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The Mobile Network

How antenna size and design can minimise high capacity backhaul costs

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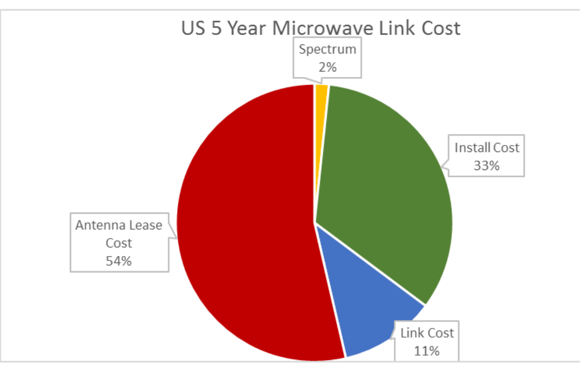
Minimising high capacity wireless backhaul costs through antenna size

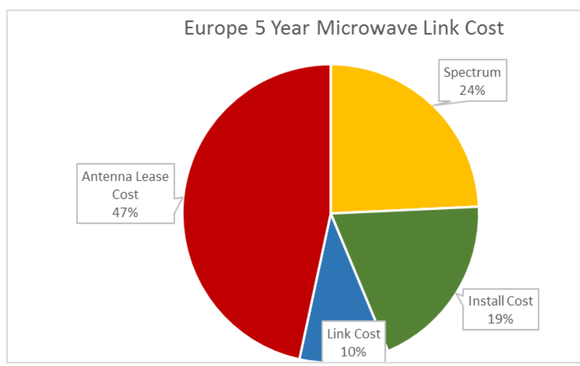
To meet the network demands of ever-increasing LTE capacities, mobile operators are exploring ways to quickly, and cost effectively, modernise their backhaul networks. One means of achieving this is by upgrading microwave backhaul networks to high capacity Ethernet systems, but this cannot be done without an attractive business case supporting it.

A rapid push for higher user capacities is driving higher modulations for microwave backhaul systems and lower resulting link budgets, which often means there is a requirement for larger antenna sizes. Microwave antennas are installed on third party towers or rooftops. The space for this antenna mount is rented on a monthly basis, and the rate scales 1:1 with the size of the antenna. As a result, tower lease costs are starting to be one of the major factors in operators' total cost of ownership, making it one of the key areas for optimisation so that operators can reduce their cost of service delivery.

Antenna sizes also factor into the cost of ownership in another significant way, because they can often limit or delay deployments. The larger the antennas size, the more wind load and space it induces on the tower. For larger antennas, this often means many towers are not suitable or they may require engineering modifications or extensive engineering studies and zoning activities. Lastly, larger antennas are more expensive, as well as being more difficult and pricey to install, with some of the largest antennas requiring the use of a crane or helicopter to deploy.

To understand the impact of antenna sizes and tower lease costs, a good exercise is to explore the total cost of ownership for a North American and European network, where spectrum costs vary widely. In most cases, a link is installed on a third party's tower or rooftop, and the mobile operator pays a monthly antenna lease fee. This fee can vary by region, but a rule of thumb is $100/month per foot of antenna. This means five years of antenna leasing for a 2' antenna link (2 ends) equates to $24,000, or over 4X the cost of the equipment itself. By reducing the antenna size by one foot, an operator can save $12,000, over 2 times the CAPEX of the link . The five year total cost of ownership of a 250-500M link in a 28/50MHzMHz channel is shown below. This model does not include any zoning or tower build costs that would be incurred should the antenna be too large for the existing mounting structure. There are models of both the United States and European backhaul network to reflect the difference in installation and spectrum costs.

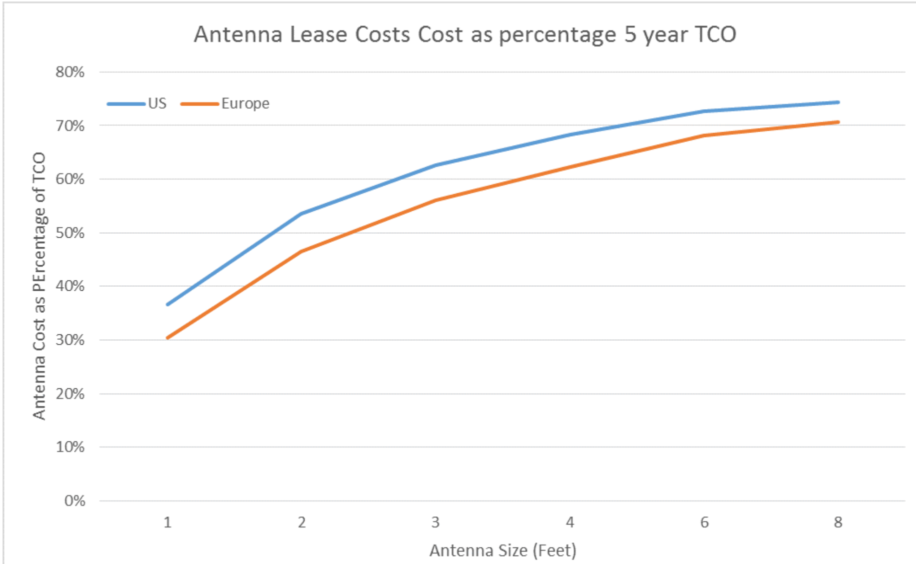




Antenna lease cost as percentage of five year TCO.

In both cases, the antenna lease costs represent 47-54% of the five-year total cost of ownership, and this for a relatively small, 2' antenna.

In the chart below, we analyse how much the antenna lease cost increases as a percentage of total cost of ownership. This is varied with antenna size and can represent up to 75% of the total cost of ownership over five years.



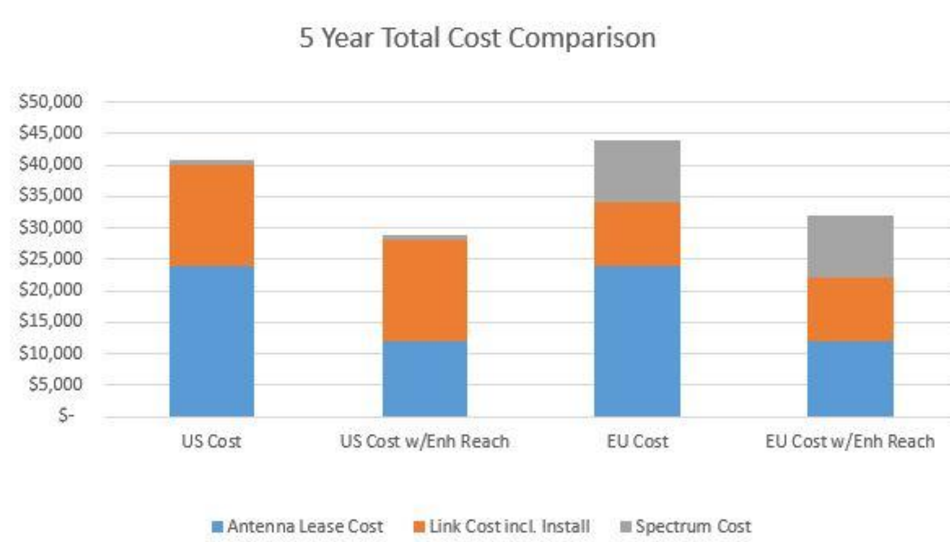
How antenna lease costs increase as proportion of TCO with size of antenna.

It is clear that lease costs for antenna space can quickly dominate operators' network costs, and hinders profitability if not carefully managed. The good news is there are a number of technologies being introduced to help improve link budget, which may allow for a reduction in required antenna size. The first of these technologies, used quite broadly in packet microwave systems, is **adaptive modulation**. Adaptive modulation operates at the highest possible link capacity, but when there is a link fade event the link will drop to a lower modulation and capacity rather than going off-line. This allows operators to engineer the antenna sizes for a link based on a lower modulation, but still operate the majority of the time at the higher modulation.

The second technology being integrated in some microwave systems is **compression**. Compression takes the incoming data and reduces it to a lower over the air data rate, replacing repeated bit patterns with shorter symbols. With compression, microwave systems can get anywhere from 40% to 200% more data into a given link capacity. This allows an operator to engineer a microwave link to lower capacity than required, using compression to meet the required data throughput. By engineering to a lower link capacity, a lower modulation can be used that provides more system gain and enables smaller antenna sizes, but that still meets the required link availability.

The third, and newly emerging microwave technology being used to optimise antenna size, is **GaN amplification**. GaN is starting to emerge across a wide range of microwave bands. With the introduction of GaN, an additional 5-8 dB of transmit power can be achieved on a microwave link. This increased system gain will typically introduce a small premium on the microwave equipment. However, this also usually results in a reduction in antenna size, providing leasing cost reductions that far exceed any CAPEX premium introduced on the equipment. The graph below shows the reach benefit of the higher transmit power of the GaN based products, which through new RF amplifier technologies can provide up to 8 dB additional output power. This model is based on 38 mm/hr rain rate, and 15GHz, 28 MHz channel sizes. The reach improvement is 20-40%, which equates to 1-2 antenna sizes, resulting in a significant annual lease cost savings and total cost of ownership improvement.

It's clear that, in cases where the mobile operator does not own its own towers, one of the largest areas for microwave link cost reduction is controlling tower lease costs. The only way to minimise these costs is through reduction of the link antenna sizes. However, operators will not consider sacrificing link availability in order to optimise these costs, as it will affect their SLAs and resulting customer revenue. In the business case below, backhaul links in the United States and in Europe are analysed, with the assumption that the enhanced output power can reduce antenna size from 2 feet (60cm) to 1 foot (30cm). As a result, in both cases, the increased output power reduces total cost by 29%. This would be a further savings in a longer comparison, or if tower lease cost is more than $100/month per foot of antenna size.



Microwave system link budget and resulting antenna costs are the largest single line item when factoring the total cost of ownership. Improving link budget drastically improves the business case for microwave backhauls costs. This is why the three link budget improvement technologies discussed – adaptive modulation, compression and increased transmit power – are critical to reduce operators' backhaul costs. However, in order to realise these savings, it is important that operators look at the complete network operating expense, not focusing solely on equipment costs.

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