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HEAVY READING
WHITE PAPER

Fixed Wireless Access and Backhaul with Unlicensed 60 GHz

A Heavy Reading white paper produced for ADTRAN

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INTRODUCTION

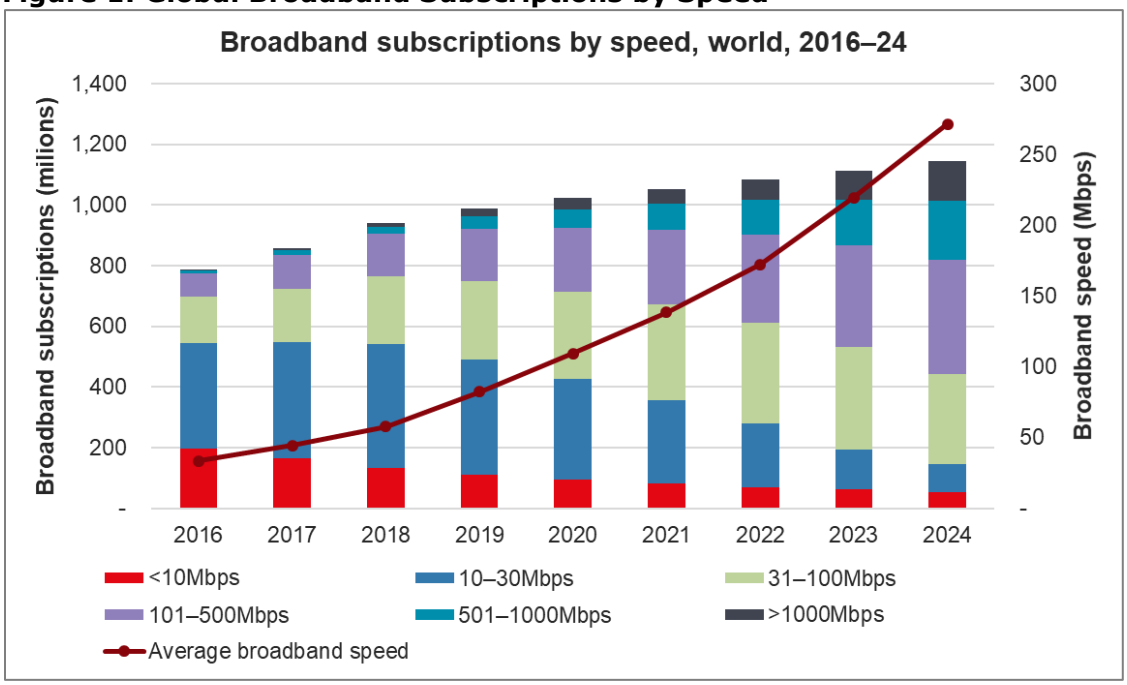
Millimeter wave technologies have emerged as an option not just for mobile 5G access, but also for gigabit broadband to homes and business – and even as a backhaul choice for 5G. While most of the millimeter wave (mmWave) discussion centers on licensed spectrum ranges being bought up by Tier 1 operators globally, an unlicensed band in the 60 GHz range also exists.

This white paper examines unlicensed 60 GHz spectrum and its application in fixed wireless access (FWA) and backhaul applications. The paper provides an overview of the fixed and mobile broadband trends that are creating an opportunity for 60 GHz technology. It also compares 60 GHz mmWave to both fiber access and licensed mmWave spectrum options and identifies the key technical considerations in evaluating 60 GHz. The paper concludes with a case study of a new service provider entrant, U.K.-based Ontix, that has based its network and strategy on 60 GHz.

FIXED WIRELESS AND FIBER ACCESS

Global broadband speeds continue to accelerate. Ovum estimates that global average broadband speeds hit 50 Mbps in 2017. As shown in **Figure 1**, they are forecast to exceed 270 Mbps by 2024. These are global averages; in developed regions, data rates will be much higher. By 2024, for example, the average broadband speed in Hong Kong is expected to hit 460 Mbps.

Figure 1: Global Broadband Subscriptions by Speed



Source: Ovum, Consumer Broadband Subscription and Revenue Forecast: 2019–24, 2020

After 100 years, copper is reaching the end of its natural lifespan, but fiber is not always an upgrade option. There have always been scenarios where urban fiber trenching is prohibited by municipal regulations or it is so costly to obtain the necessary permits and install that there is no business case for doing so. In more rural scenarios, meanwhile, population density may be so low that the ROI on fiber is too long. In other scenarios, manmade or natural obstructions may lay in the fiber path, preventing installation regardless of cost.

Until recently, there was no ultra-high bandwidth alternative to fiber. With the advent of 5G, high data rate FWA has emerged to fill the gigabit broadband need when fiber is not an option. Verizon is one example. The operator is using FWA for its Home Broadband service in various markets, including Chicago, Houston, Los Angeles, Indianapolis, and Sacramento. It is promising average downstream data rates of 300 Mbps and maximum rates of up to 1 Gbps. The operator has publicly stated that it plans to expand FWA to a total of 30 million households over time (including five new markets in 2020).

60 GHz Unlicensed Spectrum

5G FWA is based on mmWave spectrum that falls roughly into the 30 GHz–300 GHz frequency range, corresponding to wavelengths that span from 1 mm to 10 mm (thus, the spectrum name). mmWave technology is an essential component of 5G because this spectrum is uniquely capable of delivering the multi-gigabit data rates that 5G promises. While midband spectrum provides range, high band provides capacity.

The majority of mmWave attention focuses on licensed spectrum bands that offer dedicated operator use but at a cost of hundreds of millions of dollars – and more – for broad national coverage. Verizon's ultra-wide band 5G network, which includes both fixed and mobile 5G, is based on 28 GHz and 39 GHz spectrum licenses. To put licensing costs in perspective, Verizon has spent more than $3 billion over time collecting 28 GHz licenses alone (including spectrum purchases and operator acquisitions).

In contrast to licensed spectrum, unlicensed spectrum is available for use free of licensing fees. Unlicensed spectrum is not reserved for any specific user and thus is a shared use. Within the mmWave bands, the 57 GHz–71 GHz spectrum range is unlicensed and requires no government license for operator deployment. This unlicensed spectrum lies with the IEEE V-band range and is commonly called 60 GHz.

Unlicensed 60 GHz spectrum is used commercially in communications today. The IEEE has standardized the 60 GHz wireless spectrum, 802.11ad (known as WiGig), as a short-range wireless replacement for cabling of video monitors and other computer equipment. WiGig achieves data rates of up to 7 Gbps at very short ranges and is managed by the Wireless Gigabit Alliance.

Figure 2 shows details on the 14 GHz of contiguous spectrum included in WiGig.

Figure 2: 60 GHz Channels as Defined in IEEE WiGig

Channel	Center GHz	Min GHz	Max GHz	Bandwidth GHz
1	58.32	57.24	59.4	2.16
2	60.48	59.4	61.56	
3	62.64	61.56	63.72	
4	64.8	63.72	65.88	
5	66.96	65.88	68.04	
6	69.12	68.04	70.2	

Source: IEEE

Significantly, applications for 60 GHz spectrum have emerged beyond the very short reaches specified in WiGig. Extending 60 GHz communications to several hundred meters, gigabit data rates can still be achieved. These 60 GHz data rates are superior to DSL and coax-based broadband and comparable to the fiber access data rates promoted by many operators globally.

As such, 60 GHz is a valid option for offering 5G FWA, and one that does not require costly government license. Removing the licensing requirement opens 5G FWA to the thousands of smaller network operators that are priced out of obtaining licensed spectrum by the Tier 1 providers that operate in every country.

To be clear, comparing 60 GHz to other licensed 5G bands is not an apples-to-apples comparison. There are specific considerations in evaluating unlicensed versus licensed spectrum (aside from costs), and the V-band frequencies have unique characteristics compared to other 5G ranges. Heavy Reading delves into technical considerations later in this paper, but the key point is that, for many operators, unlicensed 60 GHz spectrum may very well suit their requirements across a number of applications.

TECHNICAL CONSIDERATIONS IN 60 GHZ DEPLOYMENTS

Key factors in choosing a communications access technology (whether wired or wireless) are capacity, reach, reliability, costs, and ease of deployment. Here we discuss these factors with respect to 60 GHz.

Capacity and Reach

mmWave range (including 60 GHz) is a line-of-sight transmission medium, meaning that the transmit and receive ends of the link must have mutual visibility to ensure transmission. Trees, buildings, and other obstructions between the transmit and receive ends will reduce reliability or eliminate link connectivity altogether. Thus, advance inter-site line-of-sight planning is essential in any build. Within a single network, different links may have different distance, capacity, and reliability specs due to environmental factors.

Given line-of-sight and favorable conditions, 60 GHz vendors specify ranges up to 500 meters and channel capacities up to 4.6 Gbps per channel, based on current chipset designs. Real-world conditions are seldom ideal, so operators will face trade-offs between capacity and distance. Prioritizing capacity at 1 Gbps, 200–250 meters may be a practical range for an operator. Sacrificing some capacity, however, an operator may find longer ranges can be achieved.

One challenge in 60 GHz compared to fiber is that every operator build will be unique. Climate conditions will vary from region to region (and by season), and topographies will vary from route to route. The key for any operator evaluating 60 GHz spectrum is careful site planning in advance of deployments. A good vendor will offer planning tools that aid operator customers in understanding the limitations of the technology and making the right choices for every link that is being planned and deployed.

Reliability

Given the variability posed by topographies and environments, reliability is a chief operator concern when evaluating 60 GHz technology (as well as other high frequency microwave technologies). One characteristic specific to the V-band frequency range is susceptibility to absorption by oxygen molecules, which limits reach over longer distances. The limitation is most pronounced in channels 1–3 (see **Figure 2**), but for channels 4–6, the oxygen absorption effect is minimal. While early-generation 60 GHz chipsets aimed at Wi-Fi applications supported only lower channels, new chipsets on the market (including chips supplied by Silver IMA) now support the full six channels in the 60 GHz range.

Self-healing mesh topology is a system-level innovation used by some vendors to significantly boost reliability. With careful inter-site planning, wireless nodes can be deployed to ensure line-of-sight and distance availability across multiple nodes. When the primary link between nodes is impaired or if an interim relay node fails, the system automatically switches network topology within distance and line-of-sight. While the alternate link may not be ideal, it ensures continuity of services until the impaired channel returns to normal functioning. Mesh topologies can be used to interconnect a network of backhaul nodes or to provide greater availability for a FWA link to an enterprise.

Fiber redundancy is another reliability feature in wireless mesh networks that are built with multiple fiber insertion points. In these networks, if a fiber-connected node fails or if the fiber itself goes down, the topology can switch to an alternate fiber node to preserve the wired connectivity.

Ease of Deployment

Ease of deployment is one of the greatest advantages of 60 GHz compared to fiber buildouts. With access to power and poles, site installation and turn-up can be done in less than 30 minutes, compared to months of installation time for running new fibers. Systems employing self-organizing technology (as described above for reliability), coupled with a wide field of view from a single integrated radio, make the installation process quicker. Once a technician turns on a node, it communicates with the network and self-installs automatically through the software.

The caveat is that, if backhaul fiber extension is needed to reach a customer, then the operator is ultimately limited by the fiber process. For this reason, initial customer turn-up for the first customer may be lengthier than turn-up for subsequent customers along a route.

Costs

From a cost perspective, 60 GHz compares favorably to both fiber-to-the-premises (FTTP) and licensed mmWave spectrum options, though the cost of the equipment itself is not the primary factor in either case. For FTTP builds, Ovum estimates that in high cost labor countries, the costs of building the network can represent 80% or more of the total FTTP network costs. For example, U.S. Federal Communications Commission (FCC) data for fiber construction costs per mile range widely from $20,000 to $100,000-plus, depending on whether fiber is aerial, existing ducts, or completely new builds. Still, Heavy Reading believes that most fiber versus mmWave decisions will not be based on cost analysis.

Rather, operators will choose mmWave when fiber is simply not an option or when rapid time to market is a key consideration. As noted earlier, fiber construction projects can run from several months to even years, given permitting and city approval timeframes.

Comparing unlicensed 60 GHz to licensed mmWave spectrum bands, equipment cost comparisons are dwarfed by the single largest cost factor in using licensed spectrum – the costs of the licenses themselves. Auctions for 24 GHz and 28 GHz spectrum in the U.S. generated $2.7 billion in revenue, primarily from Tier 1 mobile operators.

USE CASES AND ECONOMICS

Residential Broadband

This rapid and continued increase in download speeds has driven investment in next-generation access technologies. As shown in **Figure 1**, the global average broadband speed already exceeds 100 Mbps and continues to climb. Copper broadband technologies are quickly becoming obsolete. The growing trend is to replace the copper access network altogether with fiber-to-the-building/-home (FTTB/FTTH).

However, fiber is not feasible or economical for all residential locations. While Heavy Reading fully expects operators will migrate to next-generation access networks with a fiber-first strategy, FWA using gigabit mmWave technology has emerged as a viable secondary option for these instances. Where FWA may be suitable, unlicensed 60 GHz should be considered – particularly for smaller operators that are unlikely to have mmWave licenses. Self-install would make the case for residential FWA stronger. While not currently available for 60 GHz products, vendors are working on this function.

Enterprise Services

Enterprise services present a strong use case for 60 GHz FWA. Like residential users, businesses also require faster and faster download speeds. One difference in enterprise services is that businesses are willing to pay more for connectivity, meaning a faster ROI for operators that offer services. A second key difference compared to residential users is that enterprise staff will be more willing (and able) to self-install wireless equipment, which –

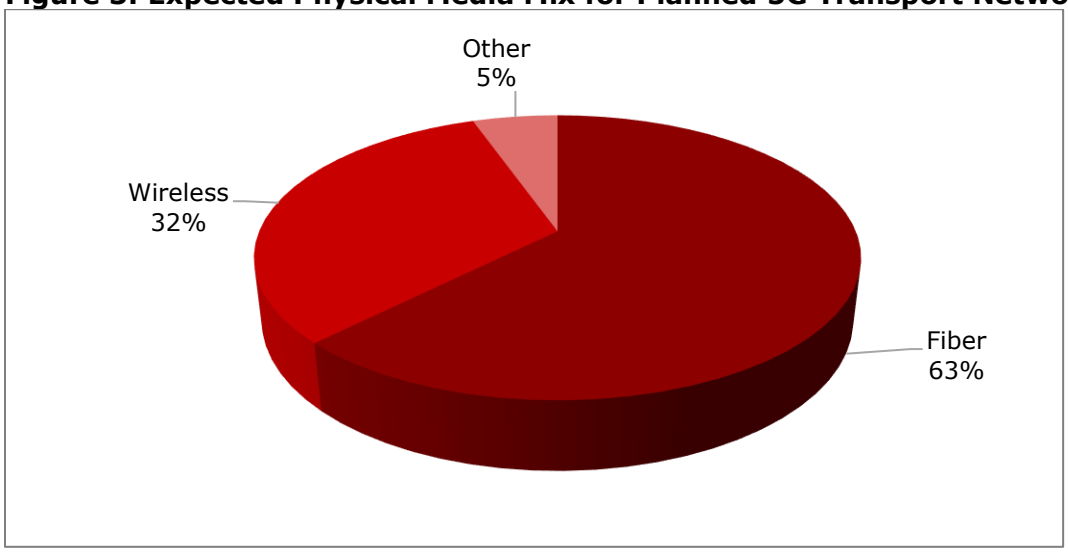
due to line-of-sight requirements – is more complicated than plugging in a Wi-Fi router. While we have not yet seen an enterprise self-install for 60 GHz, the model will surely be introduced in enterprises first before moving to the residential market. Finally, an important consideration in enterprise applications will be availability and service-level agreements (SLAs). Here, a mesh connectivity option will be an important differentiator.

Backhaul

As new macro sites and particularly small cells are deployed globally to support 5G, demand for backhaul connectivity – moving data from the macro or small cell site to the mobile core – is set to skyrocket. For small cells in particular, these will be new connections that require new backhaul infrastructure to support them. As in next-gen access, fiber is the first choice among operators for 5G backhaul.

But fiber is not the only choice for backhaul. Heavy Reading was surprised at how much operator demand exists globally for using wireless technologies in 5G transport networks. Nearly one-third of 5G backhaul connectivity may be by wireless media, according to a 2019 global survey of network operators (**Figure 3**) completed by Heavy Reading. Different mmWave options exist, but, particularly for small cell deployments, unlicensed 60 GHz backhaul will be an option.

Figure 3: Expected Physical Media Mix for Planned 5G Transport Networks



N=130
Source: Heavy Reading 5G Network & Service Strategies Survey Report, 2019

The rise of smart cities presents another opportunity for 60 GHz transport. In these cities of the future, Internet of Things (IoT) sensors and other devices collect and analyze reams of data to help city officials better monitor and manage a host of urban services, including transportation, power, water, waste management, schools, hospitals, and many others. Connectivity is essential for tight integration among citizens, devices, and service providers, and small cells are set to play a major role in providing that connectivity. In the smart city architecture, unlicensed 60 GHz can provide small cell backhauling, which includes 5G backhaul, but could also include 4G, CCTV feeds (for security and surveillance), and whatever other traffic needs backhauling.

Industry Progress

The 60 GHz opportunity is not theoretical. Commercial deployments exist today in several countries. South Valley Internet (San Martin, California) is one service provider that is using 60 GHz to meet gigabit service demands for both residential and enterprise customers.

Sweden's MicroNat is another. The broadband provider targets real estate owners, housing cooperatives, and businesses – both residential and business services. The provider reports that the combination of data rates, pricing, and redundancy enables it to compete successfully with inner-city fiber-based ISPs.

The U.K.'s Ontix uses 60 GHz primarily for wholesale backhaul services. Heavy Reading profiles Ontix's 60 GHz application below.

ONTIX CASE STUDY

Founded in 2017, London-based Ontix is an innovative new network operator that sells infrastructure to mobile network operators to help them densify their 4G and new 5G networks with small cell radio access points. Additionally, Ontix provides gigabit broadband services direct to business customers. The service provider operates within the populous Central London borough of Westminster. It aims to provide full connectivity for small cells attached to city lampposts, for which it has gained borough-wide access rights. Westminster is prize territory in the U.K. for small cell densification, and thus the primary focus for Ontix.

While Ontix runs a fiber distribution network connecting some nodes to its data center hub, 60 GHz wireless is an essential component of its network and strategy. Currently, the service provider has 100 live nodes in the network. One in five of those mmWave nodes is connected with fiber. Ontix plans to turn up an additional 250 nodes in 2020 and, within the next 5 years, connect 2,000 lamppost nodes throughout Westminster.

The business model is primarily wholesale, targeting mobile network operators (MNOs) looking for small cell access to the high traffic but fiber-poor region. These operators benefit from both cost-savings and time-to-market advantages by buying wholesale capacity on the Ontix network. Savings come in part through shared backhaul infrastructure, as multiple operators can (and do) share 60 GHz connectivity on lampposts.

It is early days in deployments, but according to Ontix COO Barnaby Dickinson, 60 GHz mmWave is a success. Speed of turn-up is a key differentiator. Installation of the 60 GHz equipment can be done in just 30 minutes. If the fiber network is in place, it is just a matter of scheduling the installer. Installation is slower in new build areas (roughly 8 weeks), since fiber and optical equipment are required. But once a first customer is online, adding new customers proceeds much more quickly.

Reliability has not been an issue, according to Dickinson, who says the network has been live for 6 months without any adverse environmental issues. Capacity up to 1 Gbps is delivered to any pole or end customer, and Ontix has planned its network with ranges up to 200 meters (though the equipment is specified to up to 500 meters, per the data sheets).

SLAs have not posed a concern. Dickinson said that MNO customers are still determining their small cell SLA requirements, but he does not expect that 60 GHz mmWave will be a gating factor. The issues, he states, are operational challenges due to the fact that small

cells are typically deployed on street furniture in dense urban environments. When operators set their small cell SLA, they will be the same whether they are connected by fibers or by air interface, according to Dickinson.

Finally, while Ontix's primary focus is wholesale backhaul connectivity, it also offers some FWA retail services to businesses, including 100 Mbps, 300 Mbps, and 1 Gbps services. FWA services share the Metrohaul backhaul network but require MetNet customer premises equipment to be mounted on the building. Retail FWA is a tactical decision (as it helps monetize the network), but ultimately Ontix wants to move to wholesale FWA. In the future model, the provider would sell wholesale FWA capacity to established FTTP providers that would then market services under their own brand and own the end-customer relationships. The model is a cleaner one for a small operator like Ontix that would rather not juggle retail and wholesale businesses.

CONCLUSIONS

Most mmWave discussion today centers on costly licensed mmWave spectrum bands. However, operators should also consider unlicensed spectrum in the 60 GHz range, which is an option in many countries.

Compared to fiber-based access and backhaul, Heavy Reading positions 60 GHz as a complement rather than a direct competitor to be used in cases where fiber is simply not economically or physically viable. In these applications, 60 GHz mmWave provides fiber-like capacities with rapid time to market. Compared to licensed mmWave technologies, 60 GHz holds a significant cost advantage because government licensing is not required. The lack of licensing will be appealing to Tier 2 and 3 operators in any market that are largely priced out of the spectrum auctions.

Reliability and reach will be key considerations in any deployment, but vendor innovations such as self-organizing mesh, wide fields of view, and use of higher channels greatly improve reliability compared to previous product generations. Most significantly, there are commercial deployments, including those by Ontix (profiled in this paper). As operator awareness about 60 GHz grows, Heavy Reading is confident that 60 GHz deployments will expand across residential, enterprise, and backhaul applications.