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Fixed Wireless Access: An Explorative Study of WIMAX FWA and 5G FWA Networks

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ABSTRACT: Driven by the growing demand to provide high speed internet service to household subscribers, especially those in remote rural areas with difficult terrains, where fiber cable is expensive to lay and maintain, fixed wireless access (FWA) is becoming the mainstream internet service proposition. FWA is one of pivotal use cases of the 5G network and a fast selling point in the telecoms market. While 5G FWA is new in the FWA market, WIMAX FWA has been in the business of providing FWA. This paper studies 5G FWA and WIMAX FWA, investigating key features that give one technology an edge over the other. The methodology used for this study was a systematic review of related literature, studying white papers from major telecommunication player and excerpts of interview from experts in the industry. Findings show that while 5G FWA and WIMAX FWA exhibit some technical similarities, 5G FWA has a better user Equipment (UE) ecosystem, and deploys networking slicing needed to meet the download-centric demand of traditional consumer and mobile markets. WiMAX, On the other hand, has an edge within the industrial markets as it securely meets the upload-centric demands of these industries.
Keywords- FWA, MIMO, Beamforming, SDN, NFV

I. INTRODUCTION

High speed internet broadband service is difficult to roll out in remote rural areas where laying of cables is almost impossible. According to a new research, 50% of the world's population is still waiting for reliable broadband access (Ericson, 2020). This significant number of the world's population have limited cost-effective alternative for internet connectivity. Fixed wireless access (FWA) is a viable and cost effective option for providing broadband services to these areas. It is also an alternative to Wired broadband service such as Digital Subscriber Line (DSL), cable modem and fiber optic.

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In the Past, fixed wireless has been costly to deploy because FWA subscriber numbers were low and it was best suited for densely populated areas where stations could achieve line of sight (LoS) transmission. A few telecoms operators later addressed the demand for FWA. The first deployment of FWA was focused on voice services based on 2G technology, and later voice and Internet connectivity with 3G, WiMAX FWA technologies, and subsequently 4G LTE (GSMA, 2018, pp. 2). Unfortunately, 4G LTE and WIMAX were both plagued by the high cost and complexity of providing fixed broadband service. While 4G LTE FWA was expensive to deploy, spectrally inefficient and incapable of delivering speeds needed to compete with other wired broadband services, WIMAX FWA demanded a completely new overlay infrastructure and expensive proprietary equipment. The tide, however, seems to change. With 4G LTE doing a comeback with 5G FWA as a key use case of the 5G network, and a fast selling point in the telecoms market. What will the scenario be between 5G FWA and WIMAX FWA?

The motivation for this work stems from the competition that existed between WIMAX and 4G LTE and the argument that WIMAX, though a powerful network, is a failed network. Our work will contributes to understanding FWA – a topic away from mobile broadband access.

II. METHOD

This paper seeks to explore the following research questions using the mentioned methodology.

i. If 4G LTE was incapable of delivering FWA at comparable speeds, what has 5G network done differently to provision for an ultrahigh speed FWA.
ii. With WIMAX FWA already in the market, what has WIMAX done differently to sustain itself in the FWA market?

We conducted a systematic review of the research topic by first studying white papers from major telecommunication players, extracted excerpts of interview from experts from the field and then reviewed related literature. We approached the first question by describing the new technological advancement 5G network features that enables it to provide ultrahigh speed. We further considered possible limitations and ways 5G network mitigates them. To answer the second question, we attempted to identify new technological features WIMAX made since 4G LTE. We considered possible limitations and mitigation, and compared features of WIMAX with that of 5G network to look out for the technology that has predominance.

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III. LITERATURE REVIEW

A decade ago WIMAX was potentially the biggest thing that will happen in the world of telecommunication. Proponents of WIMAX fronted an ideal network that would meet all demands for high speed connectivity. In practice, WIMAX did not live up to its projected performance. Some consumers' expectations were cut short, referring WIMAX as a mired opportunity hype. WIMAX was quickly overshadowed by a rapidly advancing mobile market with the introduction of LTE. WIMAX and 4G LTE were prime candidates to becoming the 4th Generation wireless mobile network. That race ended in favor of LTE 4G widely used as the 4th Generation mobile network while WIMAX was used in parts of Japan, Korea, Malaysia and parts of USA. Due to widespread adoption of 4G LTE, the growth rate for WIMAX slowed down for traditional Telecom Internet access markets. Few operators deployed WiMAX solutions in limited markets and WIMAX continued to see sustained participation in the market because it is a major player of FWA developed a long time ago.

Byrne (2015), in an interview, maintained that until LTE addresses the need of a fixed wireless access market, WIMAX will very much be in the market. Christensen, 2019 believes that the main use case for WiMAX will be for traffic off-loading, Wi-Fi back-haul, and campus type deployments such as hotels or office buildings (i.e. FWA); and that WIMAX has certainly not represented serious competition for LTE, nor will it for 5G.

Working with the initial use case of 5G to be FWA, Gabriel (2019) is of the opinion that in a few years' time, it is likely 5G FWA will be thrown back to the same difficult models that made WiMAX FWA tough – to undercut fiber and be forever stuck in price wars; or to target areas unserved by fiber, which brings high operating cost and, often, a low income user base. In an analysis, Mastrangelo (2019) disagrees with the opinion that 5G FWA will go the way of WIMAX because 5G FWA features new Radio waves, leverages on LTE networks and offers better speed on better technology advancement. With respect to WIMAX, Christensen (2019) concludes that WIMAX holds great promise if it addresses its limitations.

IV. FWA NETWORK

Fixed wireless access (FWA) is the process of providing wireless broadband using radio links between two fixed points(example: base station to building or building to building) connected via fixed wireless access devices and equipment. Traditionally, enterprises used leased lines or cables to connect two

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different locations. However, FWA approach involves connecting two fixed locations via a radio transmitter and a receiving antenna. These antennas are setup with point-to-point or point-to-multipoint with beamforming, thus focus transmitting power to receiving devices which will result in higher data throughput. A FWA setup that will offer good signal strength, coverage radius, and bandwidths is determined by factors such as: antenna technology, spectrum, proximity to base stations and technology choice.

We now consider WiMAX FWA and 5G FWA technology in this light.

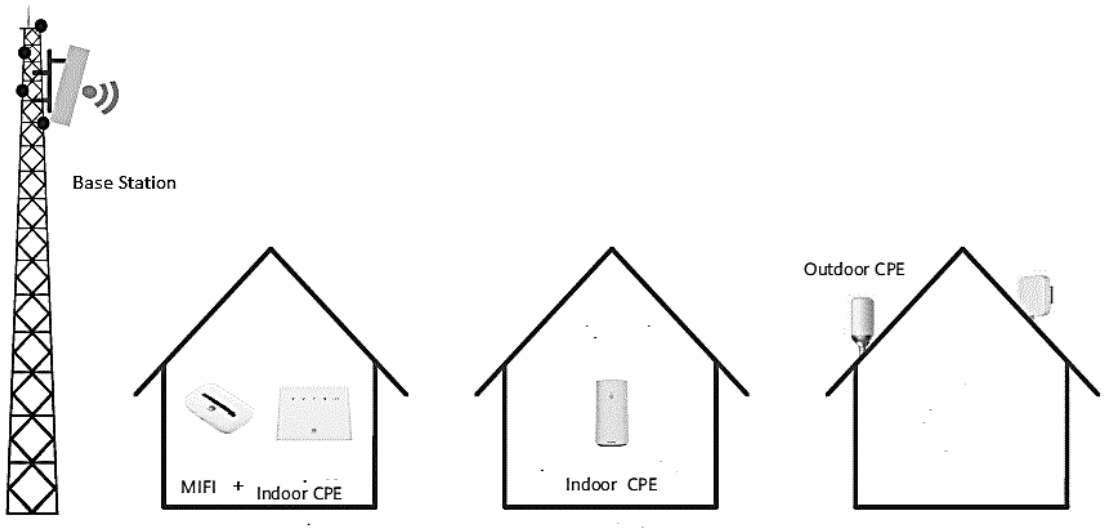

Fig i. Fixed wireless access (*Huawei, 2019, pp. 7*)

A. Frequency Spectrum

WiMAX (Worldwide Interoperability for Microwave Access) is based on IEEE 802.16 air interface standard providing wireless broadband services on last mile connection using microwave radio technology. It offers both line-of sight and non- line-of- sight communication in place of wired connections. WIMAX is designed to cover wide geographical areas accommodating both fixed and mobile connectivity. WiMAX operates in between 10 and 66 GHz Line of Sight (LOS), covering a range of up to 50 km (30 miles). It also operates at 2 to 11GHz non Line-of-Sight (NLOS) typically covering a range of up to 6 - 10 km (4 - 6 miles) for fixed customer premises equipment (CPE) while the mobile standard covers below 6 GHz. WiMAX uses OFDMA as a multiple access carrier technique (Banerji1 & Chowdhury). In NLOS multipath channel OFDMA has superior performance due to its simple transceiver structure. Fixed WiMAX employs TDD as a duplexing mode and Mobile WiMAX deploys both Time Division Duplex (TDD)/ Frequency Division

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Duplex (FDD). It can be FDD or TDD depending on the frequency band, however, TDD is more beneficial than FDD in mobile internet services and also suitable for advanced antenna techniques.

5G mobile network is an evolution of LTE 4G mobile network of 3Gpp standards. 5G is due to provide 10 to 100 times more capacity and higher data throughput rates than 4G (AMTA, 2019, pp. 3). 5G is designed to meet growth in data and connectivity of today's modern society and tomorrow's innovations. 5G will initially operate in conjunction with 4G LTE networks before evolving to fully standalone networks in future releases (AMTA, 2019, pp.7). 5G features new Radio in the millimeter wavelength (mm Wave) bands, with Millimeter waves occupy a relatively unused portion of the electromagnetic spectrum between 30 GHz and 300 GHz, which offers excellent throughput and increased capacity (Research and Market, 2020).5G will use a mix of spectrum ranges below 6GHz with different combinations of millimeter wave (mm Wave) spectrum band (26-28 GHz). 3.5GHz will be popular for initial deployments of cellular communication. Spectrums below 6GHz would provide much better coverage than mm Wave spectrum, however, spectrums below 6GHz is limited by availability and relatively narrow bandwidths. Hence the choice for mm wave frequency. 5G uses OFDMA as a multiple access carrier technique. It employs both Time Division Duplex (TDD) and Frequency Division Duplex (FDD).

5G FWA Proposed Frequency Bands	Coverage	Data throughput
3.4-3.8Ghz	Good	Good
24.25-27.5Ghz (mm Wave)	Poor	Excellent

Table 1. Characteristics of proposed 5G FWA frequency bands (*Metaswitch, 2021*)

B. Antenna Technology and proximity to Stations

With FWA, the last hop is a wireless point-to-multipoint radio and therefore shared; which means that speeds will degrade with increasing cell load, and connection quality will vary across connection points. These characteristics are considered when dimensioning an FWA network. With the ability to employ higher radio frequencies and advances achieved in transceiver technology, network operator can deliver FWA that achieves ultra-high-speed internet services.

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5G will initially operate with 4G LTE networks before evolving to fully standalone networks in subsequent releases and coverage expansion (AMTA, 2019a, pp. 7). 5G FWA will be dimensioned on top of an existing 4G LTE or 5G mobile network. This collaboration will operate such that when a 5G connection is established, the device connects to both 4G LTE network and 5G network. 4G LTE provides the control signaling while 5G network provides the fast data connection. 5G networks, in conjunction with 4G networks will make use of a range of macro cells, small cells and dedicated in-building CPE systems. Small cells are pivotal for 5G networks as the mm Wave frequencies have a very short connection range and prone to interference. 5G FWA employs multiple input, multiple output (MIMO) advanced antenna technique that allow more user connections with maintained high data throughput. Beamforming is also employed to direct radio signal to users rather than in all direction hence, reducing radio interference. 5G network features network slicing using Network function virtualization (NFV), and Software-Defined Networking (SDN). NFV and SDN are the main element of 5G network architecture to support powerful wireless communication. Network slicing transforms a network into a set of logical networks: logically separated, self-contained, independent and secured; on top of a shared infrastructure targeting different services with different requirements on speed, latency and reliability (Ericsson, 2020). Network slicing is an effective and efficient way of utilizing network resources and ensuring that resources are sufficient at busy hours.

WiMAX uses advanced multiple input, multiple output (MIMO) antenna technique to improve coverage and data throughput. Cell coverage is enhanced using Beamforming. WiMAX provides flexible frequency reuse using sub channelization, low rate coding, and power boosting and debossing features (Garhwa & Bhattacharya, 2012).

V. CHALLENGES AND MITIGATIONS

Previous FWA initiatives failed due to the proprietary nature of the technology they employed. This resulted in a poor ecosystem of equipment vendors and support, which consequently reduced competitive choices and increased prices (Ericsson, 2019). This was the major pitfall for WIMAX but an advantage seized by 4G LTE. 5G enjoys a large supplier ecosystem over WiMAX due to backhaul of standardized User Equipment and mobile networking equipment from 3G and 4G that can be reused for FWA with no modification. WIMAX may have mitigated this shortfall by integrating its services with 4G LTE.

Fixed wireless is most effective when deployed using small stations to transfer data. Stations are usually clustered, hence, capable of delivering faster internet speeds with lower latency. The challenge SG

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may face is with mm Wave spectrum band. It is prone to penetration loss in buildings and has smaller coverage area. In the mm Wave spectrum radio link performances is poor when the transmitter and receiver are not in Line-of-Sight. 5G network mitigates this condition by antenna enforcement (i.e. mounting indoor and outdoor CPE); and beamforming and massive MIMO antenna technology to radiate higher levels of radio power to maintain an acceptable link. The use of antenna enforcement makes operations more complex and increases the cost of a wireless last mile connection. There will also be need to acquire technologies to maintain adequate safety from Radio Frequency exposure.

VI. COMPARISON

WIMAX and 5G are two similar technologies with few differences.

Aspect/Parameter	5G	WIMAX
Standard	3GPP /5GPPP	IEEE 802.16-2004
Frequency	3.4 -3.8Ghz 24.25-27.5Ghz	2.5 - 11 GHz (fixed WiMAX) 2 - 6 GHz (mobile WiMAX)
Waveform	OFDMA	OFDMA
Modulation	16 QAM, 24 QAM, 256 QAM	BPSK, QPSK, 16 QAM, 24 QAM
Duplex Mode	FDD/TDD	FDD/TDD
Multiple antenna techniques	MIMO	MIMO
Network Slicing (NFV/SDN)	Yes	
Beamforming	Yes	Yes

Table 2: Comparing key parameters of 5G FWA and WIMAX FWA

VII. DISCUSSION

To answer our research questions, 5G network is capable of provisioning an ultrahigh speed comparable to other wired broadband services because 5G FWA implements mm wave frequency spectrums, advanced antenna techniques (MIMO and beamforming) and network slicing. Analyst opine that the growth of 5G FWA is expected to be driven by the high speed offered via high-frequency millimeter waves and increased wireless network capacity, making it a competitive alternative to wired broadband services

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(Research and Market, 2020). WIMAX Network will see sustained presence in the FWA space because of its strategic integration with 4G LTE for seamless co-exiting in the wireless communication environment, thereby, expanding their ecosystem to include more compatible devices. While the household space may be dominated by 4G LTE, WiMAX has created a niche within industrial markets such as Aviation, Utilities/Smart Grid, Oil & Gas and Transportation as it securely meets the upload-centric demands of these industries.

We therefore, submit that 5G FWA and WIMAX FWA operations are similar, with one having an edge over the other in some regard. WIMAX FWA would have been cheaper than 5G FWA to deploy but 5G has an advantage of a better Consumer premises equipment (CPE) ecosystem that allows network operators to easily integrate and migrate without making huge investments on acquiring new equipment. While WIMAX may have found their niche in other industries, and despite the huge takeover by 4GLTE and consequently 5G, Judging from the network integration achieved by WIMAX, it is safe to say that WIMAX is working on addressing its limitations and in a matter of time, will stand on equal footing with 5G and also become a traditional telecoms go-to for household, providing broadband services on the last mile for the next major fifth generation phase of telecommunications industry.

VIII. CONCLUSION

This paper has presented an overview of Fixed Wireless Access (FWA) Network with respect to 5G and WIMAX. 5G FWA and WIMAX FWA were discussed in the light of frequency spectrum, antenna technology, along with their challenges and mitigations. Comparisons were made on key Parameters of these technology. Finally/ discussion was made on what makes one have an advantage over the other and their chances in the telecommunication industry.

REFERENCES

[1]. AMTA. (2019, August). *5G and EMF Explained*. EMF Explained Series. http://www.emfexplained.info/site/misc/emf/downloads/5G&EMF%20Explained_AMTA_23Aug_2019_20.pdf

[2]. Banerji1, S., & Chowdhury, R. S. (2013). Wi-Fi & WiMAX: A Comparative Study. *Ndian Journal of Engineering*, *2*(5), 2. https://www.researchgate.net/publication/235432234_Wi-Fi_WiMAX_A_Comparative_Study

[3]. Byrne, D. (2015). *Q&A: Declan Byrne Discusses the Basics of WiMAX*. Https://Www.Mwrf.Com/Technologies/Services/Article/21846161/Microwaves-Rf-Qa-Declan-Byrne-Discusses-the-Basics-of-Wimax.

[4]. Christensen, G. (2019). *WiMAX: The Hype and Hope*. Https://Www.Linkedin.Com/Pulse/Wimax-Hype-Hope-Gerry-Christensen.

[5]. Ericsson. (2020). *Network slicing accelerates 5G for business*. Https://Www.Ericsson.Com/En/Network-Slicing?Gclid=EAIaIQobChMIw93Oh8O27wIVBGgYCh16NA3TEAAYASAAEgIVYfD_BwE&gclsrc=aw.Ds.

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[6]. Ericsson. (2019). *Experiences from smart fixed wireless access deployment*. (2019, June). Https://Www.Ericsson.Com/49d02a/Assets/Local/Mobility-Report/Documents/2019/Emr-June-2019-Smart-Fwa-Deployment.Pdf.

[7]. Gabriel, C. (2019). *5G fixed wireless is thriving, but will it go the way of WiMAX?* Https://Rethinkresearch.Biz/Articles/5g-Fixed-Wireless-Is-Thriving-but-Will-It-Go-the-Way-of-Wimax/.

[8]. Garhwa, A., & Bhattacharya, P. P. (2012). A review on WiMAX Technology. *International Journal of Advances In Computing And Information Technology*, 167–172. https://doi.org/10.6088/ijacit.12.10021

[9]. GSMA. (2018). *Fixed Wireless Access: Economic Potential and Best Practices*.

[10]. Huawei. (2019). *Wireless Fiber: 4G/5G FWA Broadband*. Huawei Technologies Co., Ltd.

[11]. Mastrangelo, T. (2018). *Are we having a fixed wireless access resurgence?* Https://Www.Blog.Adva.Com/En/Are-We-Having-a-Fixed-Wireless-Access-Resurgence.

[12]. Metaswitch. (2021). *what is 5G Fixed Wireless Access (FWA)?* https://www.metaswitch.com/knowledge-center/reference/what-is-5g-fixed-wireless-access-fwa

[13]. Research and Market. (2020, November). *Global 5G Fixed Wireless Access Market Report 2020-2026*. https://www.prnewswire.com/news-releases/global-5g-fixed-wireless-access-market-report-2020-2026-301179903.html

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