Balancing Cost and Performance in 3 GHz: A Comparison Between PMP 450 and LTE

FINDING BALANCE BETWEEN SYSTEM COST AND PERFORMANCE FOR A SPECIFIC USE CASE IS THE KEY TO PROVIDING NETWORK OPERATORS A PROFITABLE SOLUTION.

Introduction

The LTE (Long Term Evolution) standard enables great performance and has many features that make it well suited for fixed wireless network operators. The 3rd Generation Partnership Project (3GPP) originally came together as an industry group to create mobile standards that would move mobile (cellular) infrastructure forward. The LTE standard, backed by the largest telecommunications groups in the world, has had billions of hours and dollars poured into it to continue to evolve the standard protocol for mobile telecommunications. Chipset manufacturers are doing their best to keep up with the release schedule and are incorporating features defined in these releases into their latest offering.

However, a standard is just that: a standard. Just because a product utilizes the LTE standard does not inherently mean it has taken advantage of all the features in the standard or delivers the maximum level of performance enabled by the standard. The system implementation (that is, the application of a standards-based chipset to a functional system) makes all the difference. As is nearly always the case, systems designers are faced with tradeoffs. Striking the proper balance between system cost and performance for a specific use case is the key to providing network operators a profitable solution.

Customer Experience

Globally, licensed 3 GHz frequency band was defined for the WiMAX standard. It is not typically available to service providers without having purchased or leased this frequency. However, some efforts have been made to make it more readily available in certain parts of the world. Specifically, in the United States and Canada, 50 MHz of this spectrum (3650-3700 MHz) had been available under a “lightly licensed” condition. An operator needed to obtain a nationwide, nonexclusive license at very low cost from the regulatory body. Then, they needed to register any equipment that would be operating in that band. This propelled the use of this band forward over the last several years.

A substantial number of operators are helping to bridge the digital divide and connect rural customers.

Cambium Networks introduced the 450 platform operating in the 3 GHz band in 2014. Since then, it has been deployed in hundreds of networks globally. This represents a substantial number of operators that are helping to bridge the digital divide and connect rural customers. Upcoming changes to this band in the United States (via the Citizens Band Radio Service (CBRS) initiative) will allow additional frequency use in this band. This will drive more demand for efficient equipment that operates in these frequencies.

Due to the large established install base of equipment already in place, it is logical that operators wanted to continue deploying the same equipment when new spectrum became available. Cambium Networks' customers were able to achieve migration to the new bands with a simple software upgrade and avoided physically replacing the equipment. In addition, the 450 platform evolved to include cnMedusa technology in this band, which further enhances the performance, capacity and spectral efficiency of the system.

Operating Range and Coverage Area

The 3 GHz frequency band is attractive to many operators for a few different reasons. A primary consideration is that of the coverage area and the potential for overcoming obstacles such as foliage. As the frequency gets lower, the ability for the radio signal to penetrate foliage gets better. Therefore, 3 GHz works better than 5 GHz, which is more widely available and typically unlicensed. It can be sought after in areas that are difficult to reach.

With regards to coverage, the LTE standard provides some advanced tools in the chipset. Utilizing Orthogonal Frequency-Division Multiple Access (OFDMA), the many subcarriers that the channel is divided into can be assigned to different subscribers in the same frame. This leads to enhanced performance. Because the standard was designed with mobility in mind, the primary performance is slanted toward the downlink direction. The protocol lends itself toward maintaining the downlink connection, which leads to better range. Another possibility is the use of customer-installed indoor devices, such as table-top subscribers or dongle units.

When compared to the 450 platform, the LTE frame structure (with additional modulation coding schemes (MCS), more subcarriers and OFDMA) can provide enhanced range and capability to perform better in Near- and Non-Line-of-Sight conditions. It is also typical that LTE systems have higher transmit power capability than the 450 platform. In the lightly licensed scheme found in the United States, this is not critical because the 450 platform can nearly reach the regulatory maximum Equivalent Isotropic Radiated Power (EIRP). However, where the frequency is licensed, the maximum power is typically much higher. In fact, when new CBRS rules are in place, the power limit will be higher.

Interference Mitigation

Interference is always a concern of any wireless equipment operator. The ability to deal with or avoid interference often is the difference between success and failure. The PMP 450 platform has evolved over many years to tolerate interference when it exists, and to avoid interference where possible. Although the LTE standard provides many MCS levels, which allows for great receive sensitivity and very low required signal-to-noise ratio (SNR), the 450 platform was designed as a purpose-built fixed wireless system.

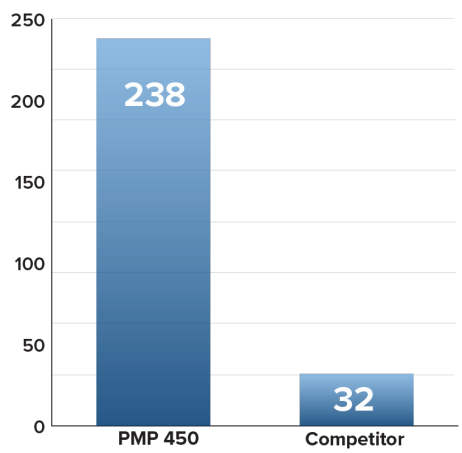
The ability to deal with or avoid interference often is the difference between success and failure.

That means the design assumes:

1. Complete control over the channel information at both ends of the link.
2. It is not constrained by the standards.

This provides an opportunity to implement advanced techniques to manage interference. For example, cnMedusa technology provides incredibly fast beamforming, with the ability to achieve very narrow energy lobes and steer energy nulls (i.e., the absence of antenna energy). The implementation of this can outperform anything in the LTE space and allows for advanced interference avoidance with better, more accurate beam steering. Additionally, it allows active interference cancellation techniques by pointing destructive energy toward a radiating interference source.

Scalable Networks



The 450 platform supports up to 238 subscribers per sector while one competitor claims to only support 32 users per sector. Another caps the total number of subscribers per EPC to 500 users.

- **Subscribers per Sector**
  The 450 platform supports up to 238 subscribers per sector. In rural environments, this kind of density may not always be necessary, but there may be cases where there are many subscribers per sector. While installations vary greatly, many 450 network operators will have 100 or more subscribers per sector. Data from 450m (cnMedusa) sectors in the 5 GHz range show that greater than 100 customers is sustainable with the amount of capacity that these sector radios can provide.

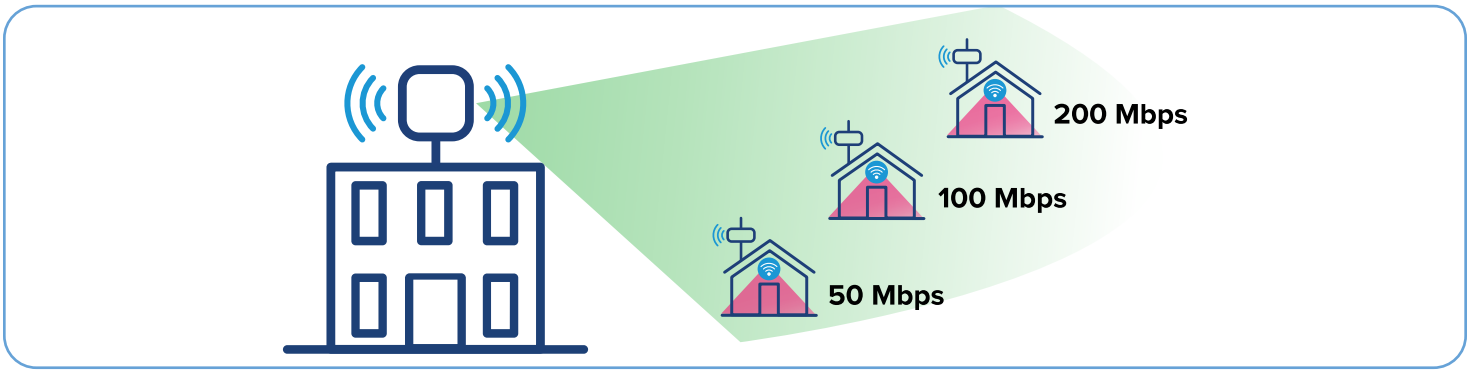
  Of the competitors noted in this space today, there is a limited ability to support a scalable number of subscribers per sector. One competitor claims to only support 32 users per sector while another caps the total number of subscribers per Evolved Packet Core) to 500 users. This could present a problem when attempting to scale the network in terms of total subscribers.

- **Bandwidth per Subscriber**
  Increasingly, operators are offering a mix of performance levels and price points. At the very high end, an operator may need to provide a significant amount of capacity dedicated to a single customer. The 450 platform is designed to be very flexible, and the duty cycle (i.e., the uplink/ downlink ratio) can vary from 85% to 15% downlink, in increments of 1%. Flexibility like this can allow the operator to tailor the service to the customer. In fact, the 450 platform subscriber module can provide up to 300 Mbps of capacity to meet any service level agreement required.

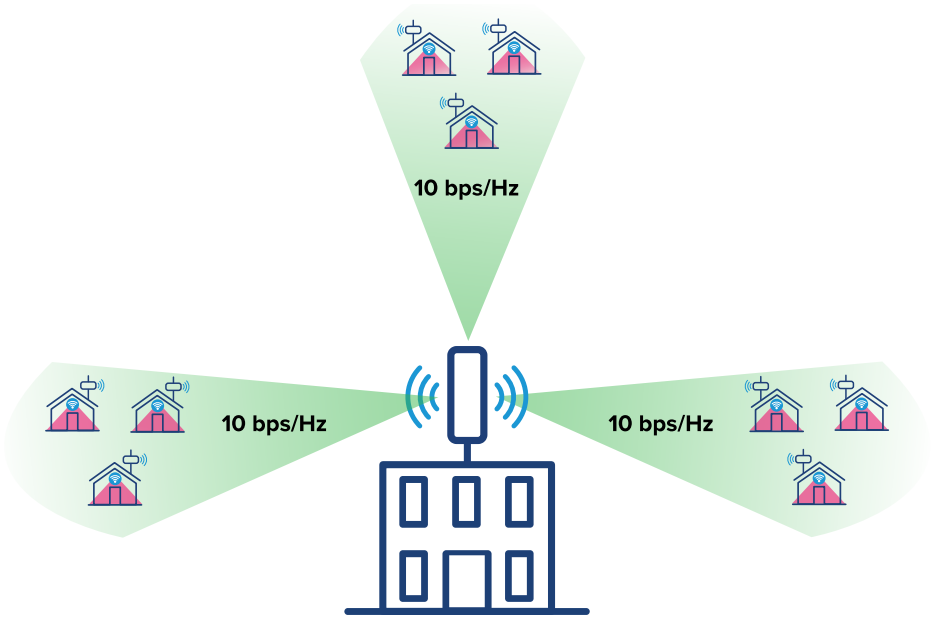
  By contrast, while LTE Customer-Premises Equipment (CPE) typically have a cost advantage over purpose-built fixed wireless, the performance of these low-cost devices needs to be looked at carefully. In most cases, there is a limited ability to provide over ~130 Mbps of throughput in aggregate through LTE CPEs. Further, the uplink is usually severely limited (~20 Mbps) and cannot be altered to provide more. This is largely due to the LTE protocol itself.

- **Total Sector Capacity**
  The total capacity of a sector can be another factor in how well the network can scale. With LTE, the standard allows for very advanced techniques that have great capacity. For example, Release 10 (also referred to as LTE-Advanced) allowed for up to 8x8 MIMO and carrier aggregation. This is a potential maximum of 600 Mbps per sector.

  However, the closest competitors in this space are currently supporting only a 4x4 MIMO sector, while most only support a 2x2 radio. This would mean a maximum of about 150 Mbps in a 20 MHz channel. The 450m in 3 GHz will support 8x8 Multi-User MIMO operation, giving a multiplexing gain on top of what is seen with 450i. That is, the expectation is that there will be at least twice as much capacity in the sector compared to a 4x4 LTE system. In absolute terms, the 450 platform can support 125 Mbps per 20 MHz channel and up to 300 Mbps per 40 MHz channel in 450i. This will increase to over 600 Mbps with 450m.

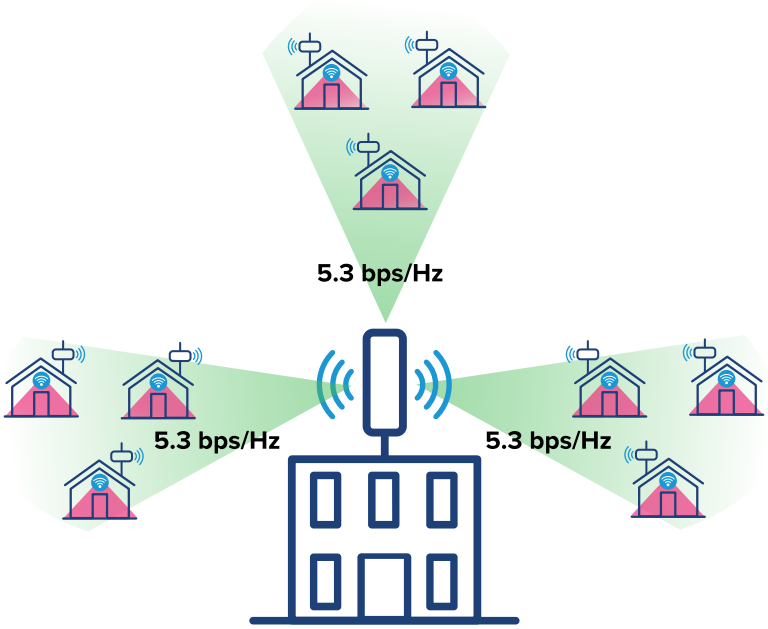


- **Spectral Efficiency**
  A high-performance wireless system must also demonstrate good spectral efficiency. That is, it should make best use of the spectrum that is available. The LTE-Advanced standard can show up to 30 bps/Hz by utilizing 20 MHz channels with a 3-sector 8x8 MIMO N=1 (i.e., reuse of the same 20 MHz channel on all three sectors) configuration. That is the best case per the standard.



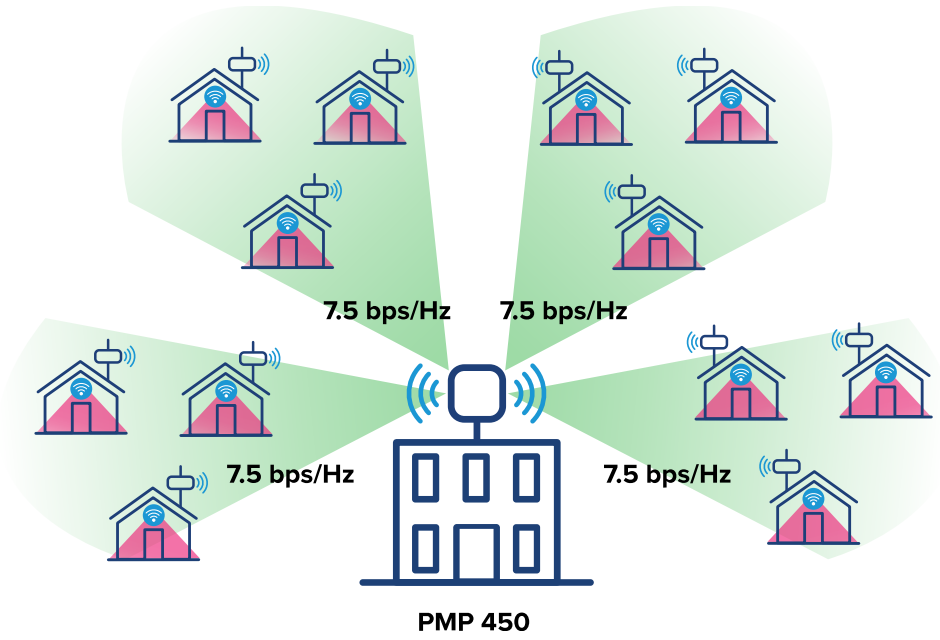
LTE Advanced Standard

In actual deployments, it is noted that three 4x4 sectors, using N=1 can provide up to about 16 bps/Hz. However, it significantly decreases the range due to limiting the transmit power to allow N=1 to work properly. This also means that the total site capacity is about 320 Mbps or just under 110 Mbps per sector.

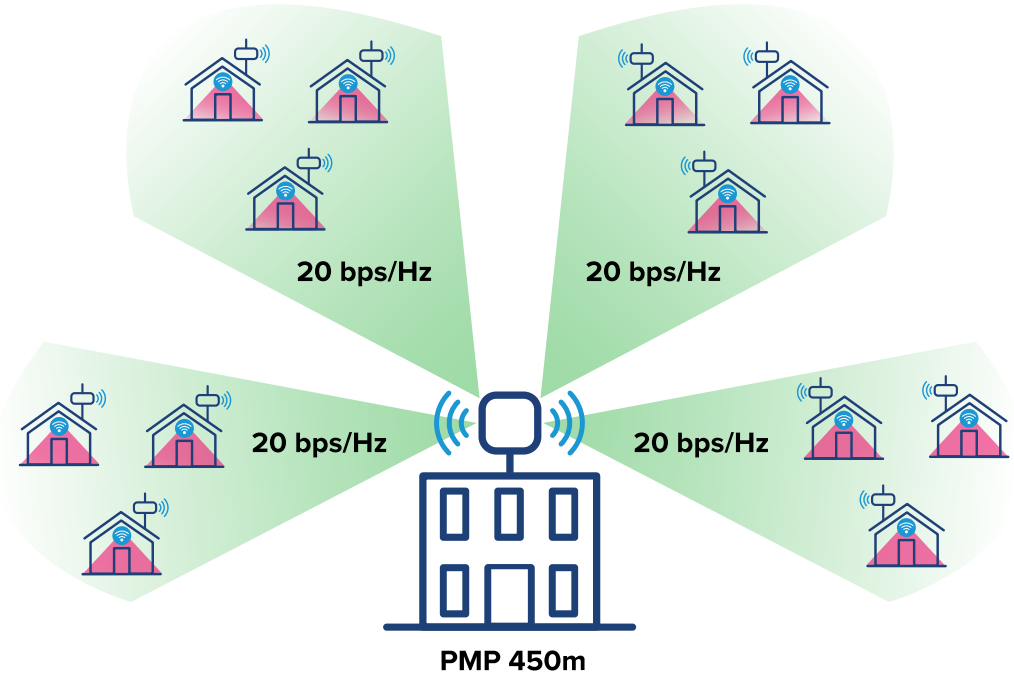


LTE Advanced Standard - Actual Deployments

In contrast, the 450 system can achieve about 40 bps/Hz. This is possible due to the system specification of the platform. First, a four-sector deployment is recommended rather than the typical cellular model of a three-sector deployment. This, combined with antenna systems that are optimized to properly isolate the front-to-back energy, allows the 450 platform to effectively reuse frequencies in a back-to-back fashion. In a four-sector deployment, this equates to a N =2 (or ABAB) configuration. A single sector is capable of 7.5 bps/Hz (that is, 300 Mbps in a 40 MHz channel) or 15 bps/Hz at a site when employing N=2.



If 450m with cnMedusa Multi-User MIMO technology is used, this becomes two to three times better, resulting in up to up to 20 bps/Hz per sector or 40 bps/Hz per site. This far exceeds the LTE-standard efficiency. If the network is spectrum constrained, a 450 system is only about double the capacity using the same amount of spectrum. However, if additional spectrum can be used (2x40 MHz in this case), the overall site capacity is a staggering 2.4 Gbps.



Added Infrastructure Costs (EPC)

The PMP 450 platform was designed to be a flat, Layer 2 architecture that is simple to deploy and manage. It consists of only two components required to complete a link from a subscriber to the network core. That is, the access point (AP) can be connected directly to the network core, and the subscriber module (SM) connects to the customer. There are no other ancillary components required. However, in the LTE standard, due to the requirements for mobility, an added infrastructure component is the EPC. This piece of the architecture helps manage the movement of a subscriber from one node to the next and is not really required for fixed wireless implementations. However, because it is part of the standard, something needs to be done with it, even in fixed equipment.

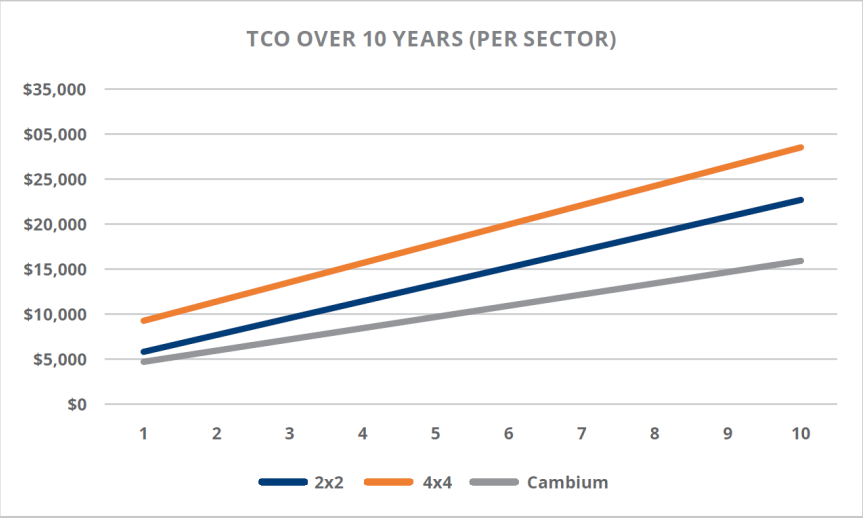
In an effort to reduce the complexity and cost of a fixed network, equipment vendors attempt to reduce the need for a true EPC. There are two main methods that have been noted. The first method is containing the EPC at the site, or "virtualizing" the EPC. This means the EPC function will be contained within each sector unit. This is effective but may result in limitations of the total number of subscribers supported and has the potential for added costs to the operator, depending on how it operates. Second, the system may be supported by a cloud EPC. This eliminates the need for actual infrastructure equipment, but the network now depends on communication with a cloud service. If this service or communication to this service is interrupted for any reason, the network could cease functioning until that is restored. Further, if the company that provides this cloud service should stop operating, it is not known what might occur with the cloud EPC.

Ongoing Operation Costs

Although LTE equipment providers have attempted to reduce operating costs of fixed LTE networks, there are still several considerations when choosing between LTE and the 450 platform. With 450, there are zero required ongoing operational expenses. Once the capital equipment is purchased, the operator can utilize all features and expand the network as necessary with additional capital expenditure.

By removing the costs associated with much of the back-end infrastructure required in a mobile LTE network, fixed LTE equipment providers have reduced the capital cost of that equipment. However, many retain the recurring maintenance and operational costs associated with these EPCs. For example, one vendor charges a monthly fee for the cloud EPC. Another charges a scaled fee for every 500 subscribers on the network. There are usually recurring charges associated with each subscriber as well for subscriber identity module (SIM) card services, which is typical of mobile telecommunication systems.

By example, setting aside the recurring EPC and SIM costs, only counting equipment cost, installation and power consumption, a 4x4 LTE sector starts around $10,000 and has a Total Cost of Ownership (TCO) of about $30,000 over 10 years. A 2x2 LTE sector starts around $6,000 and costs $23,000 over 10 years. Cambium starts around $5,000 per sector and consumes less energy over its life, resulting in $16,000 TCO.



Conclusion

The LTE standard was developed as the “evolution” of the global mobility standard. If mobility is required for a given network deployment, much of the architecture that creates additional overhead and complexity exists to allow this aspect to function. The EPC helps to manage handoff between sectors and across the network. If, however, fixed deployments will be the primary use case for the network, the purpose-built 450 platform may be a better solution.

While LTE does many things quite well with respect to network coverage, range and near and Non-Line-of-Sight connectivity, the 450 platform from Cambium Networks can provide better overall performance, is less expensive to deploy and reduces the TCO over its operational life.

BEST ● ◓ ○ ◒ ● WORST	EXISTING LTE SOLUTIONS	CAMBIUM PMP
Customer Experience	◒	●
Range and Coverage	●	○
Interference Mitigation	○	●
Total Sector Capacity	○	●
Subscriber Bandwidth	◒	●
Infrastructure Costs	●	●
Mobility Support	●	●
Total Cost of Ownership	●	●

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Cambium Networks delivers wireless communications that work for businesses, communities and cities worldwide. Millions of our radios are deployed to connect people, places and things with a unified wireless fabric that spans multiple standards and frequencies of fixed wireless and Wi-Fi, all managed centrally via the cloud. Our multi-gigabit wireless fabric offers a compelling value proposition over traditional fiber and alternative wireless solutions. We work with our Cambium certified ConnectedPartners to deliver purpose-built networks for service provider, enterprise, industrial, and government connectivity solutions in urban, suburban, and rural environments, with wireless that just works.

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