The Future of Mobile Broadband

How mobile operators can deliver the connected life between now and 2025

February 2017
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Technological advances are opening up a myriad of new business opportunities for mobile operators around the world. Drawing on interviews with a cross section of industry executives and extensive desk research, this report explores the opportunities they provide for new service propositions in the consumer, household and business markets, before outlining how mobile operators can move up the value chain by adopting new business models and working with partners to fuel innovation.
A better connected life outdoors

Both consumers and business people are increasingly using their mobile devices to consume video while they are out and about. They watch videos on the bus or train, stream footage of live events and make video calls from almost anywhere. In fact, mobile devices are gradually becoming the primary screen for consuming video content, taking over from television.

At the same time, mobile games are becoming increasingly sophisticated and demanding. The augmented reality phenomenon Pokemon GO hints at the kind of immersive entertainment that is becoming possible as computing and connectivity technologies advance. In particular, augmented and virtual reality looks set to transform entertainment. This has huge implications for mobile operators: the more bandwidth and the lower latency, the better the virtual reality.

A better connected life in the household

Mobile operators are increasingly serving households and families, as well as individuals, opening up new revenue opportunities. The provision of home broadband access (fiber or wireless) provides operators with a solid foundation from which they can expand into the market for smart home services. As mobile technology evolves from 3G to 4G, 4.5G and 5G, providing more and more network capacity, the cost of providing wireless home broadband services is falling.

Huawei estimates that only 36% of the approximately 2.2 billion households worldwide have fixed-line Internet access. Most of the remaining 64% will use mobile networks to get online, as a fixed broadband connection typically costs a consumer about twice the price of a mobile broadband connection. Huawei forecasts that 300 million families will use wireless home broadband by 2020 and a further 100 million families with fixed-line speeds of less than 10Mbps will use wireless home broadband to obtain a faster connection. By 2025, those numbers will have increased to 480 million and 200 million respectively.

A better connected life in the car

Rising car ownership and increasing congestion means that people spend a growing amount of time in their vehicles. During these journeys, drivers and passengers want access to information, communications and entertainment services delivered via wireless services. Connectivity can enable on-demand music, navigation and real-time traffic status, usage-based insurance, remote diagnostics, automated emergency calls, driver assistance systems and many other services that can make car journeys easier, safer and more enjoyable. For mobile operators, the connected car market opens up multiple business opportunities, which will grow over time. Huawei estimates the addressable market for mobile operators will grow three to fourfold between 2016 and 2022. There is the potential to earn US$92.3 billion from infotainment and telematics services, such as mobile data traffic, web-based entertainment, call center support and remote diagnostic services by 2022 and US$21 billion from fleet management for enterprise customers. Moreover, Huawei estimates the addressable market for V2X services, which enable vehicles to communicate with other vehicles and infrastructure, will be worth US$31.5 billion in 2022.

A better connected life at work

Working life is being transformed by always-available connectivity. Mobile broadband enables business people to spend less time in an office or factory and more time with customers or partners. Telepresence services enable people to use smartphones, tablets or PCs to have meetings at any time in any location. Mobile operators can also bring broadband connectivity to small businesses lacking fixed lines or as backup connectivity in case the fixed-line fails. To successfully serve this market, mobile operators will need to ensure they provide highly reliable coverage indoors. By 2025, Huawei anticipates there will be 50 million SMEs using wireless broadband.
Mobile operators need to bring greater value to their existing customers by being more responsive to their requirements and providing more personalized services.

This report explores the opportunities for mobile operators to open up new revenue streams and provide greater value to both consumers and businesses.

Drawing on interviews with a cross section of industry executives and extensive desk research, this report explores the role of mobile operators in the consumer market and how that role will change over the next five to 10 years. As entertainment, communication and information services become increasingly bandwidth-hungry, consumers are seeking high-speed connectivity on the move, in the home, in the car and at work. For operators, meeting that demand is both a challenge and an opportunity.
Mobile broadband networks are delivering high-speed and very responsive connectivity across cities, towns and villages, reaching deep inside buildings. These networks have put an array of information, entertainment and communications services at people’s fingertips, enabling them to improve their lives. Today, there are about four billion mobile broadband (3G and 4G) connections worldwide. By 2020, Huawei anticipates that figure will climb to 6.2 billion, and by 2025, to 8.5 billion (see Figure 1). These connections will enable new categories of services that will increasingly integrate the physical and digital worlds, improving individuals’ quality of life and boosting their productivity. For mobile operators, mobile broadband services provide a solid foundation on which they can develop new digital services. Their success in the digital services market will depend to a large degree on the size of their mobile broadband subscriber base.

As entertainment, communication and information services become increasingly bandwidth-hungry, consumers are seeking high-speed connectivity on the move, in the home, in the car and at work. For operators, meeting that demand is both a challenge and an opportunity.
How mobile broadband is changing daily living

Mobile broadband connections are getting faster and more responsive, transforming the user experience. By 2025, 2.5 billion people will have a gigabit (4.5G or 5G) wireless connection capable of delivering data at 1Gbps. With such a fast connection, users can download 25 songs in one second, a TV show in three seconds and an HD film in 36 seconds.

Insights from operators

“By making use of all available technologies, we can still increase revenues by providing higher speeds. One of the technologies we developed is GiGA LTE, which aggregates LTE and Wi-Fi to provide better throughput. Based on the GiGAtopia vision, we are upgrading access networks with GiGA speed...KT is really strong on the access side and it is really working in the market. We have to have a good network to provide good services.”

Byungki Oh,
VP, Global Business Collaboration Global Business Group, KT Corp

“Consumer experiences, like virtual reality and 360 video, will require CDNs, mobile operators and last mile networks to provide throughput to devices at a much higher rate than today. The capacity needed for a 4k video can quickly grow to the equivalent of 8k and 16k for VR and 360 video. Today we're supporting several customers who stream 4k, 360 video, and VR, and we will continue to grow our network and peering agreements in anticipation of these exciting new video experiences.”

Jonathan DiVincenzo,
VP, Product Management at Verizon Digital Media Services.

“The shift to data has a profound impact on gross margins. Revenue growth has slowed, but margin can grow strongly because data doesn’t need to be terminated on another network, so the transition can push margins up to 60% to 70% from 40% to 50%. YouTube and other social video services have been an enormous stimulus on our network and we sell connectivity by the meter. We have done a number of comparative calculations of how much we earn from an hour’s YouTube browsing versus what Google earns. Our capital is much higher, but our revenue is also higher.”

Andrew White,
Chief Strategy Officer, Zain Saudi Arabia
Indeed, there will be a step change in the capabilities of mobile networks over the next five to 10 years. Even at the edge of a cell, users will enjoy a high-speed broadband connection. Average network speeds at the edge of cells are set to increase six-fold by 2025 (see Figure 2). By then, 85% of the global population will be able to experience throughput speeds of at least 30Mbps.

**Figure 1: The growth in global mobile connections excluding cellular M2M**

![Figure 1: The growth in global mobile connections excluding cellular M2M](image)

**Figure 2: The performance of mobile networks will improve dramatically**

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<th>2016</th>
<th>2020</th>
<th>2025</th>
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<td>Average data traffic consumption per month</td>
<td>0.9GB</td>
<td>8.2GB</td>
<td>30GB</td>
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<td>Cell edge experience rate</td>
<td>5 Mbps</td>
<td>10Mbps</td>
<td>30Mbps</td>
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Source: Huawei Global Industry Vision 2016 & Huawei Wireless X Labs
Building the gigabyte society

Mobile operators around the world are moving rapidly towards providing gigabit connectivity. For example, in South Korea, SK Telecom, has launched a 500Mbps LTE-A service thanks to the use of five-band carrier aggregation, and, by 2019, an even faster 1Gbps downlink. Looking to build a “bridgehead for the development of 5G technology,” SK Telecom plans to launch the faster network service first in the capital city of Seoul by 2018 and expand coverage to 90 per cent of the country the following year employing more than 90,000 base stations.

Operators say that high-speed connectivity is helping them to build stronger ties with customers. Presenting to financial analysts at the end of 2015, US operator AT&T drew a direct link between the strength of its 4G LTE network and its high scores in customer experience research, saying its net promoter score (a widely-used customer experience metric) is 2.5 times that of cable companies.

The growing availability of very high-speed and very responsive connections is enabling the development of exciting new service propositions. Over the next three to five years, the expansion of low-cost broadband will enable consumers and businesses to enjoy a growing range of multimedia communications, information and education services in high definition. Within a decade, the arrival of very low latency connections will enable users to easily tap artificial intelligence and augmented reality services, or immerse themselves in virtual reality sports, gaming and movies. Moreover, the smart home, the connected car, and digital financial services will all become commonplace, transforming daily life and wider society and the broader economy.

Huawei estimates that, by 2025, consumers worldwide will collectively be using 40 billion connected devices, of which 20 billion will be smart home appliances (see Figure 3). By then, 20% of the people worldwide will have more than 10 smart devices, while app-enabled virtual connections to various services, people, things, families and office interoperability, will enrich people's daily lives.

Figure 3: The total number of personal smart devices worldwide by 2025

Source: Huawei Global Industry Vision 2016
Increasingly rich services will generate huge volumes of traffic on mobile networks. People will no longer wait to be on Wi-Fi – they will want to be online continuously wherever they are. Huawei anticipates that mobile traffic will grow 30 times between 2016 and 2025. The average person will consume 1GB of data traffic per day in 2025, compared with 8.2GB per month in 2020 and 900MB per month in 2015. Increasingly regarded as a basic digital right of modern society, ubiquitous wireless broadband will be at the heart of a fast-growing digital economy.

Mobile broadband connectivity will bring major changes in four key aspects of daily life:
- Connected life outdoors
- Connected life in the household
- Connected life in the car
- Connected life at work

Figure 4 shows the average time Americans spend in different environments, according to the American Time Use Survey Summary. The survey found the boundary between the office and household is blurring.
A better connected life outdoors: Enjoy high-speed entertainment anytime, anywhere

Mobile video everywhere

People want to enjoy multimedia entertainment communications and information services wherever they are. Both consumers and business people are increasingly using their mobile devices to consume video while they are out and about. They watch videos on the bus or train, stream footage of live events and make video calls from almost anywhere.

In fact, mobile devices are gradually becoming the primary screen for consuming video content, taking over from television as the main conduit for entertainment. Today, people with a mobile device spend an average of two hours a day using that device and Huawei believes that figure will rise to 3.5 hours by 2020 and 5.5 hours by 2025 (see Figure 5). Consumers increasingly use their mobile devices to access on-demand content, rather than watching linear broadcast TV.

Figure 5: The time people spend on mobile devices is rising rapidly

5.5 hours spend on mobile devices

| Average time spent on mobile devices per day |
|-----------------|----------|
| 2016            | 2 hours  |
| 2020            | 3.5 hours|
| 2025            | 5.5 hours|

Source: Huawei Wireless X Labs
Immersive entertainment goes interactive

At the same time, mobile games are becoming increasingly sophisticated and demanding, evolving from the simple Snake game through Angry Birds, Candy Crush Saga to Clash of Clans and the augmented reality phenomenon Pokemon GO. Pokemon GO uses augmented reality and GPS signals to superimpose cartoon characters on images of the real world viewed through the smartphone camera. To progress in the game, players need to move around the real world capturing the cartoon characters, making a mobile broadband connection indispensable.

Pokemon GO hints at the kind of immersive entertainment that is becoming possible as computing and connectivity technologies advance. In particular, virtual reality looks set to become a major form of entertainment. Whereas augmented reality services superimpose information and graphics on live images of the user’s immediate vicinity, virtual reality applications surround people with either live or recorded images of another location, be that in the real world or a fantasy world. For example, consumers wearing head-mounted displays could watch live streams of sports or music events in 360-degree virtual reality.

Now being developed by NextVR, JauntVR, Otoy and others, real-time virtual reality could be used to sell virtual seats in stadiums to fans or give them behind-the-scenes access to sports stars and performers’ preparations. In this way, it could open additional revenue models for sports and entertainment companies through sponsorship sales, subscriptions, and pay-for-view.

Enabling technologies

By 2025, mobile broadband networks will be able to support ubiquitous HD video streaming with high quality assurance. The coverage of video services will be close, or even reach, the coverage of voice service, thanks to a new network planning methodology designed to support the mobile video experience.

The falling cost of head-mounted displays, and the integration with smartphones is likely to fuel demand for virtual reality content and sales of specialist cameras that can capture still and moving 360-degree images. It will also drive demand for better mobile broadband. As virtual reality is a bandwidth-intensive application, both the content producer and the viewer may be prepared to pay a premium for fast and reliable broadband connections. At a live event, a wireless connection will typically be the most cost-effective and flexible option.

The more bandwidth, the better the virtual reality. Humans can process an equivalent of nearly 5.2 Gbps of sound and light, according to Bo Begole, VP and global head of Huawei Technologies’ Media Lab5.

To realize their full potential, virtual reality, augmented reality, ultra-high definition video, telepresence and the remote control of machinery, robots and drones will require ubiquitous, fast and robust wireless broadband. Figure 6 shows the network requirements for an augmented reality and location-based game, such as Pokemon GO, and how they are likely to evolve.

For mobile operators, augmented reality and virtual reality services will increase the number of connections, as well as the volume of traffic on their networks, thereby generating new revenues. Figure 7 shows how adoption of augmented reality and virtual reality equipment is set to grow, according to Huawei.

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<th>GPS location</th>
<th>Pokemon GO</th>
<th>Next iterations</th>
<th>Future iterations</th>
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<tr>
<td>E2E RTT time delay</td>
<td>50ms</td>
<td>20ms</td>
<td>5ms</td>
</tr>
<tr>
<td>Experience data rate</td>
<td>5Mbps</td>
<td>30Mbps</td>
<td>150Mbps</td>
</tr>
<tr>
<td>Traffic consumption</td>
<td>30M per hour</td>
<td>200M per hour</td>
<td>1G per hour</td>
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Source: Huawei Wireless X Labs

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<th>AR/VR</th>
<th>2020</th>
<th>2025</th>
<th>2020–2025 CAGR</th>
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<td>AR+VR equipment</td>
<td>186 million</td>
<td>804 million</td>
<td>34%</td>
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<tr>
<td>VR equipment</td>
<td>117 million</td>
<td>504 million</td>
<td></td>
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<tr>
<td>AR equipment</td>
<td>69 million</td>
<td>300 million</td>
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Source: Huawei Wireless X Labs
Mobile operators around the world are already capitalizing on the growth in on-demand entertainment both by distributing the content and providing the underlying connectivity. Here are some examples:

- Video services now generate €2.14 billion per year for the Madrid-based telecoms group Telefónica, about 5% of total revenues. In 2015, Telefónica’s video revenues were up 27%.

- Deutsche Telekom has said that its video proposition “Binge On” has proven highly popular with US customers. Its revenues increased 8.1% in US dollars in 2015.

- Reporting its 2015 annual results, China Mobile said it now has 5.67 million customers for a high-definition Internet video-on-demand service delivered via its self-branded set-top box. “Concurrently, we have pushed forward the construction and operation of CDN and other internet content distribution networks, thus improved our internet content delivery capability and our handset on-net hit rate continued to increase,” the operator added.

- Leading US operator AT&T estimates that mobile video traffic will grow by 66% per year between now and 2020 as people spend more and more time viewing content on smartphones.

- Presenting its annual results in May 2016, multinational mobile operator Vodafone said: “Customer demand for data continues to grow very quickly, stimulated by the increasing availability of great TV, sport and video on smartphones and tablets, the improving reliability and speed of mobile networks, the continued deflation in unitary data pricing, and the increasing size and quality of smartphone screens.” In Italy, Vodafone says the provision of 95% 4G coverage has enabled it to ensure 91% of data sessions achieve speeds of at least 3Mbps (enough to stream video on a smartphone) and become a clear number one in terms of NPS (net promoter score). That helped Vodafone Italy put in a strong commercial performance: the operator’s ARPU has increased and its churn has fallen as it has rolled out 4G.

**Insights from operators**

"Video and gaming is something we are focusing on, as an aggregator and curator, rather than as a producer. In augmented reality, Pokemon Go has shown the way and how addictive this kind of gaming can be."

Dieter Trimmel,  
Director of Group Strategy at the Telekom Austria Group

"Virtual reality and augmented reality are big opportunities. We are creating virtual reality content and live VR broadcasting of professional baseball games (for KT Wizs - KT owned professional baseball team in Korea)."

Byungki Oh,  
VP, Global Business Collaboration Global Business Group, KT Corp

"Our TV Plus platform is providing a new revenue stream. Launched in 2016, we have already seen 2.3 million downloads. And users on our Fizy music platform stream two million songs a day."

Aysem Ertopuz,  
Turkcell Group Chief Strategist and Director of Subsidiary Management

"Immersive augmented and virtual reality need low latency, which has a lot to do with distance and plays to our strengths. With live sport, for example, you can watch it with a friend on the other side of the city and their avatar will celebrate when you celebrate. We will use edge computing as you need to reduce the time for transporting it and to offload composition of the video stream as we think the battery in a smartphone will also be a major limitation."

Franz Seiser,  
VP Core Network and Services, Europe & Technology, Deutsche Telekom

**Operators in action**

Mobile operators around the world are already capitalizing on the growth in on-demand entertainment both by distributing the content and providing the underlying connectivity. Here are some examples:

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A better connected life in the household: Fast and low-cost connectivity for the home

The smart home is the lynchpin for the future proposition for an operator. The in-home environment is complex and doesn't always work. You need to get the wireless signal into every corner of the house and the garden and the basement. The service capabilities of the operator are a key asset. You need a local service capability and big Internet players can't provide it.

Dieter Trimmel, Director of Group Strategy at the Telekom Austria Group

Device makers want it to be more convenient to connect additional devices, such as laptops, tablets, and bicycles, for an incremental sum of money to the main mobile subscription. That will drive usage and ARPU uplift... People may upgrade from our standard 20 Gb allowance in Sweden to 50 GB and 100 GB. We are currently piloting this kind of offering in the Swedish market.

Lars Torstensson, EVP, New Growth & Strategy at Tele2.
Serving families and smart homes

Mobile operators are increasingly serving households and families, as well as individuals. In many cases, they are providing family tariffs, in which the data allowances are shared between individual members, while some operators now offer a converged fixed and mobile proposition for a household. Operators say that customers are less likely to switch out of family plans, reducing their sales and marketing costs.

Moreover, the provision of home broadband access (fiber or wireless) provides operators with a foundation from which they can expand into the market for smart home services. In future, each household will have hundreds of connected sensors supporting home security and safety, video streaming, video surveillance and health monitoring. By 2025, every gadget, TV, appliance, and even broom closet will be fitted with a wireless chip, enabling consumers to remotely monitor and control their home. The smart home could also become a virtual shopping mall: in time, consumers are likely to stream holographic images and virtual reality content to browse through products and services from the comfort of their living rooms or kitchens.

The expanding role of wireless

Huawei estimates there are 1.3 billion households worldwide that have no internet access, and 300 million households with low speed internet access providing less than 10Mbps.

Although fixed broadband can provide a stable and high performance broadband connection, deploying last mile fixed connections requires a large amount of civil work. In many countries, fixed broadband deployment is costly and slow due to difficulties gaining access to private land or geographical barriers, and the cost of connecting isolated households can limit further development. According to research firm Ovum, the number of fixed broadband connections is only growing at 2.6% per annum (see Figure 9).

<table>
<thead>
<tr>
<th>No internet access</th>
<th>1,300 million</th>
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<td>Have internet access of less than 10Mbps</td>
<td>300 million</td>
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Figure 8: A minority of households worldwide have internet access

Figure 9: The number of fixed line connections

Source: OVUM Total Fixed Broadband Subscription and Revenue Forecast: 2016
As many households don’t have a fixed line connection, providing wireless broadband to homes represents a large potential market for mobile operators. Wireless broadband technology is a cost-effective way to bring broadband to households quickly, offering a rapid return on investment, and is an effective supplement to fiber. The enormous potential to provide wireless broadband services to households in emerging markets is one of the reasons that many operators have expanded from developed regions, such as Western Europe, to developing countries, such as India, Latin America, and Sub-Saharan Africa. Bringing wireless broadband, entertainment and smart home services to households could open up a major new market for mobile operators. Huawei forecasts that 300 million families will use wireless home broadband by 2020 and a further 100 million families, with fixed-line speeds of less 10 Mbps, will use wireless home broadband to obtain a faster connection. By 2025, those numbers will have increased to 480 million and 200 million respectively (see Figure 10).

The cost of deploying new fixed line networks is one of the main reasons that the number of mobile broadband subscriptions far outstrips the number of fixed broadband subscriptions in every region of the world. At the same time, there is still significant scope for growth in many emerging markets, where mobile broadband penetration is still below 50%.

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<th>2020</th>
<th>2025</th>
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<tr>
<td>Home relying solely on wireless broadband (cumulative)</td>
<td>300 million</td>
<td>480 million</td>
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<tr>
<td>Homes using wireless broadband to provide a faster connection (cumulative)</td>
<td>100 million</td>
<td>200 million</td>
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Out of the 680 million households using wireless broadband by 2025, 100 million will have wireless broadband capable of throughput speeds of 1GBps, according to Huawei’s forecasts.

Enhancing technologies

As mobile technology evolves from 3G to 4G, 4.5G and 5G, the spectral efficiency of mobile networks is improving. Multi-antenna technology can increase spectral efficiency and network transmission rates by several times. Multi-antenna technologies, such as 4x4 MIMO and even higher-order massive MIMO, are now mature, and have delivered throughput rates of up to 650Mbps on demonstrations on commercial networks in Shanghai in 2016. Advanced technologies can generally be deployed on customer-premises equipment (CPE) at an early stage in their development, because compared with mobile phones, the size and power consumption of CPE is not limited and there is no need to support display or call functions. With the release of commercial 4x4 MIMO chips at the end of 2016, 4x4 MIMO CPEs are available, empowering end-to-end commercial solutions. In a similar vein, Deutsche Telekom has estimated that it would cost €80 billion to bring a fiber connection to every home in Germany. Bruno Jacobfeuerborn, Group Chief Technology Officer, told analysts in 2015: “If you have fiber-to-the-home to every household, the capex will be kind of significant, it must be... if you get everything done in Germany it would cost you €80 billion, minimum,” he said.

Enhanced with these new technologies, wireless networks are able to provide more and more capacity, and the cost of providing wireless home broadband services is falling. In fact, a wireless broadband connection can be far more cost-effective than a fiber connection. The capital costs of FTTH deployment typically exceed USD 1,000 per home served, according to the OECD. In addition to direct expenses, the necessity of digging up streets, gaining access to telephone poles or conduit space, and gaining physical access to homes adds to the financial burden. The OECD says that Verizon's costs for laying fiber in the US were US$750 per home passed in a neighbourhood, plus an additional US$600 for each home that actually subscribed. Verizon’s “take rate” for the service was approximately 30%, meaning the effective up-front expenditure for each subscriber was nearly US$3,000, the OECD calculates.

Enabling technologies

As mobile technology evolves from 3G to 4G, 4.5G and 5G, the spectral efficiency of mobile networks is improving. Multi-antenna technology can increase spectral efficiency and network transmission rates by several times. Multi-antenna technologies, such as 4x4 MIMO and even higher-order massive MIMO, are now mature, and have delivered throughput rates of up to 650Mbps on demonstrations on commercial networks in Shanghai in 2016. Advanced technologies can generally be deployed on customer-premises equipment (CPE) at an early stage in their development, because compared with mobile phones, the size and power consumption of CPE is not limited and there is no need to support display or call functions. With the release of commercial 4x4 MIMO chips at the end of 2016, 4x4 MIMO CPEs are available, empowering end-to-end commercial solutions. In a similar vein, Deutsche Telekom has estimated that it would cost €80 billion to bring a fiber connection to every home in Germany. Bruno Jacobfeuerborn, Group Chief Technology Officer, told analysts in 2015: “If you have fiber-to-the-home to every household, the capex will be kind of significant, it must be... if you get everything done in Germany it would cost you €80 billion, minimum,” he said.
Operators in action

In Japan, mobile operator Softbank is using its 4G network to provide households with wireless broadband access. Its Softbank Air service offers download speeds of up to 261Mbps. Similarly, in Norway, Telenor is using 4G to provide broadband to households where it doesn't make economic sense to upgrade the fixed-line network. Telenor believes that its “Fixed LTE” proposition may be applicable for up to 200,000 households.

Verizon plans to use 5G in place of fiber to connect homes in some regions of the US. At a J.P. Morgan Conference in May 2016, Verizon CEO Lowell McAdam said that the operator could cut the cost of high-speed household broadband by getting a fiber connection within 1,000 meters of a building and then connecting that building to the fiber network wirelessly via a 5G router on the outside of the building. Verizon said that its 5G tests at its New Jersey headquarters achieved throughput speeds of up to 1.8 Gbps.

Verizon’s main rival AT&T is also using mobile broadband to serve households. At an investor briefing in 2015, AT&T told financial analysts that LTE access is a core part of its proposition to households.

Insights from operators

“We will address the household market with mobile broadband. High-frequency 5G networks can be an alternative to fiber and there is the benefit of a solution that you can take with you. We need to be able to provide a guaranteed speed over mobile broadband for homes. That is the main topic currently. We need to be able to say that you can get 50 Mbps every day of the week. It’s that consistency we need and even more so in the future.”

Lars Torstensson, EVP, New Growth & Strategy at Tele2

“We are addressing the household market with mobile broadband. High-frequency 5G networks can be an alternative to fiber and there is the benefit of a solution that you can take with you. We need to be able to provide a guaranteed speed over mobile broadband for homes. That is the main topic currently. We need to be able to say that you can get 50 Mbps every day of the week. It’s that consistency we need and even more so in the future.”

Mikhail Gerchuk, CEO Eurasia at VimpelCom

“The question for me if browsing traffic is replaced with streaming traffic, can mobile handle it? For sure, not with the current layout. But with a very dense small cell grid serving 10 homes, it could become feasible again and could be more cost-effective than fiber in the ground… For more rural areas, mobile is very nicely positioned.”

Dieter Trimmel, Director of Group Strategy at the Telekom Austria Group

“We are addressing the household market with mobile broadband. High-frequency 5G networks can be an alternative to fiber and there is the benefit of a solution that you can take with you. We need to be able to provide a guaranteed speed over mobile broadband for homes. That is the main topic currently. We need to be able to say that you can get 50 Mbps every day of the week. It’s that consistency we need and even more so in the future.”

Scott McKenzie, Group Strategy Director at VimpelCom
Rising car ownership and increasing congestion means that people spend a growing amount of time in their vehicles. For example, people spend an average of 52 minutes a day in their cars in Beijing and 48 minutes in Guangzhou and Shanghai. During these journeys, drivers and passengers want access to information, communications and entertainment services delivered via wireless services. Connectivity can enable on-demand music, navigation and real-time traffic status, usage-based insurance, remote diagnostics, automated emergency calls, driver assistance systems and many other services that can make car journeys easier, safer and more enjoyable.

There are several different dimensions to the connected car. Firstly, a connected car needs continual Internet access to stream entertainment and to access real-time information services, such as traffic data. Secondly, a connected car will communicate with other vehicles in the vicinity and nearby infrastructure. For example, a car will warn other cars that it plans to turn right and will receive real-time information from upcoming road signs, such as a warning to slow down because of an accident ahead. Thirdly, a car may also have a dedicated connection to the manufacturer or a specialist service provider that can monitor a vehicle for faults, call the emergency services if the car suffers a high-speed impact and alert the owner if the vehicle moves outside a pre-designated location.

Regulators are increasingly requiring the addition of connectivity to cars to improve safety. The US, for example, is looking to make vehicle-to-vehicle connectivity mandatory in new cars from 2020, while an EU Directive will require all vehicles to be equipped with an automated call system, which will contact the emergency services in the event of an accident.
Figure 11 shows the findings of a survey by operator Telefónica of more than 5,000 customers in Spain, Brazil, the US, the UK, and Germany. It shows that most consumers want safety and telematics services, suggesting they are more likely to pay for such propositions.

For mobile operators, the connected car market opens up multiple business opportunities, which will grow over time. In revenue terms, Huawei estimates the addressable market for mobile operators will be three to four times larger in 2022 than it is in 2016. There is the potential to earn US$ 92.3 billion from infotainment and telematics services, such as mobile data traffic, web-based entertainment, call center support and remote diagnostic services, by 2022 (up from US$27.3 billion in 2016) and US$ 21 billion from fleet management for enterprise customers (up from US$8.7 billion in 2016).

Huawei estimates the addressable market for V2X services, which enable vehicles to communicate with other vehicles and infrastructure, will be worth US$ 31.5 billion in 2022 (see Figure 12). Standards body 3GPP has introduced the C-V2X (Cellular Vehicle to X) standard, which will evolve further with the deployment of 5G communication networks. Moreover, the establishment of the 5G Automotive Association is likely to speed up the development of V2X solutions.

Figure 12: The growth of the global connected car market
Addressable market of connected cars for mobile operators

Source: Huawei Smart transportation report
By 2020, 50% of new cars will be connected to cellular networks, according to Accenture, and by 2025, all new cars be connected. The consultancy estimates the total business value of connected car services will reach €100 billion by 2020, and €500 billion by 2025. On a per-vehicle basis, a fully-fledged connected car, assuming heavy usage, could deliver more than €5,000 in additional value over its lifetime. Analyst firm Frost & Sullivan has estimated that by 2020, Internet-connected vehicles will be transmitting more than 350 KB of data per minute.

Over time, cars will use connectivity to become increasingly autonomous, enabling all the occupants of the vehicle to access entertainment, information and communications services as they travel. Frost & Sullivan says that, between 2020 and 2025, “level three” autonomous vehicles, which will automatically handle safety-critical functions, such as braking and steering, under certain traffic or environmental conditions, will become popular. By 2025, completely autonomous (level four) cars will become available, the research firm anticipates. By 2030, level three and level four autonomous vehicles will represent 25% of all vehicles sold in North America, Frost & Sullivan forecasts.

Enabling technologies

Cars will increasingly ship with built-in 4G modules, enabling their occupants to benefit from high-speed Internet connectivity. Automakers General Motors and Audi, for example, have announced that they will install 4G modules in their cars. Moreover, a new mobile broadband technology, called LTE-Vehicle (LTE-V), is specifically designed to be embedded into vehicles to enable them to receive early warnings of changes in road conditions and implement necessary controls before a traffic accident can occur place. As it can fully utilize existing base stations around the world, LTE-V technology can be deployed rapidly and at low cost.

Huawei is working with telecom operators and automobile manufacturers to conduct LTE-V performance tests, field demonstrations, and standards formulation. In April 2015, Huawei and SAIC Motor conducted the first LTE-V field demonstration with a base station at the 14th Annual ITS Asia Pacific Forum. In June 2015, Huawei, together with Vodafone and Jaguar Land Rover (JLR), also demonstrated LTE-V and conducted a field test in Gaydon, in the UK. Huawei is also cooperating with China Mobile in Zhejiang, Alibaba Group, SAIC Motor and other partners to forge an LTE-V incubation base in Hangzhou.

Huawei has developed a roadmap (see Figure 13) for mobile operators seeking to play a valuable role in smart transportation. It envisages operators will take three major actions in the next five years:

- Become active in the telematics service market for embedded systems in new vehicles and add-on solutions for second-hand vehicles.
- Leverage existing technologies to provide an end-to-end solution for smart parking and create a new revenue stream using NB-IoT technology.
- Lobby governments to commission emergency services networks based on the public cellular networks: A highly reliable, but low-cost, solution.

Figure 13: Roadmap for telecom operators to play a valuable role in smart transportation

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<td><strong>Customer Demand</strong></td>
<td><strong>Infotainment</strong></td>
<td><strong>Telematics + Dedicated Network</strong></td>
<td><strong>V2X + ADAS</strong></td>
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<tr>
<td><strong>Products/Services</strong></td>
<td>Driving experience, e.g., real-time navigation in-car entertainment</td>
<td>Safety, e.g., Remote Diagnostics, Tracking</td>
<td>Safety, avoiding human errors, e.g., collision avoidance, auto-brake system</td>
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<tr>
<td>Voice/Data Plan</td>
<td>• Telematics Service, e.g., UBI,Fleet Management</td>
<td>Safety improvement service based on V2X communication</td>
<td>Cloud-based supporting for self-driving car</td>
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<td>Business Role</td>
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<td>• Pipe + Remote Service + Data Analytics</td>
<td>Pipe + Remote Service + Data Analytics</td>
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<td>Network</td>
<td>3G – 4G</td>
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Source: Huawei Smart transportation report
Leading operators in action

UK mobile operator EE is collaborating with insurance companies to provide drivers with a tailored insurance policy that reflects their driving style and the miles they cover. Fitted inside the driver’s vehicle, a telematics box uses EE’s mobile network to transmit driving performance data back to the insurance company. Some of EE’s partners say the technology can lead to a 40% drop in serious accidents among young drivers in their first six months on the road, enabling insurers to reduce premiums by an average of 30% for this customer segment.

In the US, Verizon is taking a similar tack, providing solutions that enable insurance companies to offer drivers usage-based premiums with discounts based on driver behavior. Verizon moved into the car insurance and fleet management markets following the acquisition of Hughes Telematics in 2012 for US$612 million and through a strategic partnership with Towers Watson.

China Unicom and its telematics partner WirelessCar enable BMW’s customers in China to use a range of connected car services, including emergency, breakdown, and concierge calls, as well as remote door unlock, traffic information and other internet-based services.

“With autonomous driving, there are two parts...proximity and network-based. When you need to make an instant decision, you need proximity communications and edge computing capabilities. But for non-critical decision-making, you need network-based information, such as traffic information and road conditions, etc. There is clearly a role for mobile operators.”

Byungki Oh, VP, Global Business Collaboration Global Business Group, KT Corp

“Although the revenues per car will be small, the volumes will be big – every car will need to be connected. For infotainment, we need to convince the consumer that they need to have WiFi in the car, separate to that they could get by tethering from their smartphone.”

Scott McKenzie, Group Strategy Director at VimpelCom
A better connected life at work: Efficient and effective communication anywhere

The anytime, anywhere office

Working life is being transformed by always-available connectivity. Mobile broadband enables business people to spend less time in an office or factory and more time with customers, suppliers, and partners. Telepresence services enable executives to use smartphones, tablets or PCs to have meetings anytime and in any location with high-definition video pictures making communication easier. High-quality video links help people to interpret body language and facial expressions: Only 7% of any message is conveyed through words, 38% through certain vocal elements, and 55% through nonverbal elements, such as facial expressions, gestures, and posture, according to a widely-cited study by Albert Mehrabian, author of Silent Messages.

Mobile operators can also provide broadband access to small businesses lacking fixed lines or as a backup connection should the fixed-line fail. Businesses can create a virtual private network on a wireless broadband connection, just as they can on a fixed-line network. In many cases, a mobile broadband connection could be the most cost-effective option. The ITU says that a mobile broadband connection typically costs about half the price of a fixed broadband connection. Figure 14 shows the average price of broadband services with a 1GB data cap.
Huawei projects that, by 2025, there will be 50 million small and medium enterprises using wireless broadband worldwide. By that date, virtually all businesses will have gone entirely wireless using a combination of Wi-Fi and mobile broadband to connect smartphone, tablets, and PCs.

In the same timeframe, about 60% of transportation hubs, shopping malls, stadiums and office space should have full indoor wireless coverage. In future, Huawei estimates that buildings will need to be able to support a wireless traffic density of 10Mbps for every square metre (see Figure 15).

Mobile operators can also provide businesses with security solutions, as well as connectivity. Small businesses, in particular, are likely to value the convenience of buying security and connectivity-bundled together.

Enabling technologies
Advances in mobile broadband technology are enabling operators to provide businesses and households with highspeed, high-capacity Internet connections. In each district, operators can deploy a combination of fiber and high-speed wireless links, selecting the optimum technology to connect a particular building. Wireless technology is now capable...
of providing very high-quality broadband over the last mile between a fiber connection and a business premises. Using new technologies, such as 4x4 MIMO, 256QAM, FDD + TDD CA, Massive CA and Massive MIMO (see the last section of this report for more details), operators with 40MHz-60MHz spectrum can deliver a single cell peak rate of 1Gbps or more. For operators, wireless broadband has several major advantages over fixed-line broadband, including shorter time-to-market, faster subscriber growth, and a shorter payback period.

However, mobile networks will need to be increasingly dense to meet the needs of large numbers of workers gathered together in offices and factories. To serve this market, mobile operators can now deploy solutions designed specifically to improve coverage indoors. For example, Huawei has developed the multi-mode, easy-to-install LampSite solution to provide deep indoor coverage solution and increase the capacity of the existing mobile network.

Rethink Research forecasts that operators’ deployment of small cells for public access or enterprise use will grow 62% per year between now and 2019. (The forecast excludes home offices since a large proportion of those use their residential small cells). Rethink forecasts that in 2020, 3.5 million small cells will be deployed in the enterprise market worldwide, up from 975,000 in 2016.

Google Fiber looks to switch to wireless

Google, which provides a growing range of advertising and marketing services to small and medium businesses, has also moved into the connectivity market with the rollout of its Google Fiber and Google Fi propositions in the US. Google Fiber offers small businesses a choice of three plans, ranging from US$70 a month to US$250 a month depending on the speed. Google spent more than US$1 billion to deploy fiber across the Kansas City region in the US, according to sources cited by Recode. But using wireless links could be far cheaper — a fifth of the cost of fiber, which is roughly $1,000 per home, Recode noted, explaining how Google Fiber has won approval to place special antennas on city light poles in Kansas City that could potentially beam broadband directly into homes. Google Fiber plans to have a network up and running by the end of 2017, following tests in late 2016.

Leading operators in action

Multinational operator Vodafone has increased the number of points of presence for its IP-based virtual private network proposition from 171 in September 2013 to 268 in March 2016. Its enterprise division reported a 7.4% increase in mobile customers in the year to March 31, 2016. In the US, AT&T’s new Blazing Fast program aims to provide one million corporate customers with broadband service speeds of up to 1Gbps.

China Unicom has deployed small cell technology to enable travelers using Beijing Capital Airport, the busiest airport in China, and Zhengzhou Railway Station, the country’s second-largest station, to get online at high speeds. Using Huawei’s LampSite solution, Unicom has installed more than 100 cells in Beijing Capital Airport providing business travelers with 4G download speeds averaging 100Mbps. Unicom’s data traffic in the airport has grown 27 times following the installation of the new cells (see Figure 16).

![Figure 16: China Unicom’s data traffic at Beijing Capital Airport rose 27X after the installation of LampSite](source:Huawei Wireless X Labs)

Multinational operator Vodafone has increased the number of points of presence for its IP-based virtual private network proposition from 171 in September 2013 to 268 in March 2016. Its enterprise division reported a 7.4% increase in mobile customers in the year to March 31, 2016. In the US, AT&T’s new Blazing Fast program aims to provide one million corporate customers with broadband service speeds of up to 1Gbps.
It is very strategic for us to increase the amount of fiber in cities and have the strongest 4G coverage anywhere and everywhere. And this is not just about serving the home, it is also about bringing high-speed connectivity to the office and the workplace.

Aysem Ertopuz,
Turkcell Group Chief Strategist

Coverage is very key. How can we maintain the customer experience? We have to provide very good voice coverage — people get very annoyed about dropped voice calls. Reliability is our top priority and the user experience — we want to the user to be able to download content at decent speeds. Indoor coverage is a top agenda item.

Head of RAN Strategy & Architecture
at an operator in Europe

5G is a real competitor to fiber where there is no fiber. In Africa, 3G and 4G are the only way to get broadband. We need cost-effective 5G for these large coverage needs...Expanding connectivity in emerging markets is a big opportunity and challenge as well. We want 5G to deliver low-cost coverage in remote areas. We will need the spectrum, but the technology also needs to deliver on that.

Yves Bellego,
Director Network Strategy, Orange Labs Networks
Cross-industry cooperation helps to build an open and healthy wireless ecosystem. To that end Huawei is setting up X Labs, a global open laboratory researching the future of mobile network connectivity. It provides a forum in which players from across the industry can explore new applications that may make a significant contribution to the connected life of the future.

For more whitepaper of X Labs, please refer to:
- Smart Transportation: Maximize mobile network’s value beyond connectivity
- Mobile Video Report: China Trailblazing Mobile Live Video Market
- m-Health: Connecting the smart future
- Smart agriculture market assessment whitepaper

Sources
1. These interviews were designed to capture a variety of different viewpoints and the executives quoted in this report do not necessarily endorse the views expressed elsewhere in the report.
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February 2017

The Future of Mobile Broadband

How mobile operators can deliver the connected life between now and 2025