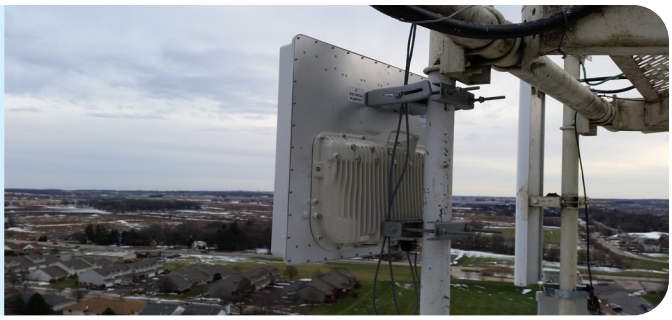
Exploring the Benefits of a Purpose-Built Fixed Wireless System



HOW DOES A PURPOSE-BUILT FIXED WIRELESS SYSTEM STACK UP AGAINST LTE SYSTEMS? LEARN MORE ABOUT THE ADVANTAGES OF FIXED WIRELESS, WHAT IT MEANS FOR WISPS AND THE KEY PERFORMANCE INDICATORS BETWEEN THE TWO.

RECENTLY, THE WIRELESS TELECOMMUNICATIONS INDUSTRY has evolved through standards-based technologies quite rapidly... from 2G to 3G, then to 4G, also known as Long-Term Evolution (LTE). Lately, 5G seems to be all that people are talking about. However, for fixed wireless systems, LTE-based protocols are in heavy use and remain at the forefront of mindshare, especially among large service providers that are creating or augmenting their mobile networks with a fixed wireless business unit. Transitioning from the world of mobility, it is easy to see why this linkage exists. The technology can be and has been successfully adapted to serve the purpose of providing fixed wireless access (FWA) in many networks globally.

Many features of the LTE wireless system make fixed wireless applications attractive. First, the LTE standard supports many modulation modes, even beyond 256-QAM at the high end (allowing high data rates where great signal levels can be achieved) down to BPSK (to maintain connection where signal is poor). Further, Orthogonal Frequency-Division Multiple Access (OFDMA) is an advancement over Orthogonal Frequency-Division Multiplexing (OFDM), resulting in better sensitivity and resistance to noise and interference. Both features lead to a superior ability for LTE systems to maintain the connection to the User Equipment (UE), Customer-Premises Equipment (CPE) or endpoint in the downlink.

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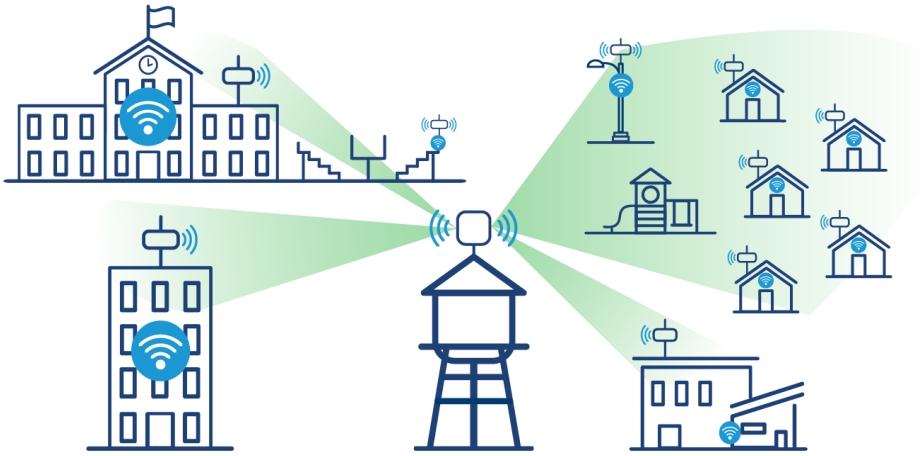
However, even with these advanced features that are built into the chipsets, there are stark and significant drawbacks to using a technology for *fixed wireless* that was originally created for the purpose of mobile communications. First is the complexity (and cost) of the required architecture. The concept of the Evolved Packet Core (EPC), which is required to process every packet of data, makes sense for data coming from mobile handsets that traverse sectors while moving. However, in a fixed system, this is not necessary, and the architecture can be significantly simplified.

An even more significant issue also arises from the mobile-centric heritage of LTE systems. In mobile applications, the Base Transceiver Station (BTS) is typically very high powered and outputs a lot of energy, while the UE is a handset; very capable of receiving high data rates but limited in the amount of data that can



be sent in the uplink due to the limited transmit power and antenna gain (i.e., link budget). This results in an imbalanced link, which is always downlink-heavy. There are Time-Division (Duplex) LTE (TD-LTE) frame configuration options that assign more of the frame to the uplink (such as Frame Config 0) but doing so will cut the total sector capacity significantly while marginally improving the uplink throughput. This imbalance is addressed by the purpose-built fixed wireless solutions that Cambium Networks offers. As virtual meetings (work from home) and cloud-based applications become more prevalent, more emphasis must be placed on a robust uplink.

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Reaching back to the birth of the Wireless Internet Service Provider (WISP) industry circa 2001, Cambium Networks (then part of Motorola) devised a purpose-built, software-defined radio system intended as a fixed wireless broadband solution. Because chipsets and protocols available at the time were sub-optimal for outdoor fixed wireless applications, a decision was made to create a proprietary Media Access Control (MAC) layer and scheduler to process and manage IP data transport. Known as "Canopy™," this technology fostered the birth and growth of the WISP industry as it is known today due to its robust RF signaling, ease of use and IP/networking feature set that has continued to evolve to the present day. From that original design, continuous evolution and advancements led to the Cambium Networks PMP 450 platform in 2012, with a 3.65 GHz variant being released in 2015. In 2016, a groundbreaking innovation was released, known as cnMedusa™ technology, which allows the PMP 450 platform to operate using beamforming and Massive Multi-User MIMO techniques to multiply the sector capacity. This was first released in unlicensed 5 GHz, then adapted to 3 GHz in 2018 with the 8x8 Massive MU-MIMO PMP 450m. This technology allows Cambium users to maximize their use of limited spectrum. Thinking ahead, the development of this platform included provisions to meet the requirements of Citizens Broadband Radio Service (CBRS), and the entire PMP 450 platform of products was certified for CBRS use in 2019.

This foresight was essential to successfully launch CBRS in 2020. First, there was a large base of installed 3.65 GHz devices still in operation, and these devices faced elimination if they were not able to meet the standards of CBRS. Second, the alternative technology available for CBRS is solely that of LTE, which, for reasons described above, is not that well-suited for fixed wireless deployments. However, when it was first applied to this use case, the impressive range and coverage that could be achieved was marketed quite well. In fact, when cnMedusa was released in 2018, Cambium Networks had designed the system for Line-of-Sight (LOS) operation and had some reservations about how well it might work in many of the scenarios that WISPs might attempt (3 GHz equipment is often used where LOS is not available - through foliage, for example). Because of this, there was concern that the Massive MU-MIMO benefits might not be realized under Near Line-of-Sight (nLOS) and Non-Line-of-Sight (NLOS) conditions. However, via test after test, and from many customer testimonials, it has become obvious that the PMP 450 system outperforms nearly every LTE system that exists today.

Advantages for 450:

- Ease of Use
- Ease of Deployment
- 8x8 MU-MIMO
- cnMaestro™ Cloud Management
- Low TCO

There are several reasons for this. First, when LTE-based systems were introduced in 3 GHz, testing under CBRS rules (which allows higher effective isotropic radiated power (EIRP)) led to a perceived major difference between those platforms and the existing PMP 450 platform. This perception was erased when it became clear that both the 450m (Base Station) and the 450b (CPE or endpoint) products also achieve this higher level of power. Further, while most LTE CPE units on the market are 2x1 (that is, 2 Rx and 1 Tx), the 450b CPE is a 2x2 MIMO radio, meaning that it incorporates two transmitters to allow for better uplink benefits in both capacity and diversity.

The concern about not having LOS was also overestimated. There is still concern that if obstructions or diffracting clutter is near the sector antenna, this would impede the ability to best utilize MU-MIMO. However, in practice and in most cases, the obstructions occur near the SM (i.e., the tower site is clear, but the subscriber is behind some tree cover). Due to this, most of these subscribers still qualify to be grouped by the multi-user MIMO algorithm and are part of the beamforming and grouping beneficiaries, resulting in enhanced sector capacity.

Cambium Networks' PMP 450 platform reduces the Total Cost of Ownership (TCO) of the network for several reasons. First, the capital equipment cost is reasonable compared to other high-performing radio equipment. The quality and reliability that Cambium Networks is known for reduces maintenance and ongoing operational expenses. Eliminating the complexity associated with mobile networks (such as the Evolved Packet Core) eliminates ongoing costs of these components as well. As seen in the graph, with modest capital investment, ROI can be achieved within 12-18 months, and TCO remains low throughout

an estimated five-year operating horizon.

In summary, Cambium Networks' customers are realizing fantastic performance from the 3 GHz PMP 450 product family, maximizing both spectral efficiency and capacity, while maintaining ease of use and a low total cost of ownership, especially in terms of ongoing operational expenses. While LTE is advancing toward 5G NR platforms, and some equipment may have that promise, it remains a path built with mobility as the primary goal, while the PMP 450 platform is purpose-built for fixed wireless. Because it's software-defined, further innovation is being undertaken and many advances are yet to come. Not only is the current performance above and beyond what the standards can offer today, Cambium Networks believes it can continue to outpace standards-based performance in the future.

ABOUT CAMBIUM NETWORKS

Cambium Networks empowers millions of people with wireless connectivity worldwide. Its wireless portfolio is used by commercial and government network operators as well as broadband service providers to connect people, places and things. With a single network architecture spanning fixed wireless and Wi-Fi, Cambium Networks enables operators to achieve maximum performance with minimal spectrum. End-to-end cloud management transforms networks into dynamic environments that evolve to meet changing needs with minimal physical human intervention. Cambium Networks empowers a growing ecosystem of partners who design and deliver gigabit wireless solutions that just work.