algérie Telecom announces major FTTH deployment”, available at: https://www.telegeography.com/products/commsupdate/articles/2018/01/31/algerie-telecom-announces-major-ftth-deployment/?utm_source=CommsUpdate&utm_campaign=742b676a11-CommsUpdate+31+January+2018&utm_medium=email&utm_term=0_0688983330-742b676a11-11619241
- ³⁴ <https://www.btplc.com/News/#/pressreleases/results-for-the-third-quarter-to-31-december-2017-2401079>
- ³⁵ https://www.telegeography.com/products/commsupdate/articles/2018/04/17/tim-brasil-launches-2gbps-ftth-in-sao-paulo-rio-de-janeiro/?utm_source=CommsUpdate&utm_campaign=454a2f71ca-CommsUpdate+17+April+2018&utm_medium=email&utm_term=0_0688983330-454a2f71ca-11619241
- ³⁶ Verizon, NTT, AT&T: ?\$200-\$400 5G Costs Much Lower Than Expected <http://bit.ly/Hans200400>
- ³⁷ “300,000 Indian Villages Fibered; 325,000 More To Come”, available at: <http://bit.ly/600KIndia>
- ³⁸ According to Intel, a self-driving car could generate up to 4’000 Gigabytes of data per hour of driving, see: www.networkworld.com/article/3147892/internet/one-autonomous-car-will-use-4000-gb-of-dataday.html
- ³⁹ Page 61, “Digital Economy Outlook 2015”, OECD, available at: <http://ec.europa.eu/eurostat/documents/42577/3222224/Digital+economy+outlook+2015/dbdec3c6-ca38-432c-82f2-1e330d9d6a24>
- ⁴⁰ <https://www.ericsson.com/en/press-releases/2018/6/5g-on-a-roll-cellular-iot-deployments-ramping-up-ericsson-mobility-report>
- ⁴¹ “Report of the Broadband Commission. Working Group on Technologies in Space and the Upper Atmosphere. 2017”, available at: www.broadbandcommission.org/workinggroups/Pages/spacetechnology.aspx
- ⁴² Report of an Expert Group presented to the Broadband Commission, “A New Deal: Investing in Our Common Future”, 2018.
- ⁴³ US Government “National Broadband Plan” 2010, p. 150, at: <https://transition.fcc.gov/national-broadband-plan/national-broadband-plan.pdf>