Advantages of Copper Over 60/80 GHz Millimeter Wave Radio For Small Cell Backhaul

Small cell mobile backhaul is a market that although still in its infancy is projected to double annually in coming years as mobile operators continue to battle each other out in the mobile data "arms race." The operator that improves coverage, capacity, and quality of experience most successfully can expect to reap rewards in terms of customer retention and luring additional customers away from competitors.

Small cells will be a critical building block of that success, because they are needed both to facilitate reuse of the limited supply of spectrum, and also are needed to better cost optimize the build out of radio access networks so that services can be offered profitably despite operators needing to be price competitive in a market that has seen rapid declines in price per bit. The cost of small cells, including small cell backhaul, must be much lower than what it was for macrocells. Fiber cannot be the complete answer, because running new fiber is simply too costly to provide a satisfactory business case. And microwave, though a viable option for some small cells, has operational complexity associated with it that makes it far from being a universal answer. Non Line of Site (NLOS) wireless technologies present an interesting alternative in theory, but in practice involve complex point in time engineering in a dynamic metro environment – and relying on reflections, multipath, and a static city scape to ensure consistent performance cannot be expected to result in carrier class transport.

Small cells have the greatest impact in areas with low spectral efficiency – locations where signal levels are low and where interference levels might be high. This kind of situation is characteristically found at the borders between macro cells. Small cell placement must be optimized for location, not based upon where backhaul is easy to reach with fiber or microwave.

One technology that has gained a considerable degree of attention lately for small cell backhaul is 'all outdoor' millimeter wave (mmW) radios which operate in the 60-90 GHz spectrum. Due to their compact designs featuring integrated planar antennas, suppliers tout their ability to deploy these radios nearly anywhere. That sounds great, but in practice deployment of these radios is much more challenging than the vendors selling them would have you believe.

Millimeter wave radio will play some part within the diverse access toolkit required to optimize small cell backhaul networks, but their role will not be as big as some might have you believe. There are six key challenges that millimeter wave solutions present which will prevent them from having a dominant role in backhaul builds…challenges which can be overcome with the use of Actelis Ethernet over Copper.

Potential for Unlicensed Frequency Contention

Unlike their bigger brothers (traditional 6-42 GHz microwave radios), mmW radios in most countries operate in either unlicensed or lightly licensed frequency bands. This sounds great from a cost and time to market perspective, but unfortunately it also makes them prone to potential intrusion or interference from other devices operating in these open frequencies. Consider for example the latest public WiFi technology, WiGig (802.11ad), which also utilizes 60 GHz for WLAN and WPAN (Personal Area Networking) to deliver multi-Gbps short range communication. Millimeter wave radio proponents will argue that WiGig is designed for indoor low power and short range (<10 m) applications, while mmW radios for higher power, outdoor deployments, and will utilize narrow signal beams for a longer range (100+ m), so they won't interfere if properly installed and aligned.

But given that operators want to use the sides of buildings to place some of these radios, WiGig technologies do potentially create an interference problem.

Alignment Sensitivity Challenges

Millimeter wave point to point radios are designed to use very narrow beamwidths, 'pencil beams' with a beamwidth as narrow as 0.6 degrees. Such narrow beamwidth requires very accurate and stable alignment between radios; without that alignment being established and maintained, the link and services riding over it are susceptible to signal fade or loss. . Transmitters and receivers must be aligned using a special alignment tool to avoid inadvertent transmission, and of course a suitable location offering line of site must be found. In addition, when these radios are being installed on light posts and other structures that flex in the wind, a gust of that wind often results in a sway of 1-2 degrees and of twisting with your typical aluminum light poles.

Either scenario can potentially throw a link out of alignment, and this is clearly not ideal for a carrier class backhaul solution.

Impact of Weather and Climate

Each microwave band has its challenges. Oxygen absorption of radio signals peaks at around 60 GHz, resulting in attenuation all along the path of the link, creating significant signal fade.

Fog, mist, and fine rain impact the 80-90 GHz bands the most, making deployments in moist and humid environments rather tricky to say the least. This is particularly unattractive since 17 of the world's 20 largest urban centers are located in coastal areas.

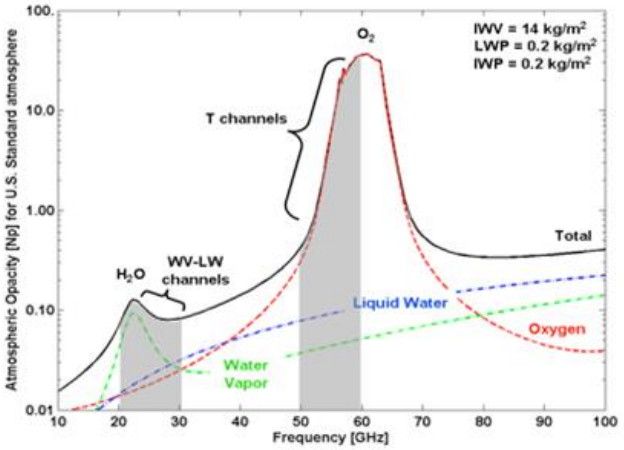

Figure 1: Source: http://wiki.eg-climet.org/

Supplying and Accessing High Power

Small cell backhaul radios have relatively high power consumption - over 50W per radio in some cases. Repeater or hub sites requiring 2 or more co-located radios are common. But supplying that amount of power can very often hard to achieve, particularly if operators hope to integrate the small cell, transport equipment, and power in a single enclosure someday – as many do.

Higher Deployment and Total Cost of Ownership

There is higher complexity and often higher installation cost associated with mmW compared to copper. As previously mentioned, mmW radios project a pencil beam that needs to be aligned between two radio devices over several 100M to a couple KM away. Think of the challenge for example of having two engineers hanging from a couple lampposts (small cell sites), on a public street in a major downtown city, trying to align a laser like beam and mount the devices at the same time. Then it's on to the next small cell link a few hours (day?) later, racking up that premium installation cost. Alignment tools help in this regard, but they only add to the cost of the system (see next challenge). And when natural and human factors change the backhaul physical environment (for example, in cases of tree growth, a tall truck or crane construction) then service outages and a need to maintain and realign these systems can occur….further contributing to higher Total Cost of Ownership.

Reducing Product Cost

Overall system cost needs to come down by 50% or more for commercial small cell backhaul deployments based on 60/80 GHz to really be viable for mass deployment. Today, 60/80GHz solutions range in cost from about $3,000 - $8,000 per link, which results in much too high a cost per bit.

The small cell business case will not work if an economic small cell backhaul solution is not applied. Consider for example that a small cell radio BTS costing $3,000 - $6,000, costs an order of magnitude lower than the cost of a macrocell radio ($30,000 - $60,000). Deploying a $4,000 macrocell backhaul device costing nearly as much as the small cell radio itself into a small cell backhaul application can kill the business case. This puts a tremendous burden on mmW radio vendors to reduce the cost to effectively address this market, as the 'future' for small cells is here and now.

The Relative Benefits of EFM over Copper

The challenges discussed prevent millimeter wave radios from becoming a dominant small cell technology, but they can be overcome with cost and effort, and this category of equipment will definitely fit network requirements in some scenarios going forward. Just as in fixed access networks which have long used a diverse access

toolkit to cope with the requirement to take bandwidth to many widely varying locations, now that mobile networks require precise placement of small cells they will need to rely on a diverse access toolkit also. Copper, specifically EFM over Copper, must be a significant part of that diverse access toolkit. Anywhere from 18 – 30+% of small cell locations will have to be backhauled over copper. That is because copper offers the most ubiquitous deployment, eliminates a lot of the complexity associated with wireless technologies, is far less expensive than fiber, and can take more than enough bandwidth for current and future small cell needs to most locations. Plus it has been made extremely robust and reliable by Actelis Networks' market leading expertise, as Actelis offers the best real-world performance per pair, and only Actelis offers a solution featuring both G.SHDSL and VDSL2 bonded copper with innovative Broadband Amplifiers that maximize the distance and bandwidth even further.

Only by deploying Ethernet over Copper from Actelis for backhaul wherever possible can an operator of a mobile network fully cost optimize their outdoor small cell deployment. That's because copper provides the quickest, easiest, and most cost effective way to get all the bandwidth needed where it's needed, and because Actelis provides the most reliable, high performance EFM over Copper solution on the market – reaching more locations with more bandwidth using fewer pairs.

A typical 3G/4G small cell today requires somewhere between 20-50 Mbps of Ethernet capacity – with future scalable needs of 2-3x that. This is all easily addressable by Actelis' advanced Ethernet First Mile (EFM) solutions which provide 100s of Mbps of reliable, low latency bandwidth using asymmetric (VDSL2/ADSL2+) or symmetric (G.SHDSL) bonding technology to optimize the solution based on distance, bandwidth requirement, and pair availability.

In addition to turning copper into a strategic asset that cost optimizes the backhaul network, Actelis also provides a solution for remote powering of both the Actelis EAD backhaul device and a small cell BTS – simplifying installation and streamlining operations.

For more information, contact us at info@actelis.com