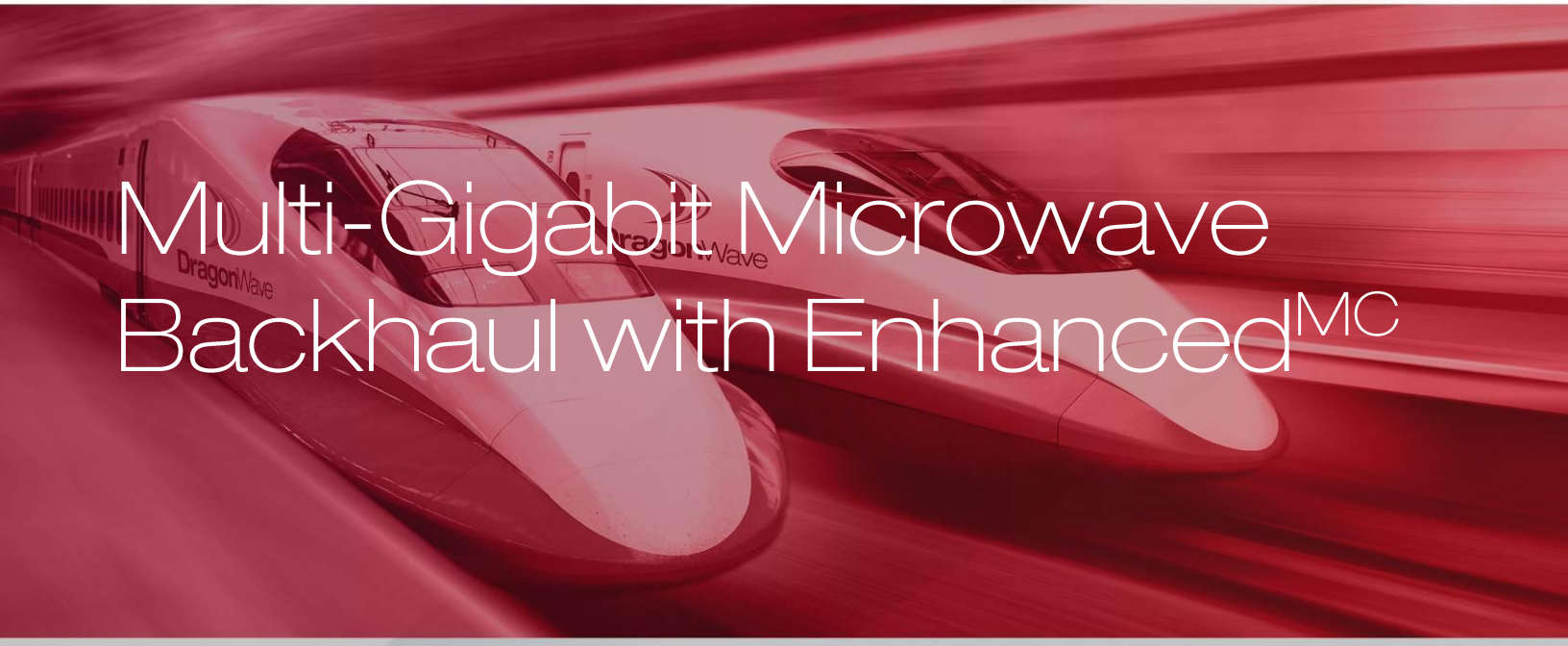
White Paper



Multi-Gigabit Microwave Backhaul with Enhanced[MC]

DragonWave

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Microwave Trends

The increase of mobile broadband service speeds enabled by LTE networks is exceptional compared with 2G and 3G networks; network evolution is sustained through the upgrade of the existing macro sites without needing to add a significant number of new sites. A new network layer of small cells and cloud RAN is starting to be added to the network to extend macro site coverage and increase per user service speeds. This new layer constitutes an important field for emerging Microwave technologies, and a new challenge for macro cell backhauling networks, as well.

Microwave, in fact, continues to be the most used technology for mobile backhaul after fiber, with characteristics of being the most cost-effective solution that brings immediate return on investment while meeting the performance requirements of LTE basestations.

Radio Access Evolution

In 2013, operators started deploying LTE. LTE is deployed aggregating up to 20 MHz bandwidth in 2x2MIMO and 64 QAM (Quadrature Amplitude Modulation) modulation, delivering a theoretical peak throughput of 150 Mbps per sector. That translates to 450 Mbps peak and 225 Mbps average throughput for a three-sector urban area site.

In 2015, many operators are pursuing expansion to 30 MHz channels in urban areas, increasing the performances of a LTE three-sector urban site to 204 Mbps peak and 102 Mbps average throughput. This milestone is very important because it creates the first challenge to the Microwave backhauling systems operating at 256 QAM and 28 MHz. Their throughput is, in fact, limited to 160-180 Mbps and a channel expansion or aggregation is required with implications of additional OPEX and CAPEX. The introduction of LTE aggregating 30 MHz bandwidth is the right milestone to introduce new, next-generation microwave systems that can deliver more than 250 Mbps in 28 MHz channel with a combination of higher modulation modes (2048 QAM and higher) and data compression techniques. These systems deliver required scalability while maintaining existing backhaul spectrum usage, minimizing Operator TCO.

In the core, LTE aggregation rings require high throughput connections of 1-4Gbps that require the aggregation of more carriers when implemented with microwave systems. This modernization is a milestone for introducing next-generation microwave systems supporting dual carriers that optimize site costs and complexity and antenna branching.

In 2016-2018, further developments are foreseen in the LTE roadmap, such as the extension to high efficiency LTE delivering 450 Mbps peak rate in 30 MHz aggregated band and the extension to 50 MHz aggregated

bandwidth with 750 Mbps peak rate. These new steps will further strengthen the requirement of high throughput, multi-gigabit microwave systems.

High Throughput Microwave Characteristics

We have seen that Microwave continues to offer significant cost advantages compared to fiber in mobile backhauling, offering easy and fast deployment and exceptional reliability. Still, capacity is becoming the key issue. At the same time, spectrum is a limited and expensive resource, and Microwave is required to enable an extensive and optimized reuse of spectrum with focus on minimizing Network Operators OPEX.

As a consequence, increased throughput and spectral efficiency are the key characteristics of the next generation Microwave systems. In addition, site cost is the most important factor affecting Operator TCO, and Microwave is moving to a zero footprint zoning-friendly architecture with direct connections to BTS. The main characteristics are integrated multiservice L2/L3 capability, embedded traffic engineering and protection, scalable channel bandwidth and modulation, and flexible channel aggregation capability. And, with higher output power capabilities antenna sizes can be reduced, drastically improving the total cost of ownership through minimized tower lease costs.

Three contributing factors to reach high throughput and high efficiency are the RF throughput (modulation and channels size), carrier aggregation, and traffic compression techniques. These three aspects, and their implementation in Harmony Enhanced[MC], are analyzed in details in the next chapters.

Radio Throughput

Radio throughput is the net on air throughput that Microwave equipment can deliver. It is a function of the used spectrum channel width and the way that Microwave Systems utilize that spectrum through modulation and coding techniques.

Operator networks largely utilize legacy Microwave systems using 256 QAM, and delivering 160-180 Mbps in a 28 MHz channel or 350 Mbps in a 50 MHz channel.

There are two ways to increase the net link throughput enabled by a single carrier Microwave system: increasing the spectrum channel width and increasing the maximum modulation mode.

In the traditional Microwave frequencies in the range of 4-42 GHz, different channel widths are regulated. We referred above to 28 MHz and 50 MHz channels. With Harmony Enhanced[MC], these channel bandwidths can be increased to 112 MHz in ETSI and ITU environments, and 100 MHz in FCC countries, allowing the throughput to be increased proportionally by the same amount.

With or without extending the channel width, another way to increase Microwave net throughput is to extend the maximum allowed modulation mode. Increasing the modulation from 256 QAM to 4096 QAM increases net throughput by 50%. This increase in modulation results in a link budget reduction of 9dB, but this can be managed through adaptive modulation.

The Harmony Enhanced[MC] system provides modulation up to 4096 QAM in the 6-42 GHz frequency bands. When this high order modulation is combined with wide channels, the Harmony Enhanced[MC] can deliver up to 1 Gbps of radio throughput in a single channel before any compression.

Carrier Aggregation

Net radio throughput can be extended on the same radio by aggregating more carriers, and therefore increasing the link throughput. Traditionally, this is achieved by adding multiple radios. With Harmony Enhanced[MC], this can be achieved through the multi-carrier feature, supporting 2 channels in a single radio. Harmony Enhanced[MC] can support two channels in the same polarization, or using its integrated OMT, and can deliver a vertical and horizontal channel at the same frequency with XPIC (Cross Polarization Interference Canceller). This dual carrier configuration is shown for a single and dual radio installation in the figure below. This configuration can deliver capacities of 4-8 Gbps, meeting the scalability requirements of next generation mobile networks. Of course at this capacity, connectivity to the base station becomes a challenge. To enable this, Harmony Enhanced[MC] is 10GE ready, with an SFP slot capable of 10GE ports.

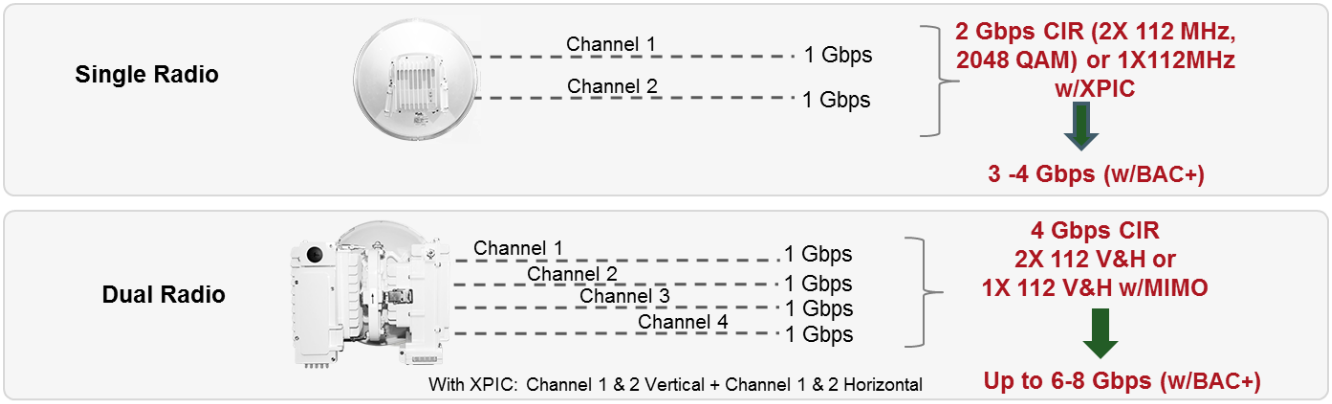

Figure 1: Single vs. Dual Carrier Configuration

Bandwidth Accelerator+

DragonWave's Harmony Enhanced[MC] uses a compression algorithm branded *'Bandwidth Accelerator+'* to deliver an increase of 20-100% of delivered user traffic, with an immediate significant saving in terms of both CAPEX (medium number of ODUs per link), and more importantly, the dominant OPEX (medium power consumption, site leasing cost, and channel license fees). Compression techniques are real time and lossless, without any, or with negligible, delay added, and they compress the header, the inter packet gap and the payload.

Bulk compression techniques decouple performances from packet lengths and they have huge compression scores in any condition. The performances are deterministic for each traffic type and the total score depends on real time traffic mix. The figure below represents DragonWave Bandwidth Accelerator performances for several traffic types. The performances are strong even on highly compressed source traffic such as compressed Voice (20%) and MPEG4 Video traffic (46%). The most important value is the 108% gain of "Mix traffic (Web, Video, FTP)' line that is the typical traffic mix in a Mobile Backhaul network; this value is the outcome of a real Mobile Network audit in Asia Region.

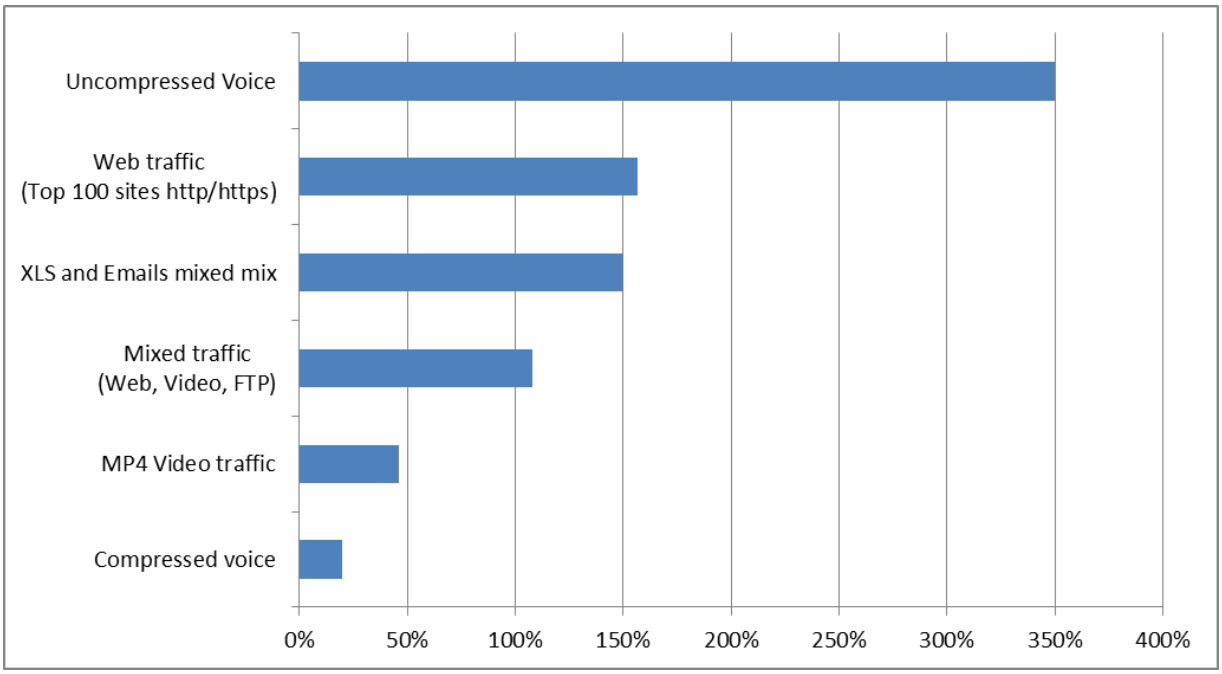

Figure 2: DragonWave Bandwidth Accelerator Performances for Traffic Types

Improved Systems Reach

Harmony Enhanced[MC] enables higher output powers, increasing link budgets by 7-10 dB to enable higher modulation modes in the aggregation part of the network where link reach is higher. These improved reaches can be used to reduce antenna sizes, significantly minimizing tower lease costs. Typical reach improvements are shown in the figure below.

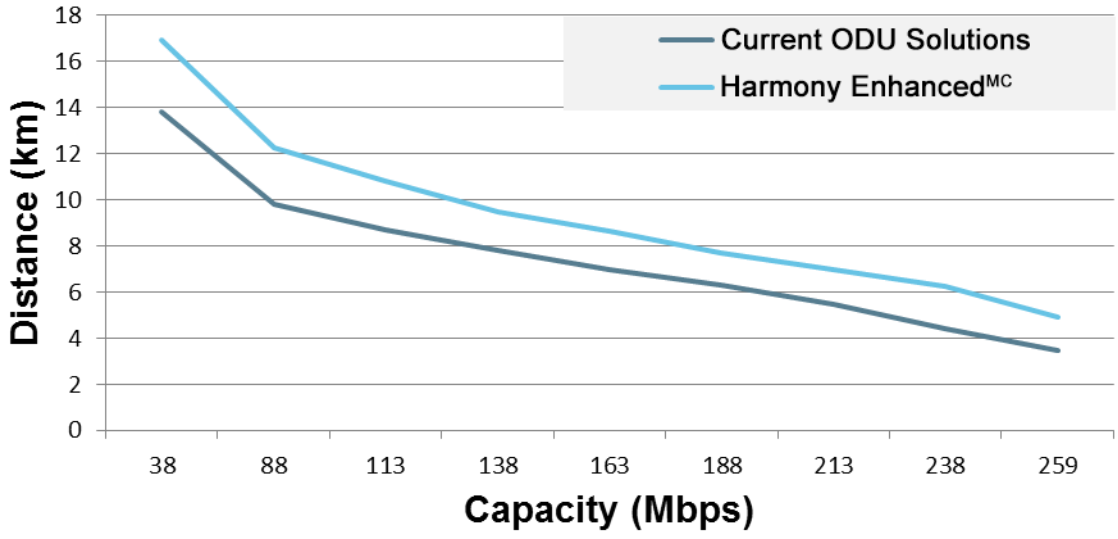

Figure 3: Harmony Enhanced[MC] Reach Improvement

Harmony Enhanced[MC] Full ODU Capabilities

In addition to its high capacity capabilities, Harmony Enhanced[MC] has a number of industry leading networking features that eliminate the requirement for an additional indoor switch. This includes the introduction of the first 10GE port on a microwave system to enable connectivity to next generation base stations and routers.

Key Features of Harmony Enhanced[MC] are:

- 4 x GE ports
- 1X 10GE Port
- 6 GHz – 42 GHz frequency bands
- 4X4 MIMO support
- Fully integrated Ethernet and MPLS switch
- Full range of system types with 2x2MIMO, 4x4MIMO on top of 1+1HSBy/SD/FD, 2+0 FD/XPIC, N+0;
- Green ATPC with up to 10W power saving at minimum transmitting power;
- Support of 256AES data encryption along with an extensive management layer encryption (RADIUS/TACACS+, SSL, SSH, SNMPv3)

- Next generation network packet synchronization:
    - 1588v2 Transparent Clock
    - SynchE with SSM management

- ELAN/ELINE service support
- WRED congestion avoidance
- 802.3ah, 802.1ag, Y1731

Harmony Enhanced[MC] – Delivering Lowest TCO

Harmony Enhanced[MC] brings together a number of differentiated features. Not only does it deliver the highest capacity on the market in 6-42 GHz with up to 8 Gbps on a single antenna, it also delivers the lowest total cost of ownership. This is enabled through three network differentiators. The first is reach, which enables reduced antennas resulting in lower tower leasing costs. The second is spectral efficiency, which allows the Harmony Enhanced[MC] to operate in the minimal amount of spectrum, reducing annual spectrum charges. Finally, the dual channel capability of Harmony Enhanced[MC] reduces equipment cost and installation cost by halving the amount of hardware required. This combination of features results in over a 50% cost savings on a 5-year basis, as shown in the graph below.

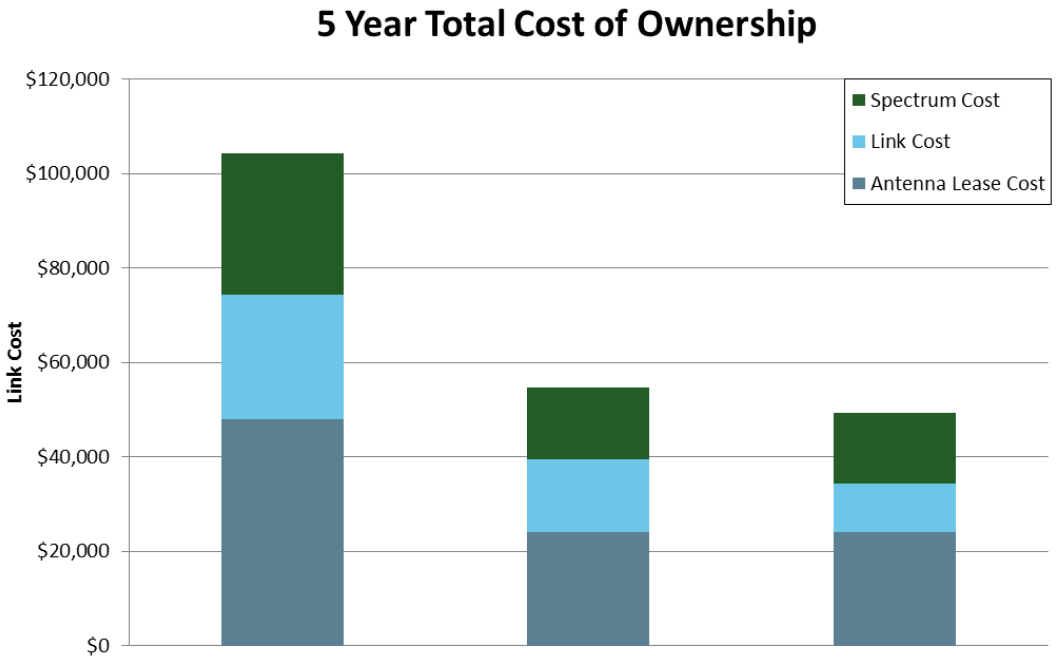

Figure 4: Harmony Enhanced[MC] – 5 Year Total Cost of Ownership

Scaling Your Network with Harmony Enhanced[MC]

Harmony Enhanced[MC] is a future proof microwave platform. With capacities up to 8 Gbps, your network will be ready for 4G and 5G scalability. Harmony Enhanced[MC] also brings the next generation of networking with SDN, MPLS-TP and 10GE capabilities. Synchronization needs are delivered with 1588 TC and SynchE support. Most importantly, Harmony Enhanced[MC] ensures these services can be delivered cost effectively, with an industry leading total cost of ownership.