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Evolving Your Backhaul Network from 4.9 GHz

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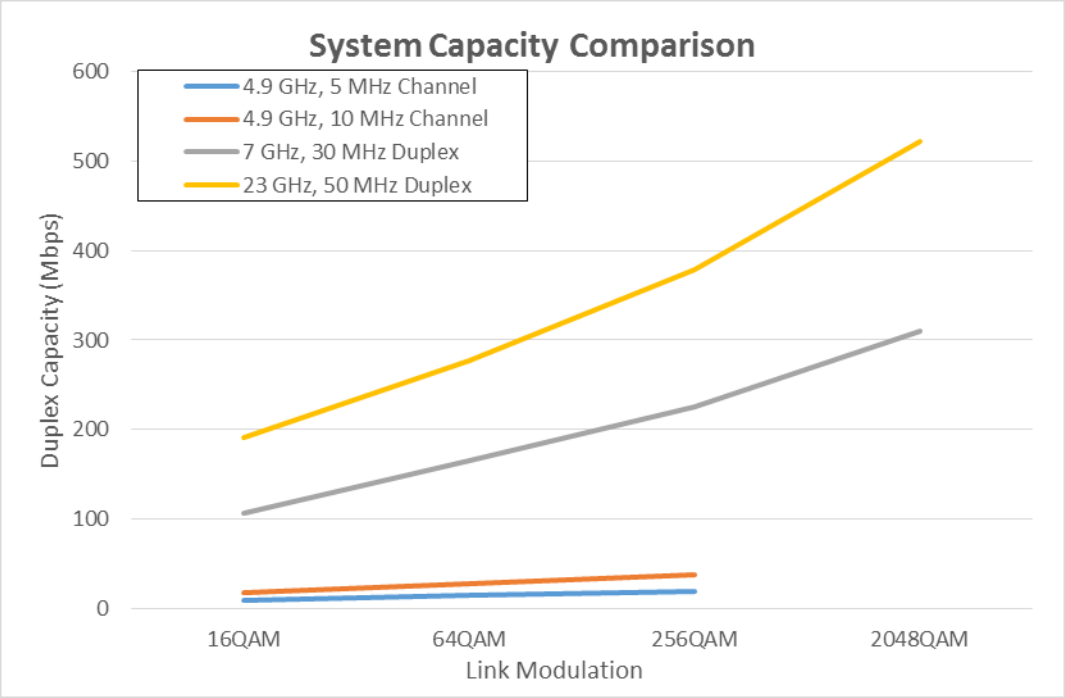
Municipalities and public safety departments have long relied on the 4.9GHz band in the United States to build local wireless networks. The US government has set aside this band for the delivery of "public safety" services. There is 50MHz of spectrum, and is lightly licensed. There are a few benefits that have driven local government agencies to utilize this spectrum, namely:

- No Cost of use – For eligible government agencies, there are no fees associated with use of this spectrum.
- Not as interference prone as 5.8/2.4 GHz – The spectrum is licensed, and use must be reported. In addition, use is limited to public safety applications, unlike 2/4/5.8 GHz, which can be used for any consumer applications.
- NLOS Capabilities – Fairly good propagation parameters allowing Line of sight and no- line of sight connectivity, due to operating in the low bands.

However, at the same time, there are some drawbacks making it more difficult to deploy backhaul systems in this very crowded and over-utilized spectrum. The primary drivers causing organizations to move to higher backhaul frequency bands are:

- Very Limited Capacity – The limitation of 50MHz in the band results in most links being restricted in channel size, due to wide use of the spectrum for backhaul and access systems. Although, the maximum channel size is 20 MHz, most links are limited to 5 MHz, resulting infull

duplex capacities limited to about 20Mbps. A comparison of 4.9 GHz capacity limitation versus 6-23 GHz systems is shown in the figure below.



- Highly Congested – Due to the limited spectrum, and the use of the spectrum for access, it becomes more difficult to find unutilized spectrum in many areas, especially if the access demand has grown. As a result, the agency may not be able to acquire any spectrum for the desired link.
- Increasingly Unpredictable Reliability – With over-utilized spectrum and a reduced amount of spectrum per channel, as well as self-interference with access systems, the availability of the backhaul 4.9GHz link is more and more difficult to predict. In addition, the delivered capacity can often not be pre-engineered, making service levels impossible to define.
- High Latency – Due to the TDD nature, and very thin spectrum in the 4.9 GHz band, the backhaul delays are quite high, often in the range of 2-5ms. Historically, for Ethernet services, this delay was suitable, but for LTE services, this delay is often too high for many of the desired services.

These limitations are driving many governments to evolve their backhaul networks to 6+ GHz point-to-point licensed spectrum. These bands are readily available in the United States. Licensing of a

channel is less than $1500 for a 10 year license, so the cost is minimal. In addition, with channels of up to 80 MHz duplex pairs available, operators can deploy Gigabit backhaul capacities. And, the spectrum is guaranteed and separate from any access spectrum, so a system can scale independently of what happens in the access network.

There are five major considerations for an agency to take into account when they move to licensed 6-23GHz bands:

- FCC Licensing – each link must be individually coordinated and licensed. There is no licensing fee to the FCC for government applications. That said, the process istypically handled by a 3rd party for a small fee in the neighborhood of $500, and the process usually takes about 30 days
- Link Engineering – There is more rain fade at the 6GHz+ bands than the 4.9 GHz band, but there is a wider spectrum, so sometimes lower modulations can be used. However, to determine the required antenna sizes, it is important to do a detailed link engineering exercise, which takes into account the rain rate, link capacity, path length, mounting heights and desired availability. Many value add resellers can perform this task, and some microwave vendors will also provide this service.
- Link Capacity – In the 6-23 GHz bands, there are channel sizes from 30 to 80 MHz available, with 40 MHz being a common channel size. In these licensed point-to-point bands, channels pairs are always assigned, allowing for full duplex FDD transmissions. With 2048QAM, and a 40MHz channel, 400 Mbps of full duplex throughput can be achieved, enabling significant scale versus a 4.9 GHz system.
- Line of Sight Path survey – In the 6-23 GHz bands, it is important the there is a clear line of sight path between the two radios. This can sometimes be determined by an electronic path analysis, but will also often require a two claim and path verification from someone at both ends in the case of longer paths.
- System Cost – Historically, the 6-23 GHz systems had been more expensive than 4.9 GHz systems. However, next generation systems have come down significantly in cost, and are offered at only a small premium to 4.9 GHz systems. It is important, however, to look at total cost of ownership when engineering a licensed microwave system. An all outdoor system should be considered, as it can minimize indoor costs, including power and HVAC. This will

also permit cabling and powering via low cost CAT5E cables. It is also important to understand any costs related to size of antenna on a tower. By selecting a system with an improved link budget, the agency can reduce their antenna sizes, and resulting tower rental costs.

Public Safety backhaul network have been built on 4.9Ghz for a long time, and they have historically fit the bill. However, over utilization of the 4.9 GHz band and increased network capacity requirements have pushed backhaul needs past the capabilities of the 4.9 GHz. Fortunately, the 6-23 GHz bands provide a cost-effective and scalable evolution path for existing and new networks. Operators can quickly upgrade their networks, as long as they pay appropriate attention to the few unique requirements of the higher bands.

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