ericsson.com/
microwave-outlook

Ericsson Microwave Outlook

October 2020

Lessons learned from long-haul use around the globe

Over the last decade, traffic has moved from TDM to packet. Significant capacity gains could be made with a more modern network plan.

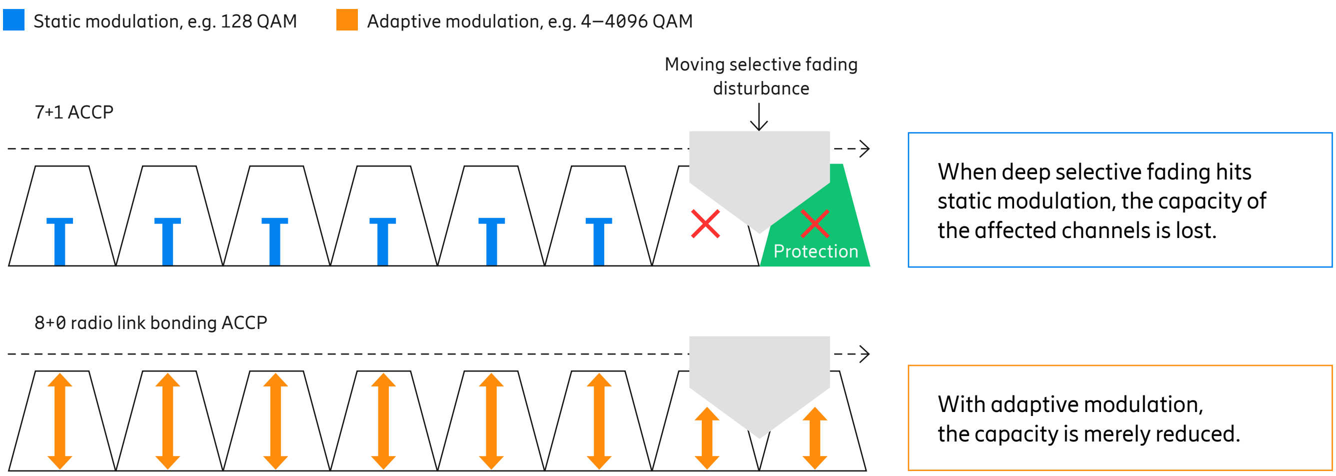
Traditional planning beliefs can be questioned with packet traffic and improved antennas. The new shorthaul techniques can now be implemented for long haul, such as Multi-band booster.

Are the old truths in radio planning ready to be revised?
The requirements concerning radio performance per TDM channel have guided our radio link planning for over 50 years.

Today, most radio traffic is packet-based while the remaining TDM traffic is migrating towards packet-based transport. Therefore, some old "truths" may need to be revisited since modern traffic has different radio channel performance requirements.

Can adaptive modulation and N+0 increase service availability and capacity?
Traditional radio link planning focuses on one channel at a time based on a single TDM service being transported over the channel, such as an STM-1/OC-3 with 155Mbps. If the radio channel fails, the service fails. Long-haul systems were used to carry multiple services in parallel; see the upper part of Figure 7. While the individual radio channel is performing, each service (STM-1/OC-3) is functional.

Figure 7: Impact of deep selective fading moving across channels



Source: Ericsson (2020)

Figure 8: The capacity of 8+0 adaptive modulation compared to 7+1 SDH

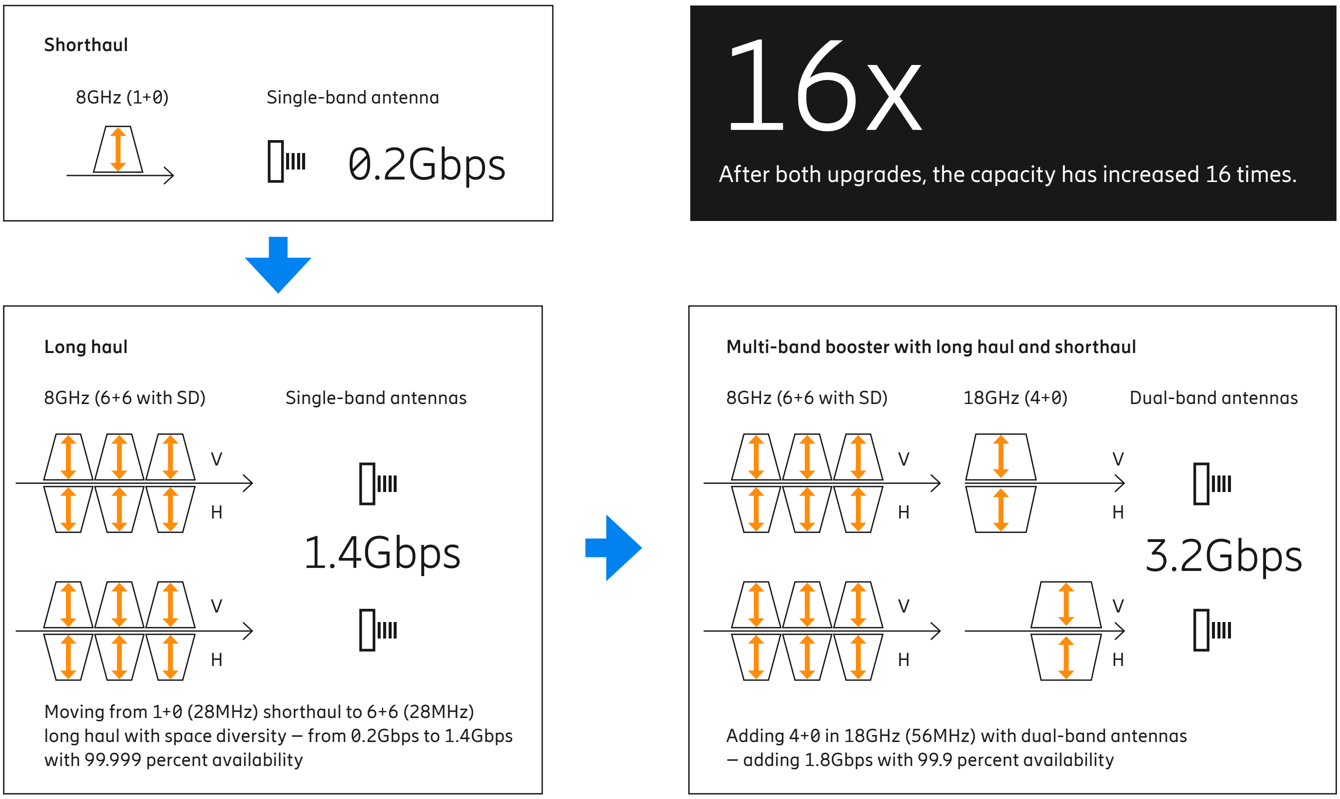
Availability	Modulation	Capacity
99.9%	4096 QAM Light	203%
99.99%	1024 QAM	172%
99.999%	128 QAM	119%
99.9999%	64 QAM	100%
99.99999%	4 QAM Strong	27%
99.999%	128 QAM (SDH 7+1)	100%

Source: Ericsson (2020)

2x

Double capacity is possible when using 8+0 and adaptive modulation compared to a 7+1 SDH link.

Figure 9: Long-haul and dual-band antennas increase capacity



Example from a real hop, 13km

Source: Ericsson (2020)

However, a modern packet link using multiple channels works differently. In a packet network, you want one big stream of packets, even when using multiple radio channels to transport this information. In the lower part of Figure 7, we see how all the packets distributed over the combined capacity of the radio channels impacts total capacity. The more each can contribute, the better, and when one underperforms, the others carry the load. This way, the performance of the aggregated sum of channels is mirrored in the service.

More specifically, as Figure 8 shows, it means that for 99.9 percent of the year, capacity is up to twice as high as traditional radio links. Since we are now dealing with low-band, long-haul frequencies, where selective fading is dominant, only one or two channels are severely impacted at the same time. Therefore, a full set of four to eight radio channels will always have better availability and capacity performance than the individual radio channel during the year. Unfortunately, current radio planning only considers availability channel by channel, and not for the aggregated capacity. For selective fading dominated links, this becomes too conservative and does not reflect the true availability of the aggregated service over the long-haul link.

The old truth of antennas

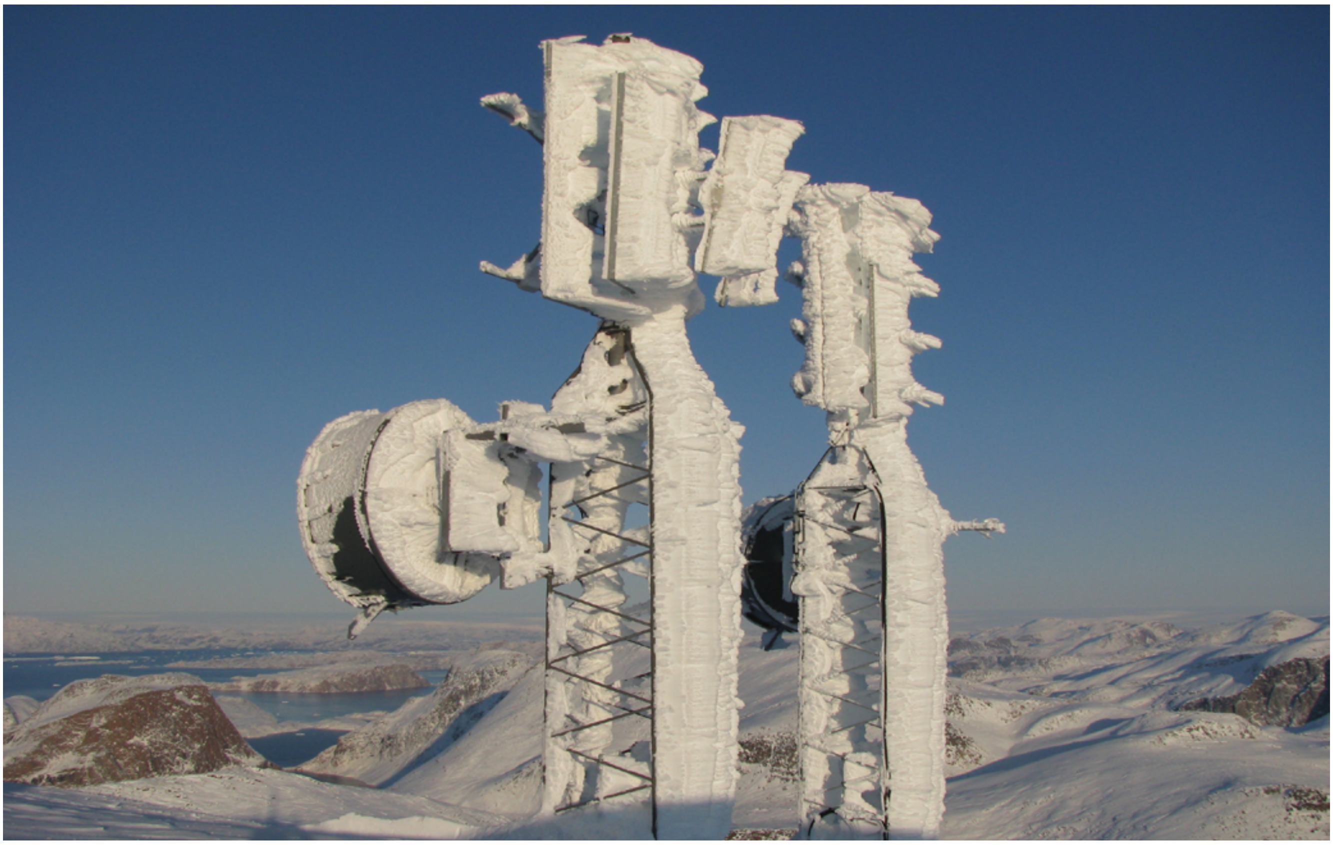
The silicon revolution over the past 50 years has moved from high-quality mechanical and analog solutions towards DSP-based algorithms with better performance. Today, most challenges are solved in the modern DSPs on modems containing equalizers and advanced XPIC solutions, enabling even better performance through antennas with worse return loss and cross-polarization discrimination (XPD) values. For the modern digital link, it is more about having a good enough antenna to reach the maximum performance of the microwave link, as the solution is no longer in the analog circuits.

When planning a long and difficult microwave link, old-school planning suggested that spending money on antennas with extremely high return loss and very high XPD value would help achieve better performance and availability for the hop. With the modern digital microwave link, this is only true up to what we call the requirement level. Beyond this, you will not achieve any improvement on the radio link. Therefore, it is better to look at a larger antenna if possible, or add a second antenna for space diversity or a Multi-band booster channel. This means that using an antenna with better return loss and XPD values than needed does not hurt, but it will not produce better performance either. Thus, the added value from these antennas has decreased.

Multi-band solutions for capacity

Combining two or more frequency bands for one link is increasingly common in our mobile networks as we search for greater transport capacity. This is becoming more common in shorthaul, even though the antennas are fairly small. One antenna instead of two antennas still reduces site rental costs. In long haul, it is more of an issue if additional antennas are required, as you often have two very large antennas for space diversity, running between 1.2m and 4.6m. Adding two more of these might mean building a much more robust tower or even a second tower, rapidly increasing civil engineering costs. Therefore, it is better to have the same antennas for two adjacent frequency bands, such as 6L+6U or 7+8GHz, to significantly reduce the antenna and tower costs while enabling a capacity increase thanks to the added spectrum.

Figure 9 describes a real customer case. They were running a single 28MHz channel, providing 0.2Gbps capacity. As they plan to evolve to 5G, they wanted a path towards 2–3Gbps. At most, they could get three frequency channels in the current 8GHz band. A first option was to migrate to long-haul technology and add a space diversity antenna for better availability at high modulations, resulting in 1.4Gbps capacity, a 7x capacity increase with five-nines availability over 6 channels.



Ice buildup can be severe and weigh several tons

To reach the 2–3Gbps target, they need even more capacity. To maintain site rental cost, a dual-band antenna can be used; however, physics must be considered. It is harder to produce a dual-frequency support antenna in a single feeder if the two frequency bands are too close, but not close enough to be considered wideband support. Here, they will interfere with each other. Dual-band support is easier if there is some distance between the frequency bands, but then the propagation characteristics will be different; see Figure 9.

The two frequency bands used in the combined dual-band antenna will have different availability figures. Using the 18GHz band enables easy access to 4 channels, 2 frequency channels in CCDP, since space diversity is not needed at 18GHz and, therefore, the radios placed on the original SD antenna can be used as normal radios in this band. This part of the total 3.2Gbps capacity will have a three-nines availability, so you cannot reach full capacity for 8–9 hours per year. This valuable additional doubling of capacity to the original service performance in the low long-haul bands will greatly improve customer quality of service.

Do icy antennas put a freeze on capacity?
In some parts of the world, it is a reality to see towers with antennas covered in heavy snow and ice. ITU-R is quite clear that: Ice formation on an antenna, or its cover or window can cause large additional attenuations. It is not considered practicable to formulate a global model for this effect since, for reliable operation under freezing conditions, antennas should be kept clear of icing.[1] Aside from the mechanical stress on the tower and antenna, a fair question to ask is how the system can function at all when it looks like this.

Research from the 1950s up to today has repeatedly shown that dry ice and snow have a rather low attenuation compared to water, whereas wet ice and snow can have extremely high attenuation, as the whole block of snow or ice becomes more akin to water.[2] This is also true for snowfall. Dry snow below the 0-degree isobar has quite low attenuation compared to rain, whereas wet snow, that is, in the 0-degree isobar, has higher attenuation than the same downpour of rain. This is because water-covered ice particles are larger than the equivalent raindrops and, therefore, attenuate the lower frequencies more than rain.

For a dry ice or snow layer on the antenna, this means that the attenuation is limited. But when the ice or snow starts to melt, it will quickly increase the attenuation and may cause the link to fail. This is also why the snow and ice that can build up inside the radiating aperture must be limited.

Therefore, these sites use technology, such as an ice shield and/or radome, to protect the equipment. The ice shield is a strong metal grid mounted over the antenna to protect against ice falling from the tower. A radome can be anything from a thin membrane wall at the antenna's front to complete coverage of the tower or site in panels with good dielectric performance for the used frequencies. In some installations, heating is fitted for controlled melting of the snow and ice before it becomes too great. The downside is increased power consumption since such heating is outdoors on a surface subject to cold air.

Radomes are also used to protect antennas from sand or dust buildup. But in some cases, they tear and birds and squirrels nest inside them, causing link failures. In conclusion, antennas should always be free from ice, snow, sand, dust and animals for trouble-free radio link performance.

[1] ITU-R, Recommendation ITU-R P.530–17 (12/2017), page 15
[2] IEEE Transactions on Antennas and Propagation, Vol. 58, No. 5, May 2010, Terje Tjelta, Member, IEEE, and David Bacon

Ericsson enables communications service providers to capture the full value of connectivity. The company's portfolio spans Networks, Digital Services, Managed Services, and Emerging Business and is designed to help our customers go digital, increase efficiency and find new revenue streams. Ericsson's investments in innovation have delivered the benefits of telephony and mobile broadband to billions of people around the world. The Ericsson stock is listed on Nasdaq Stockholm and on Nasdaq New York.

www.ericsson.com

Contact your local Sales team
Scan the QR code, or visit
https://www.ericsson.com/en/contact/sales-inquiry

Ericsson
SE- 417 56 Göteborg, Sweden
Telephone +46 10 719 0000
www.ericsson.com

EAB-20:006892 Uen