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DragonWave Whitepaper: Unlocking the Value of E-Band with Extended Reach

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Article

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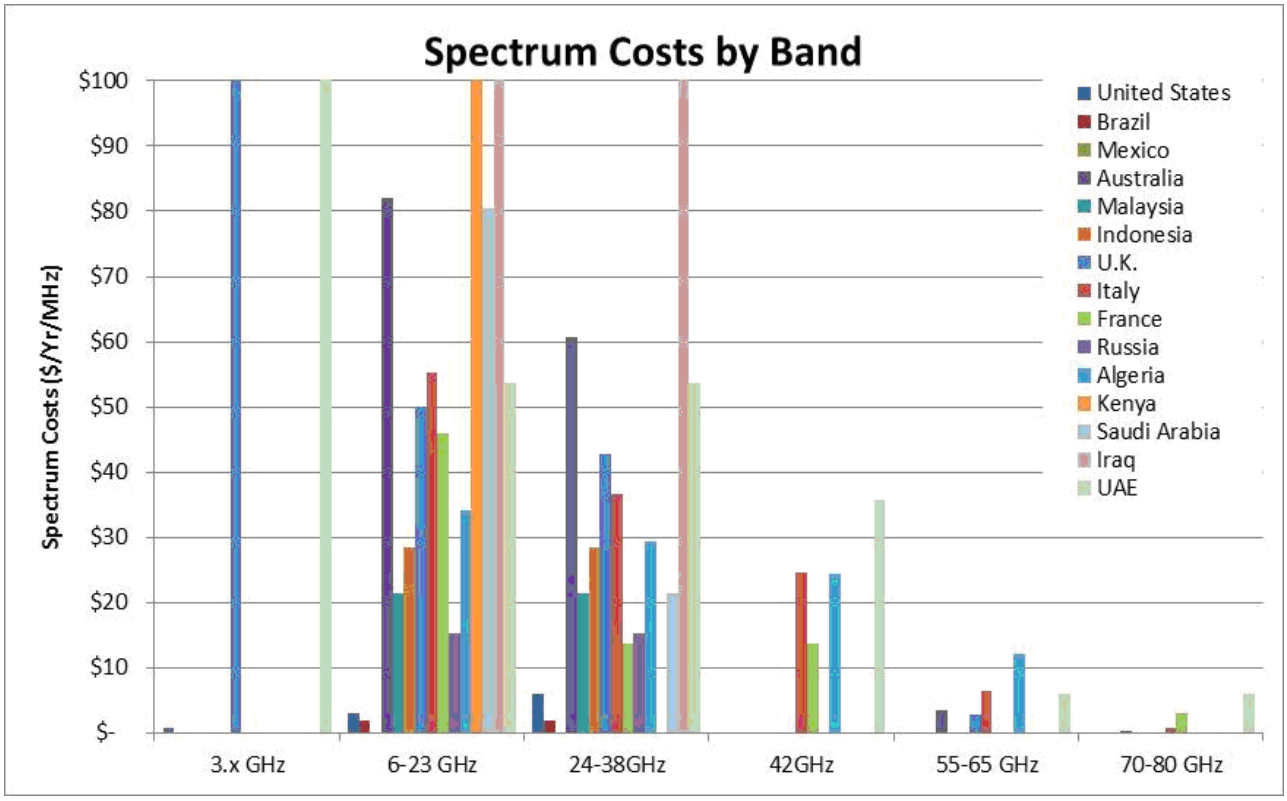
When first- and second-generation E-Band systems introduced Gigabit wireless systems to the market, they took advantage of the wide amount of spectrum available which is very low-cost, to be able to offer high capacity wireless links. However, these systems did not focus on reach and were inhibited by the high amount of rain fade present in the 70/80 GHz frequency bands. As a result, current E-Band systems have been limited to about 1-3 Km reach, resulting in a limited application space that has been primarily last mile fiber extension in enterprise and campus environments.

With the next generation of E-Band systems, and a number of features targeted at extending reach, manufacturers are now effectively doubling previous link lengths and achieving up to 7 Km of reach. This increased reach is critical to expanding the application space of E-Band products. Now, with extended reach capabilities, 70/80 GHz can be used for the traditional cellular backhaul market. These E-band ranges are comparable to 38 GHz links ranges and can be used for many 23/26/28 GHz links as well.

Using the 70/80 GHz band as a spectrum alternative to traditional 23-42 GHz links has tremendous advantages. In the 23-42 GHz band, many countries issue a maximum channel size of 28 MHz channels, limiting link capacities to 200-250 Mbps. A few countries will issue channel sizes up to 56 MHz, still limiting capacities to about 500 Mbps. However, 250 and 500 MHz channels are generally

available in the 70/80 GHz band. Using these channels, today's products can deliver 1-3 Gbps of capacity and provide operators with tremendous scalability to meet growing LTE requirements. In addition, E-Band systems offer significant total cost of ownership benefits by leveraging spectrum that costs about 1/10th as much as 23-42 GHz spectrum, as shown in Figure 1 below.



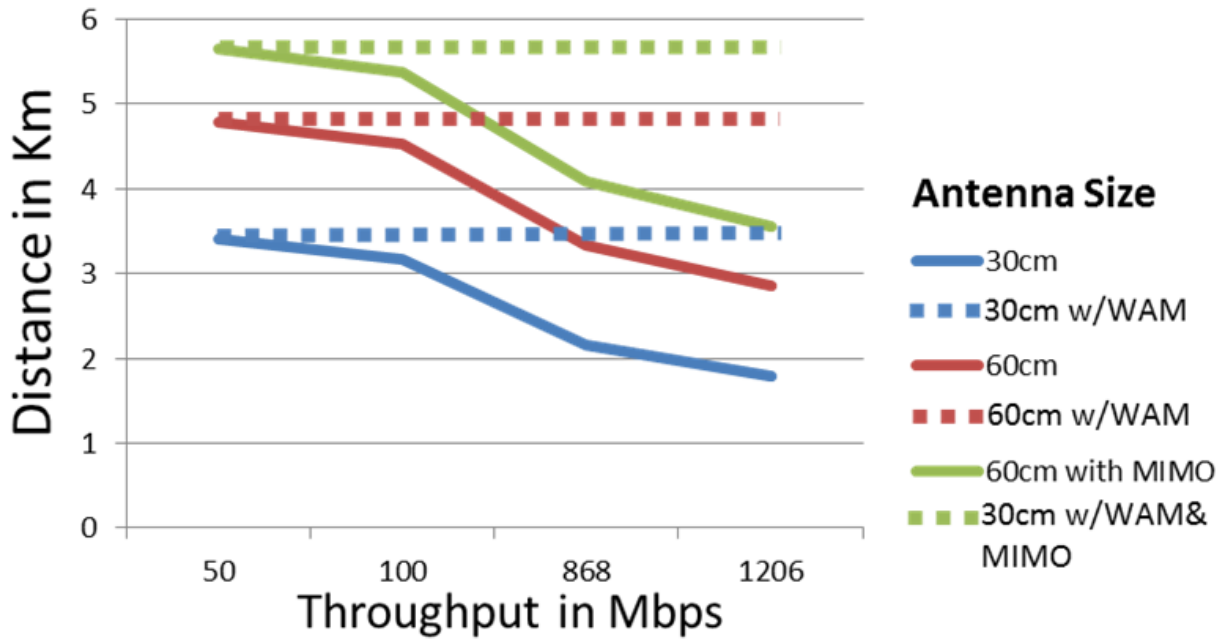
The benefits of E-Band versus 23-42 GHz are significant and offer 10 times the capacity with 1/10th of the recurring spectrum costs. Nevertheless, in order to take advantage of these benefits, reach needs to be >4 Km, which is comparable to the 23-42 GHz bands. First- and second-generation E-Band systems could not transmit this far and were typically limited to about 2-3 Km. of reach. Today, a number of new technologies are emerging to increase that reach twofold.

The first of these technologies is adaptive modulation, which monitors signal strength and shifts from the current modulation to a lower modulation during a fade event. Utilizing this technique, the system will shift from 64QAM all the way down to BPSK, resulting in a 15-20 dB link gain improvement.

The next area of reach improvement is adaptive waveform. Once the system has tried to compensate for path fade using adaptive modulation, it can then shift to smaller channel sizes, from a typical 250 or 500 MHz channel down to a 25 or 50 MHz channel. This adaptive waveform switching improves the receiver sensitivity, further increasing link budget by about 10 dB.

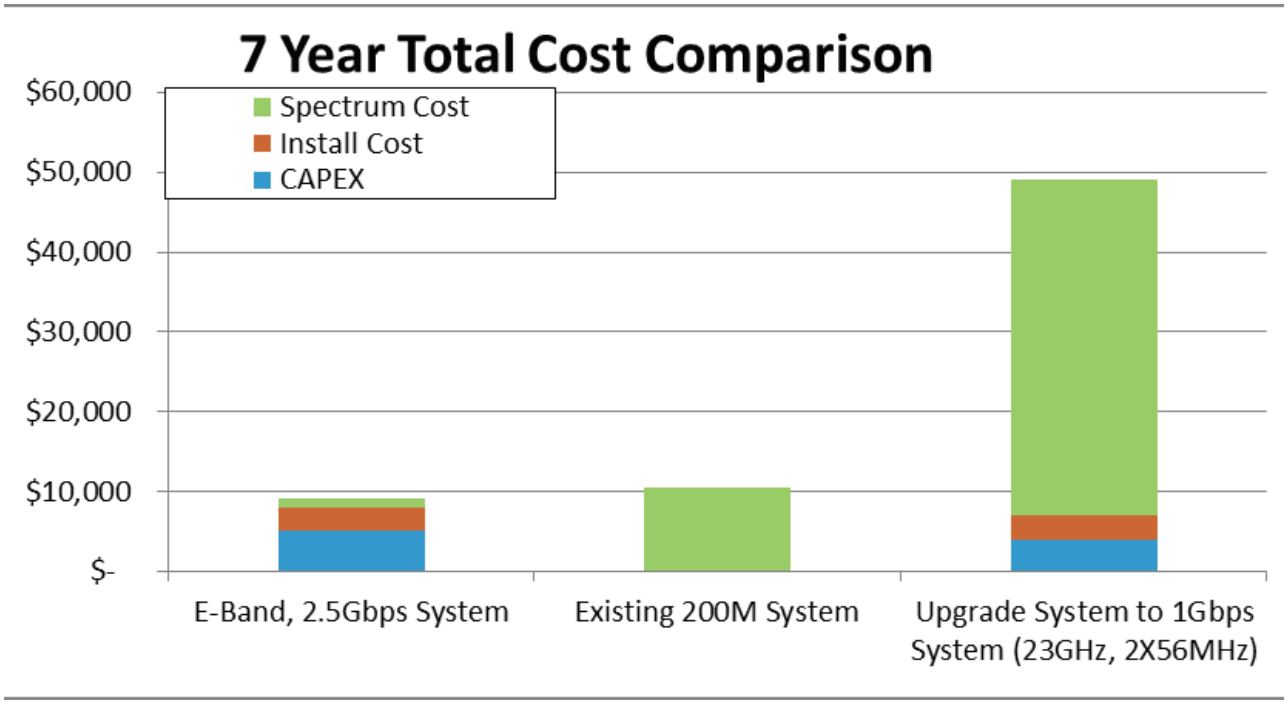
The last technique that can be used to extend the reach of an E-Band system is MIMO (multiple input, multiple output). In E-Band, MIMO can be used to transmit the same signal over two spatially separated antennas. This is different than traditional forms of MIMO which use spatial separation to achieve a doubling of capacity. In this case, spatial separation is used to get improved link budget by having 2X antenna and Receive side gain, thereby improving the total system gain by up to 9 dB. Due to the high frequency range of E-Band, the separation of the antennas required for MIMO can be very narrow, allowing them to be packaged into a single unit.

The combination of these three features can extend E-Band range to >6 Km. The graph below shows the impact of these features for a link designed at 99.99% availability in Europe. Even at this high availability, link lengths close to 6Km are achievable.



Extending the range of E-Band is a very important step in extending the applicability of E-Band. Taking this extended range and mapping it across an existing mobile network in Europe allows one to determine how applicable E-Band could be as an alternative to 23-42 GHz microwave systems. In this case, the existing links were consuming 28 MHz channels and delivering 20 Mbps of capacity. It was found that 99% of the 38-42 GHz links could be replaced with E-Band, a further 70% of the 26-32 GHz links could be replaced, and 55% of the 23 GHz links could be replaced, which amounts to 75% of the full field population of 23-42 GHz links being viable for E-band deployment.

Further analysis compares three deployment scenarios from a cost perspective. The first scenario replaces the link with an E-Band link, increasing the capacity to 2.5 Gbps, but incurring CAPEX and install cost. The second scenario leaves the current 23-42 GHz links in the field, but not being able to scale beyond 200 Mbps and continuing to incur the high spectrum lease costs. The third scenario expands the existing microwave system to 56 MHz and adds a second XPIC channel in the 23-42 GHz range. This scenario incurs CAPEX and install costs, but scales to 1 Gbps, although it will result in costly recurring spectrum charges. In addition, the third scenario may not always be deployable, as it is often not possible to acquire 2X 56 MHz channels. All three scenarios are compared for 7 years, and shown in the graph below.



As shown in the graph above, the E-Band scenario offers slight cost savings over leaving the existing system in the field and provides greater than 10X scale. It also is by far the lowest cost option for providing any scalability beyond 200 Mbps.

It's clear that E-Band systems have evolved tremendously over the past five years. In doing so, the reach and corresponding addressable market has expanded significantly. With new reach capabilities of >5 Km, E-Band systems are now a viable alternative for enhancing mobile backhaul networks. For operators, the new E-band solution is something that should be highly considered, as it provides a viable means to deliver >1 Gbps, while also achieving major spectrum cost savings.

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