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5G Fixed Wireless Access

Providing fiber speeds over the air while also helping pave the way for full 5G mobility

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Contents

About the authors

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Daryl covers the wireless infrastructure space at Ovum, with a primary focus on market activities as they apply to the radio access network (RAN). RAN coverage includes macro-, micro-, and picocell solutions for CDMA EVDO, HSPA/HSPA+, LTE (TDD and FDD), and LTE-Advanced. Daryl's research includes not only what infrastructure vendors are developing, but how mobile operators are deploying and using these wireless networking solutions.

As an industry analyst Daryl has been involved in such projects as helping technology vendors develop use cases for new products and services, identifying new technology trends, and providing market sizing and market share support. He regularly speaks at industry and vendor events on trends impacting the wireless infrastructure market. He is also sought out by trade publications to comment on mergers and acquisitions, new product announcements, and market developments as they relates to his coverage area.

Summary

In brief

5G-based fixed wireless access provides operators with several distinct benefits. First and foremost, it allows operators to offer subscribers fiber-like services. This is good for operators that find FTTx too expensive to deploy. Second, it helps operators prepare for fully mobile 5G services, at both the RAN and network core levels.

Ovum view

- Because of the technologies it is based on and the spectrum being used, 5G fixed wireless access (FWA) will be able to deliver services similar to a fiber-based broadband network. This is a significant performance improvement over previous FWA solutions.
- Because 5G FWA has fiber-like performance, operators should be able to compete directly against other nonfiber fixed broadband services such as xDSL and cable modem. 5G FWA isn't just for rural areas, but urban and suburban areas as well.
- 5G FWA is a stepping stone to full mobility. Operators can use 5G FWA to get used to new technologies that will be the basis of mobile 5G, such as higher orders of MIMO, along with implementing network virtualization and slicing.
- 5G FWA has the backing of a strong ecosystem that includes many of the world's leading operators and vendors.

Recommendations

- Operators should use 5G FWA as a way to prepare their networks for full-scale 5G deployments. That way, when 5G standards are finalized, those operators will be in a position to deploy a full-scale 5G network.
- Operators that have already deployed FTTx or other fixed broadband networks should consider 5G FWA as a solution for reaching those areas that can't be served by FTTx.
- Operators must lobby their government regulators to make more spectrum available for 5G deployments. One of the key benefits of 5G is its ability to use new spectrum bands, but government consent is needed in many places for operators to access those spectrum bands.

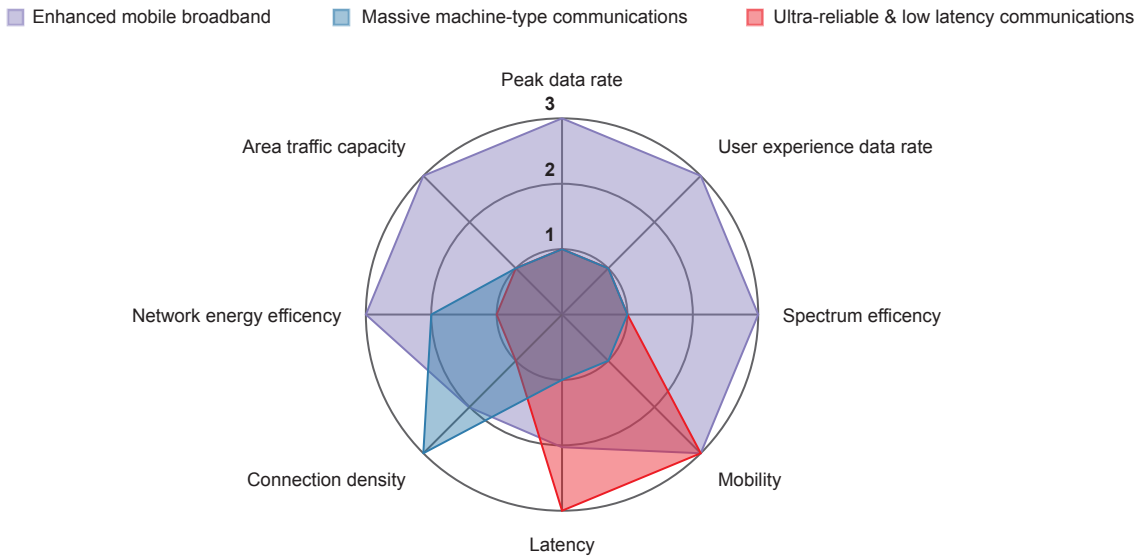
5G capabilities overview

5G will bring enhanced mobile and much more

The companies and groups designing 5G hope to create the most versatile mobile standard we have seen yet. In the past, mobile standards were designed to improve on previous standards in one or two ways, such as voice or mobile broadband. 5G, however, has a much broader scope. From its conception, the creators of 5G want the network to handle several different functions – enhanced mobile broadband; massive machine type communications, also called IoT; and critical communications or ultrareliable and low-latency communications.

Figure 1 shows the proposed different performance features of 5G and overlays it with the application requirements. Each application, while running on the same physical network, will have different requirements. For example, peak data rates and user experience data rates will be of higher importance for enhanced mobile broadband than they will be for ultrareliable and low-latency communications. Conversely, critical communications will require lower-latency communications than enhanced mobile broadband.

Figure 1: 5G network requirements associated with different use cases



Source: Ovum

5G FWA provides a stepping stone to mobility

Little public thought was given to 5G as fixed wireless access until Verizon and AT&T started talking about using 5G for FWA application. Verizon has stated a goal of launching commercial 5G FWA services in 2017, two years before 5G is fully standardized. Beyond just commercial service reasons, there are some technical drivers for such an early push for 5G by way of FWA.

Deploying 5G FWA gives operators a head start in working with different 5G elements. Those elements include new air interface, new spectrum, new radio form factors, and new antenna systems. Early experience in those areas can help speed up full 5G deployments once the standards are set. Also, early exposure to 5G technologies will allow operators to have greater influence on the final standard. Once standards are set, mobile operators should be able to reuse some of their 5G FWA assets to support other 5G applications. Beyond the radio aspects of 5G, FWA deployments allow operators to work on new network architecture with SDN/NFV and network slicing, which are also important parts of 5G. So 5G FWA not only allows operators to expand into new service areas, it also helps operators better prepare to deploy 5G once standards are set. Of course, not all operators will start on their 5G journey with FWA. For some operators, FWA does not make business sense, especially if they don't have a legacy in offering fixed services in their markets already.

How is 5G FWA different from other FWA options?

FWA is not new. There have been several approaches to building FWA networks. Some have used proprietary systems; some have used standards derived from the Wi-Fi family. WiMAX was conceived as a fixed wireless access solution. Even LTE can serve as the foundation for FWA. This raises the question, how is 5G different?

The biggest difference between 5G and the other FWA options that have come before it is performance. WiMAX offer users tens of megabits per second; LTE offers users tens to hundreds of megabits per second. 5G end-user experience will be measured in gigabits per second. A big part of the speed differences between LTE and 5G comes from spectrum capacity. Although not standardized, 5G is expected to support hundreds of megahertz of spectrum. More spectrum means faster speeds. Already vendor 5G trials have reported downlink speeds ranging from 10 to 25Gbps. Those speeds will make it easier for 5G to compete directly against fiber and other very-high-speed broadband access networks. That is something not seen with WiMAX or LTE.

A big factor in 5G's performance versus LTE comes from spectrum being used. 5G systems will be able to use millimeter bands like 28GHz. Those higher bands have more spectrum than the lower bands LTE inhabits. More spectrum means more network capacity, which means faster download speeds. Millimeter bands also provide a tighter radio beam, so the spectrum can be focused on fewer users. Fewer users means less sharing of network capacity. LTE uses lower-spectrum bands that, while they travel farther than millimeter wave (mmWave) bands, are also harder to focus. That means with LTE the network capacity is spread across more users, making higher sustained network speeds more difficult to maintain.

Another success factor for 5G comes from ecosystem. While this isn't a differentiator for 5G versus LTE, it is a big issue when it comes to 5G and WiMAX and other proprietary systems. 3GPP's backing of the eventual 5G standard ensures wide support from infrastructure and chip vendors, device makers, and well-funded service providers. Strong ecosystem support is a major factor in any standard's success. It also gives operators confidence in the technology.

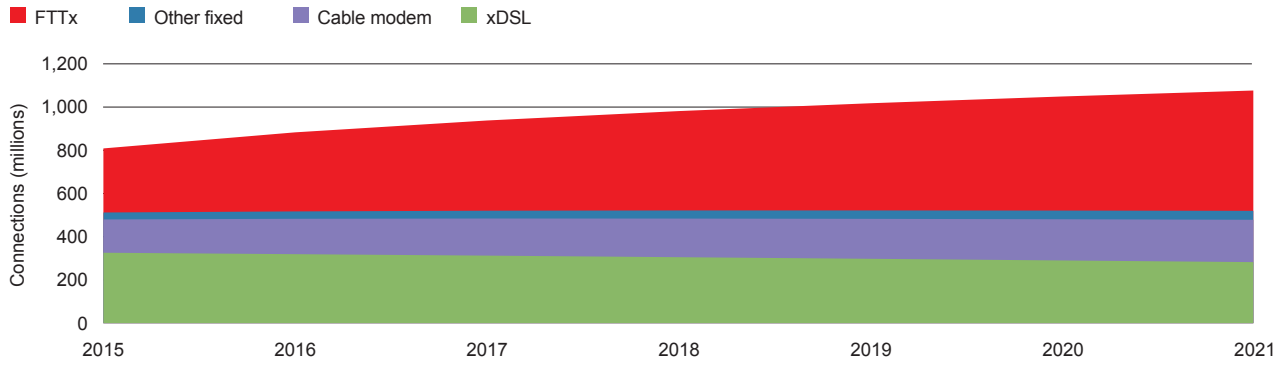
Understanding the market potential for 5G FWA

5G FWA isn't just for underserved markets

Discussion around fixed wireless access typically has focused on the potential of bringing Internet access to rural areas where traditional wired services aren't available. FWA has been positioned as a solution to serve the underserved. 5G FWA can be used in those areas, but its capabilities make it suitable for more. Operators can use 5G FWA to offer services in more developed areas that already have other broadband options.

Ovum believes 5G FWA can compete directly against DSL, cable modem, and fixed broadband technologies other than FTTx. In fact, operators should see those over half-billion fixed broadband lines comprised of fixed broadband other than FTTx as potential opportunities for 5G FWA. Figure 2 shows Ovum's forecast for fixed broadband subscriptions broken out by access technologies.

Figure 2: Global fixed broadband subscription, 2015–21



Source: Ovum

Ovum believes the 5G FWA opportunities can be divided into two categories. The first category is those markets that already have a high level of fixed broadband but low levels of fiber penetration. Those markets already have the customer base willing to pay for broadband, with 5G FWA meeting the demand for higher speeds than are currently available to many broadband users. The second opportunity is countries with low overall broadband penetration rates but with a high percentage of those broadband connections being FTTx or having very high FTTx growth rates. Those markets demonstrate a healthy demand for gigabit-speed services, which 5G FWA can satisfy.

Table 1 gives some examples. It shows both total fixed broadband penetration rates and FTTx penetration rate for selected countries.

Table 1: 2015 fixed broadband and FTTx household penetration rates

Category	Country (examples)	2015 household broadband penetration	2015 household FTTx penetration	FTTx CAGR (2013–2015)
Category 1 High broadband penetration & low FTTX penetration or growth	Australia	76%	7%	40%
	Canada	90%	6%	38%
	France	89%	5%	56%
	Germany	77%	1%	32%
	Russia	54%	26%	11%
	UK	88%	0.20%	–
	US	83%	10%	20%
Category 2 Low broadband penetration & high FTTX penetration or growth	Brazil	37%	2%	41%
	China	49%	37%	63%
	Vietnam	40%	20%	260%

Source: Ovum

FTTx includes fiber to the home or building, such as an apartment building. It does not include such broadband solutions as fiber to the node or curb where the final part of the connection is provided by something other than fiber, such as copper.

5G FWA can be a complement to FTTx

Operators don't need to think of FTTx and 5G FWA as mutually exclusive. An operator with an existing FTTx network can use 5G FWA as an alternative in those areas not currently covered by FTTx. For example, an operator may not want to tear up streets and sidewalks in older neighborhoods to offer gigabit-speed services. At the same time, the operator doesn't want to skip over neighborhoods within its service footprint. 5G could fill in those service areas where the operator doesn't want to deploy fiber. However, a few fiber strands in those areas could be deployed to help backhaul the 5G network.

Market requirements for 5G FWA success

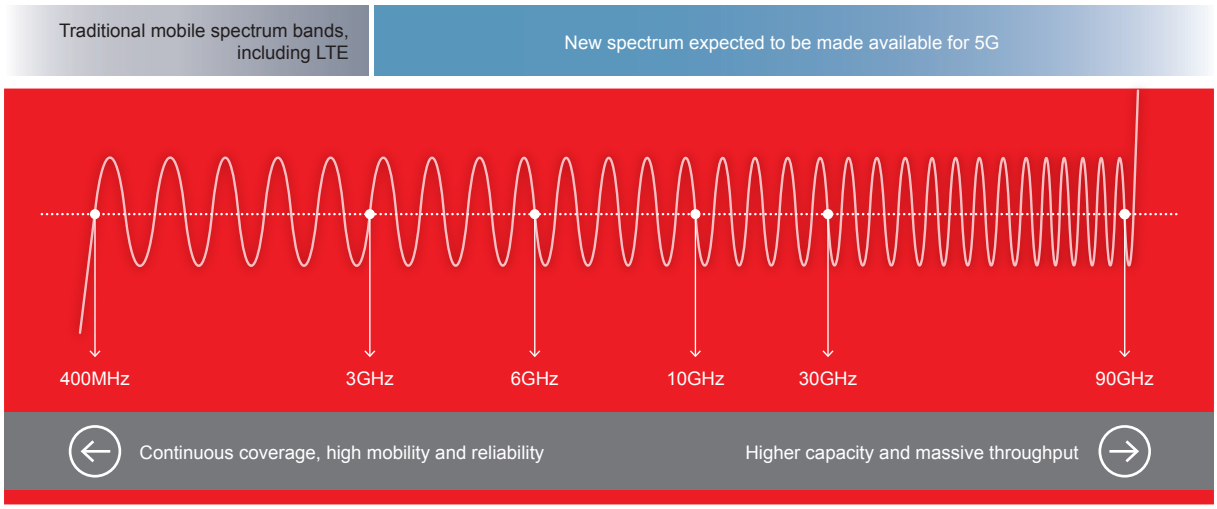
Ecosystem needed to support operators

For 5G FWA to be successful, it will need a robust ecosystem of chipset vendors, CPE vendors, and network vendors. Without that level of support, it will be difficult for 5G FWA to scale. A robust ecosystem means operators will have multiple vendors to work with. Multiple vendors keep the market competitive, drive innovation, keep prices down, and ensure that operators aren't locked into a single choice. When it comes to 5G, while it is still early days, the level of support for the technology is strong, and many major vendors are investing in 5G development.

5G FWA needs new spectrum

It is important for 5G FWA to gain access to mmWave spectrum bands. That will give it the necessary capacity to offer a fixed wireless service that can compete against incumbent wireline broadband access technologies such as DSL and cable modem and provide gigabit speeds. Also, the capacity will allow 5G FWA service providers to offer more than just raw Internet access. That capacity can also be used to support HD video and voice services. Those extra services add value to the operator's overall service offering and create extra revenue streams that can accelerate the return on investment.

Figure 3: 5G spectrum



Source: Ovum

Government support will help make 5G FWA a success

Government will play a major role in 5G FWA success. First, government can provide operators with the spectrum needed to support high-speed wireless services. Second, governments should create regulations that will facilitate deployments, such as making laws that accelerate an operator's ability to install small cells outdoors. Governments can take a proactive stand and even encourage investments in new high-speed infrastructure for both suburban and rural areas. One positive example comes from the US Federal Communications Commission. In July, the US telecom regulator made a new rule opening up 11GHz of spectrum, above the 24GHz band, for 5G deployments. The newly freed spectrum includes 3.85GHz of licensed spectrum in 28GHz (27.5–28.35GHz), 37GHz (37–38.6GHz), and 39GHz (38.6–40GHz) bands as well as 7GHz of unlicensed spectrum from 64–71GHz.

Operator interviews regarding 5G FWA

Five questions with two US operators on 5G FWA

As part of Ovum's research for this white paper, we interviewed two US operators that are both doing 5G FWA field trials and are working with Samsung as a partner for those trials. Those two operators are AT&T and Verizon.

AT&T

The following email exchange was between Ovum and Tom Keathley, senior VP wireless network and architecture, AT&T.

Ovum: Based on early observations, do you think 5G FWA could substitute for a FTTx connection to the home?
Keathley: We are still in the process of evaluating the performance characteristic of 5G FWA. Specifically, for mmWave systems, it will be important to understand several areas: percentage of homes covered by a site, throughput consistency, seasonal effects (foliage, rain, snow, obstructions, etc.), and potential for self-install versus technician install.

Ovum: How is 5G FWA different from other FWA solutions, including even LTE?
Keathley: Currently, LTE deployments are generally limited to licensed spectrum, so the bandwidth available for these deployments will be limited to the spectrum owned by the operator. We do see unlicensed and shared spectrum beginning to be used in both LTE and other wireless deployments, which will provide incremental bandwidth. 5G FWA is typically associated with mmWave spectrum. In the US, the first bands deployed will likely be 28GHz and 37–39GHz spectrum. This very-high-frequency spectrum will have propagation challenges but will provide very large bandwidths. Generally, the 5G FWA deployments hold the promise of much higher throughput performance, although the distance covered could be substantially less than LTE and other wireless deployments due to the propagation characteristics of the spectrum.

Ovum: What elements are essential for a successful 5G FWA deployment?
Keathley: The key high-level elements for a successful deployment are completion of the 3GPP release 15 and eventually the release 16 standards, which will enable a global ecosystem of devices and infrastructure; chipsets that will support devices and infrastructure; availability of mmWave spectrum; and favorable economics that advantage 5G FWA over other broadband alternatives.

Ovum: Are there elements of a 5G FWA deployment that could be leveraged for a fully mobile 5G deployment?
Keathley: We anticipate that 5G FWA infrastructure will also support mobility use cases. That's another reason why deploying standards-based equipment is critical.

Ovum: What does Samsung offer when it comes to 5G FWA?
Keathley: Thus far, we have evaluated prestandards millimeter wave systems from Samsung, and we continue to collaborate with them to advance the 3GPP standards work.

Verizon

The following interview was conducted by phone between Ovum and Adam Koeppe, VP of technology planning, Verizon.

Ovum: Based on early observations, do you think 5G FWA could substitute for a FTTx connection to the home?

Koeppe: Early results indicate it is certainly possible. Field technical trials based on FWA use case have been built to mimic FTTx environment, and so far we have seen delivery of 1Gbps speeds and higher. We have to prove this can be done reliably. With a higher order of MIMO and beamforming, you can better aim the radio pattern down to something like a pencil point. This gives us a very narrow, concentrated beam to the CPE or end-user device.

Ovum: How is 5G FWA different from other FWA solutions, including even LTE?

Koeppe: The biggest differences between 5G versus LTE FWA are advancements in antenna technology and ability to use high-spectrum bands. For antennas, this means more antenna elements and smaller antennas for better radio signaling. With higher-spectrum bands, we have access to over 100MHz of capacity, which gives us the higher speeds. The FCC has been helpful in making higher-spectrum bands available.

Ovum: What elements are essential for a successful 5G FWA deployment?

Koeppe: The availability of spectrum to support gigabit or higher speeds. Continued antenna progress on antenna miniaturization, deep fiber penetration in place for radio node backhaul. Ideally you already have that fiber in place.

Right now we are very focused on the technical trials for fixed wireless access. Millimeter trials are very different than working with lower-spectrum bands, so many real-world scenario tests are needed to know distance from radio node to household and number of households per node.

Ovum: Are there elements of a 5G FWA deployment that could be leveraged for a fully mobile 5G deployment?

Koeppe: First, it is a technical trial that we are currently doing, not a full-blown commercial deployment. The goal of our technical partners for these trials is to get early decisions made and specifications geared to support the FWA use case. Some of those specifications may lead to mobility, but really the mobility part of 5G is just taking off now, with work being done by 3GPP (Third Generation Partnership Project).

Outside of technical specification, the fiber and nodes used for FWA use will support mobility. And maybe with just a software update the radio nodes can be updated from just supporting FWA to supporting mobility. Don't expect FWA and mobility to be multiple overlay networks. I expect them to be one single network.

Ovum: What does Samsung offer when it comes to 5G FWA?

Koeppe: Samsung has taken a very aggressive path toward rapid commercialization of 5G FWA. Verizon feels Samsung shows an aggressiveness when it comes to developing 5G FWA that matches its own. Samsung has industry-leading R&D and the will to move 5G technology forward.

SAMSUNG: VENDOR ROLE IN 5G DEVELOPMENT

Note: The following section was written by Samsung .

Samsung's pioneering technology development around 5G

Samsung has announced a series of milestone 5G technology developments since research began in 2011. The core focuses of our early 5G trials have been the delivery of high-throughput and high-capacity connectivity. However, the end goal of 5G is to fundamentally transform the way we make use of mobile connectivity. Samsung became the first vendor to move beyond just a focus on throughputs, with an announcement of the world's first handover demonstration in a multicell mmWave network in March 2016. A vehicle traveling at 25km per hour was able to move between three transmitters while maintaining a gigabit data transmission.

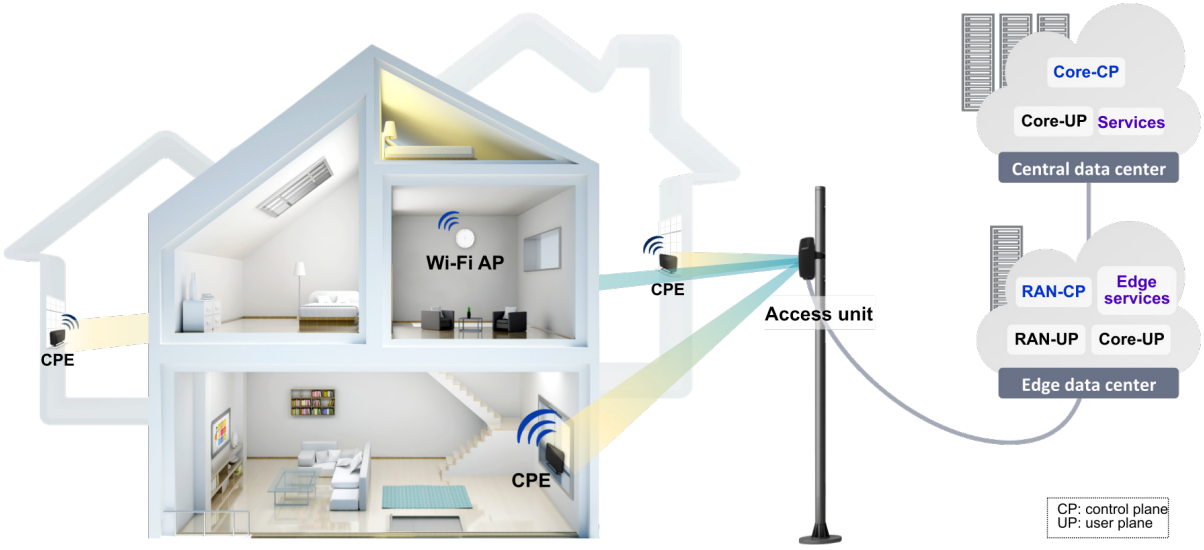
Samsung's focus on practical technology innovation extends to developing small-form-factor equipment. Miniaturizing equipment is especially important in 5G as it will be deployed in the form of compact small cells mostly utilizing higher frequencies than current mobile technologies. Samsung developed key RF technology for smaller 5G equipment and devices in June 2016. With these RF technologies, Samsung developed a new case-integrated antenna that incorporates dozens of antenna elements in a module that is less than 1mm thick. Samsung also developed efficient power amplifiers for use with mmWave signals to drive each antenna. The power amplifiers simultaneously doubled output power and improved energy efficiency by more than 50%.

Samsung has also developed an RF planning tool based on accumulated knowledge and experiences of the characteristics of mmWaves. This 5G channel modeling tool helps make network deployment easier and more accurate by minimizing the gap between simulation and reality by means of ray tracing, 3D digital map modeling, and analyzing penetration loss from shadowing, reflection of foliage, and windows. This tool is expected to significantly reduce the time and labor required for 5G network planning.

Samsung brings unparalleled, end-to-end expertise to its 5G efforts. Samsung's end-to-end mobile strategy helps us offer an integrated and stable solution even from the early stages of new technology. Samsung has developed end-to-end 5G FWA products and is paving the way for commercialization of the service. This is illustrated in Figure 4.

Samsung's pioneering research efforts have included the development of key technologies for 5G-capable radio-frequency integrated circuit chipsets, which will be integrated into our 5G CPE. Inside an access unit, RF functions and some functions of digital units are integrated. The rest of the functions in digital units are then virtualized and located in central units. Rather than blanket the area with each radio signal, as current telecommunications

Figure 4: Samsung's end-to-end 5G FWA network



Source: Samsung

do, Samsung's approach to 5G uses adaptive beamforming technology to tightly focus the radio waves into a beam that is targeted at each CPE at home. Narrow, directly focused beams help overcome the inherent limitations of the ultrahigh frequencies used for 5G.

Separation of control and user plane allows more flexible and adaptable core network in 5G. Because the control plane and user plane are independently scalable, operators can make efficient investment according to their needs. Moreover, user plane located at the edge data center is able to handle and offload part of the traffic, resulting in a flat network architecture.

Data center-friendly architecture and functional decomposition of the next-generation core network minimize dimensioning overload and lead to cost-effective scalability. For instance, mobility management functionality can be excluded in an FWA network, making it more simplified and optimized. If an operator wants to later transform its network to support mobile service, mobility management functionality simply can be added at the data center on existing infrastructure.

Samsung plays a leading role in 5G standardization

Samsung has been one of the strongest contributors to the standardization of 5G technologies, working closely with operators, academic organizations, and international standards bodies such as ITU-R and 3GPP. Samsung is a key contributor and holds a host of essential patents related to the new 5G standards, especially RAN1 and RAN2, which are expected to be finalized in 2018. Samsung holds a chairmanship in 3GPP RAN4 and SA (system architecture) and is co-rapporteur on NR channel modeling. Samsung made a study on the characteristics of frequency ranges from 6GHz to 100GHz in close cooperation with global renowned academic researchers and companies. The co-authored white paper "5G 3GPP-like Channel Models for Outdoor Urban Microcellular and Macrocellular Environments" has won the best paper award at the 2016 IEEE Vehicular Technology Conference, a prestigious conference in telecommunications area.

At the 3GPP RAN meeting hosted by Samsung in Busan, Korea, in June 2016, 3GPP approved mmWave channel model. Samsung contributed 90% of technical topics in the paper, and the research efforts will accelerate technology development and standardization of mmWave frequency, which has been considered an unchartered territory by the telecommunication industry until now.

All of Samsung's research and developments are expected to lay a foundation for 5G standardization in 3GPP.

Samsung accelerates 5G adoption with its partners

Samsung is taking a leading position in defining the 5G FWA market in the US. In February 2016, a major operator in the US and Samsung started testing the multi-gigabit wireless access in "real-world" conditions, including indoors and in moving vehicles. Samsung is also engaged with other tier-1 operators in the US to realize 5G business opportunities.

In July 2016, Samsung became a board member of the Advanced Wireless Research Initiative (AWRI), a public-private partnership spearheaded by the White House to accelerate the development of next-generation 5G wireless networks in the United States. (For more information, please see http://bit.ly/2a2sMyo.) With the AWRI, Samsung will provide guidance and assist in the development of new wireless testbeds, enabling researchers to examine and validate 5G technologies, spectrum usage paradigms, application performance, and service behavior. As a board member, Samsung will also provide direction on future research initiatives.

Samsung is bringing its drive and passion for innovation to 5G mobile advancements. We are preparing to deliver 5G trial service by early 2018 in PyeongChang, Korea, where the Winter Olympics will take place. Most recently, Samsung and one of the major Korean operators have successfully tested handover between 5G base stations at 28GHz in the outdoor environment. (For more information, please visit http://bit.ly/2cZXJEM.) The two have become the world's first to verify the performance of the 5G handover technology by connecting multiple millimeter wave base station systems to an operator's fiber optics infrastructure. Samsung has also begun trialing 5G technology in the field in cooperation with leading service providers in Japan and Europe, where we expect to see broader commercialization around 2020.

Appendix

Methodology

The information in this report comes from both primary and secondary sources. Primary sources include discussions between Ovum and the mobile operators profiled in the report and the vendor Samsung. Secondary sources include previously published Ovum research and industry publications.

ABOUT OVUM

Ovum is a leading global technology research and advisory firm. Through its 180 analysts worldwide it offers expert analysis and strategic insight across the IT, telecoms, and media industries. Founded in 1985, Ovum has one of the most experienced analyst teams in the industry and is a respected source of guidance for technology business leaders, CIOs, vendors, service providers, and regulators looking for comprehensive, accurate and insightful market data, research and consulting. With 23 offices across six continents, Ovum offers a truly global perspective on technology and media markets and provides thousands of clients with insight including workflow tools, forecasts, surveys, market assessments, technology audits and opinion. In 2012, Ovum was jointly named Global Analyst Firm of the Year by the IIAR.

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