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Bandwidth Accelerator+ for affordable 4G+ backhaul

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Article

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Mobile backhaul spectrum that's used for wireless backhaul is an intangible, yet costly, asset in most markets around the world, as indicated in Figure 1.

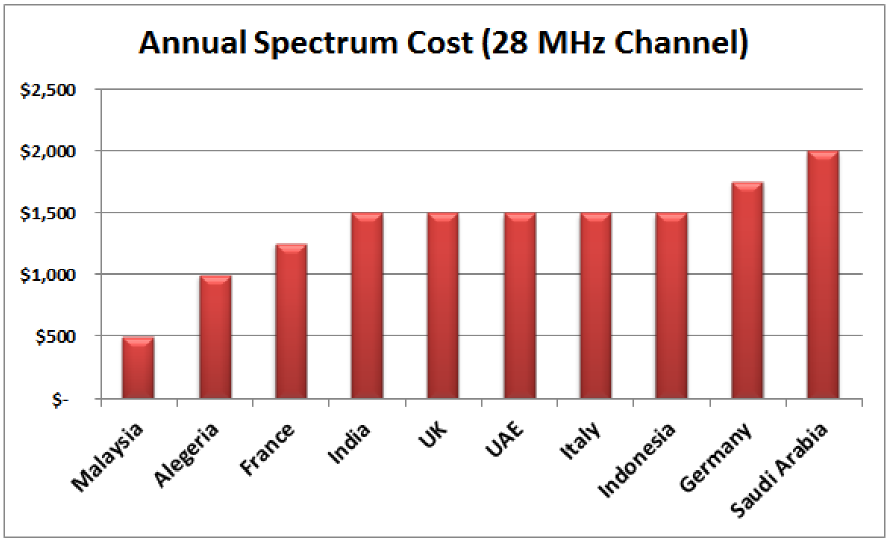

Figure 1: Indicative annual recurring cost of 28 MHz of spectrum in different markets around the world

With the advent of 3.5 and 4G technologies, the need for backhaul capacity is increasing *by an order of magnitude* (10-fold), if not more than that. 4G LTE macrocellular backhaul capacities between 150 and 500 Mbps are not uncommon today.

Unfortunately, the Average Revenue Per User (ARPU) is not following suit. In most markets, ARPU is eroding due to competitive pressures. In order to maintain profitability against a backdrop of weakening ARPU, while at the same time increasing radio access and mobile backhaul capacities by an order of magnitude, our customers are forced to cut cost.

During the past decade, a lot of the cost-reduction emphasis was put on reducing Capital Expenditure (CAPEX) outlays on equipment. That effort has proven to be successful, as can be seen in Figure 2.

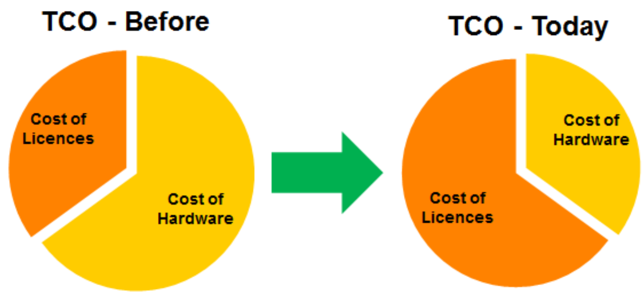

Figure 2: Typical 5-year Total Cost of Ownership (TCO) breakdown for a Microwave Radio Link in 2014 and approximately 5-10 years ago. Today, approximately 70% of the TCO is spectrum cost.

Interestingly, most buyers still focus on squeezing the 30% CAPEX-induced TCO, rather than attacking the 70% spending on licenses. This legacy approach may have worked in the past, but it won't scale in the near future because gains from price erosion alone can't continue indefinitely. This is due, in part, to fundamental constraints like the cost of raw materials and the need to sustain technological advances through funding research and development.

What *is* required here and now is a systematic reduction of operational, recurring expenses, and the prime candidate to be subjected to this approach is spending on spectrum.

This can only be achieved through improved spectral efficiency, the ability to increase capacity of a (radio based) communication channel of a given bandwidth and noise characteristics. There are manifold, complementary approaches to squeeze most bits per second out of the finite spectrum available. These include:

1. Radio frequency based approaches:
    a. Higher-order modulation schemes
    b. Cross-Polarisation Interference Cancellation (XPIC)
    c. Multiple Input Multiple Output (MIMO)
2. Baseband based data compression solutions:
    a. Header compression,
    b. Lossless wire-speed bulk compression.

All aforementioned approaches have advantages and disadvantages. The main pros and cons of each approach are listed here:

Technology	Strengths	Weaknesses
Higher-order modulation schemes	➢ Inexpensive to implement – no additional HW ➢ No impact on license fees	➢ Link budget cost of ~3 dB per modulation step ➢ Limited capacity gain of ~46 Mbps in 56 MHz channel per additional modulation step (10% when going to 2048 QAM from 1024 QAM)
Cross-Polarisation Interference Cancellation	➢ Effective – doubles capacity ➢ No impact on link budget / range / availability ➢ Simple installation with single antenna	➢ Expensive – increases link cost by 60-100% ➢ Increases license fees by 50-100% in many markets ➢ Doesn't really improve spectral efficiency in a network scenario
MIMO	➢ Effective – doubles capacity ➢ No impact on license fees ➢ No impact on link budget / range / availability	➢ Expensive – increases link cost by 90-100% ➢ Complex installation requiring 2 antennas spaced at optimal distance for full gain – impractical except for short, millimetre-wave hops in V- and E-band ➢ Doubles tower lease costs
Header Compression	➢ Inexpensive to implement – no additional HW ➢ No impact on link budget / range / availability ➢ No impact on license fees	➢ Limited capacity gain of 5-20% with realistic traffic patterns – corresponding to 1 modulation step or less
Lossless wire-speed bulk compression	➢ Effective – increases capacity by 43-200% (typically 108%) ➢ Inexpensive to implement – no additional HW ➢ No impact on link budget / range / availability ➢ No impact on license fees	➢ Gain depends on traffic pattern

Obviously, the best solution in terms of license-fee (=OPEX) reduction will be a *combination* of these various technologies. The optimal combination will be a function of the licensing model applicable to the respective market, the available channel bandwidth *and* the available budget. In any case, DragonWave's Bandwidth Accelerator+ (BAC+), a unique confluence of Header Compression and lossless wire-speed bulk compression, warrants closer scrutiny as its benefits clearly outweigh its weaknesses. *It's one of the most potent tools in today's spectrum efficiency toolbox.*

In general, microwave link capacity, range and availability are closely correlated, as illustrated in Figure 3.

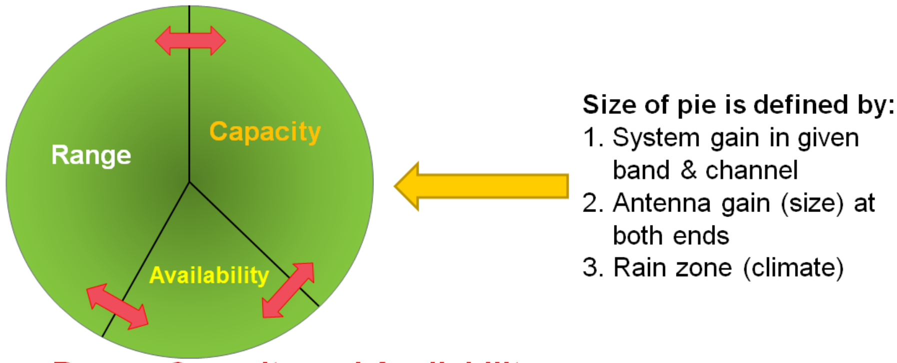

Figure 3: Microwave link range, capacity and availability are a zero-sum game where each attribute takes a slice of a cake. The overall **size** of the cake is defined & limited by the available system gain, antenna sizes (gains) and climate (rain zone).

With BAC+, we break the rules as we *can* increase net link capacity *without* affecting either link range or link availability (=quality) and *without* adding any hardware on the site. Unlike CAPEX-hungry approaches like MIMO or XPIC, BAC+ is the engineers' and procurement managers' best friend. We can apply BAC+ in three different ways:

1. 108% on-average capacity booster by suppressing redundancies and white spaces in the data stream crossing the link and force-feeding more bits/s through the same physical channel.
2. 15-17 dB range extender (or antenna gain / size reduction) by backing off modulation by 4 steps while maintaining the same throughput.
3. 50% license fee OPEX cutter with an additional 3-7 dB range extender bonus by cutting the required channel in half while maintaining the same throughput.

The third use case above is in fact the most potent one for reducing TCO by cutting OPEX in half, whilst keeping capital expenditure and maintenance budgets at bay by eliminating the need to add hardware.

BAC+ offers instant, extra-strength and inexpensive congestion relief, as attested by independent performance measurements conducted by a Tier-1 player in January 2014:

Traffic Type	Throughput w/o BAC	Throughput w BAC	
Web traffic (Top 100 sites, HTTP and HTTPS)	242.5 Mbps	622.6 Mbps	
XLS and Email traffic mix	242.5 Mbps	606 Mbps	
MP4 Video Traffic	242.5 Mbps	355 Mpbs	+46%
Mixed traffic (Web, video and ftp)	242.5 Mbps	505 Mbps	+108%

Figure 4: Microwave link capacities with a 1+0 DragonWave link in a single 28 MHz channel operating at 2048 QAM without and with BAC (no header compression) as a function of different payload profiles.

Are you ready to join us and rewrite the rules with BAC+?

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