White Paper

Delivering ENHANCED Performance and Value to Next Generation Backhaul Networks

DragonWave

www.dragonwaveinc.com

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DELIVERING ENHANCED PERFORMANCE AND VALUE TO NEXT GENERATION BACKHAUL NETWORKS

DragonWave's New Harmony *ENHANCED* is a next-generation microwave ODU, delivering the best performance in market. It simultaneously delivers the highest single channel capacity, and spectral efficiency, with a feature rich integrated switching capability and the industry's highest system gain.

The major advances of the Harmony ENHANCED are:

- Longer range operation through industry's highest system gain with over 35dBm output power
- Highest single-channel throughput capacity of up to 4 Gbps
    - Bandwidth Accelerator+ delivering bulk and header compression
    - 112MHz Channel Support
    - 4096QAM
    - MIMO Support
- Advanced networking and synchronization features
- Power conservation modes and reduced carbon foot print performance
- All-outdoor switching and MPLS-TP ready.

OPERATING RANGE IMPROVEMENTS

The Harmony ENHANCED delivers more capacity at longer ranges than any product in its market category.

Longer range operation requires state-of-the-art RF technology. Harmony ENHANCED combines the latest transmit-power innovations with advanced transmitter linearization techniques to enable superior system gain performance, even with very complex QAM modulations. The Harmony ENHANCED delivers industry leading system gain used to deliver the longest reach.

Figure 1 illustrates the reach advantage that HARMONY ENHANCED delivers as compared to leading backhaul radio systems on the market today, with an improvement of 20-40% link range. This increased gain can also be used to reduce antenna size by one, to minimize monthly tower lease costs.

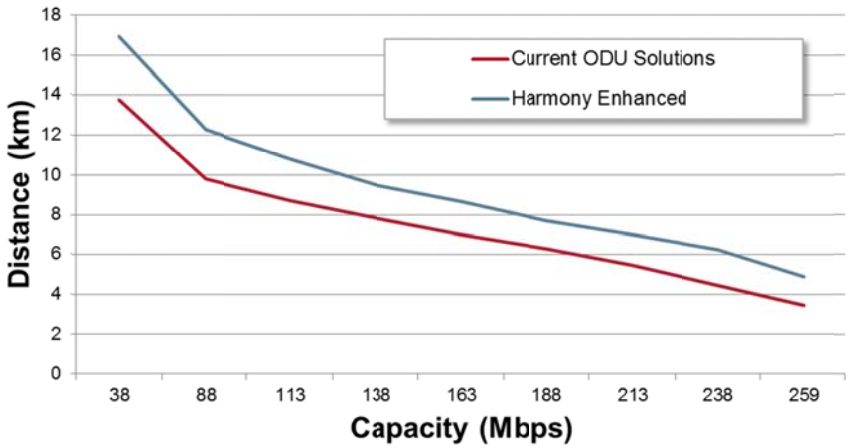

Figure 1 – Harmony Enhanced distance-vs-capacity benefit compared to other solutions

MAXIMIZED CAPACITY AND SPECTRAL EFFICIENCY

Higher capacity requires the most advanced, high-QAM modems, header and bulk compression. DragonWave pioneered modem technology for higher order QAM. Modulations up to 4096 QAM are available in the Harmony ENHANCED for maximum raw over-air throughput. This throughput is further augmented by DragonWave's unique combination of bulk data compression and dynamic header compression.

DragonWave's industry-unique *Bandwidth Accelerator* feature delivers lossless compression on all packet flow types with extremely low delay, below .1ms. In Harmony ENHANCED, DragonWave is introducing Bandwidth Accelerator+, by adding *Dynamic Header Compression*, which adaptively tracks and performs lossless compression of thousands of headers in the offered load flow-contents. Both of these compression engines can be assigned to flow queues so that the user/operator can decide what to compress and how it gets compressed.

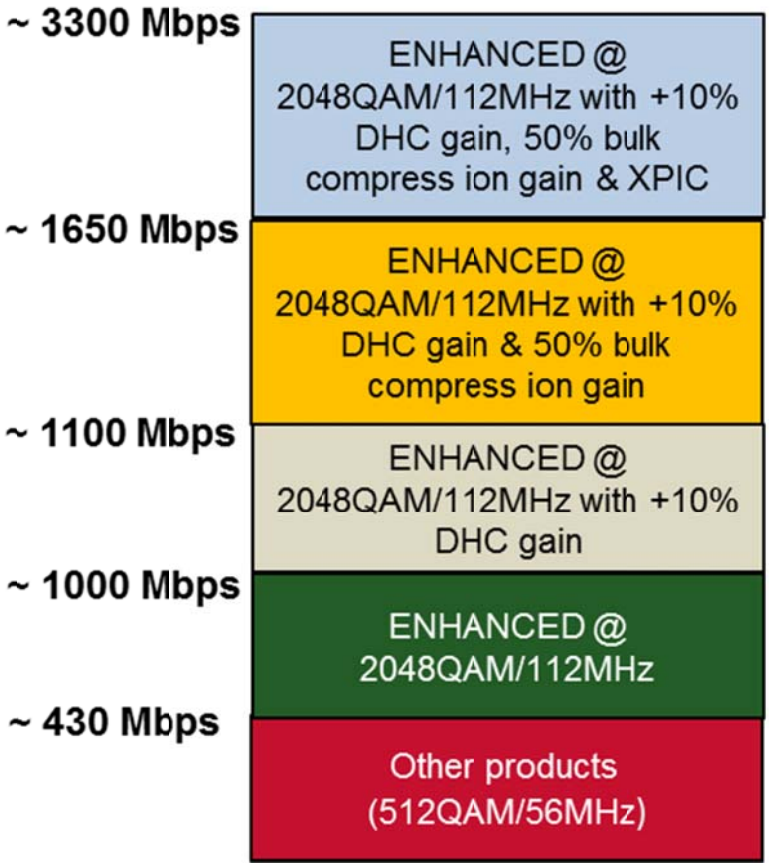

Figure 2 shows the overall throughput capacity benefits available from Harmony ENHANCED

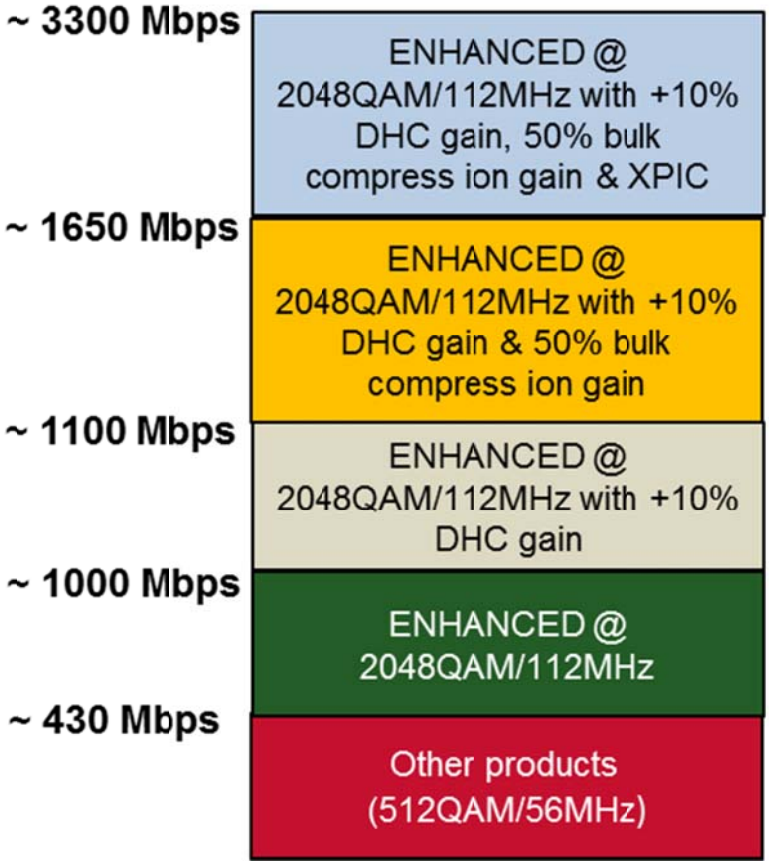

Figure 2 – Overall Throughput Performance of the Harmony Enhanced

Bandwidth Accelerator+ and 4096 QAM not only increase total capacity, they also provide significant spectral efficiency improvements, even at lower capacities. For example, with these two features, a 14 MHz channel can deliver 200-500 Mbps without MIMO and 400 Mbps to 1 Gbps with MIMO.

The benefit of MIMO highlighted in the chart above is a doubling in capacity, without any additional spectrum required. However, to achieve this, a second ODU and antenna are required on each end of the link, and must be precisely is separated a specific distance from one other, which is dependent on the link length and frequency. This can be valuable where spectrum costs are higher, and tower lease costs are low, but it does require a very detailed engineering exercise.

The spectral efficiency improvements drastically reduce annual spectrum lease costs. This combined with tower lease savings from the higher power system results in a 40% 5 year total cost of ownership savings vs. 2048 QAM systems. These cost benefits are shown in figure 3 below.

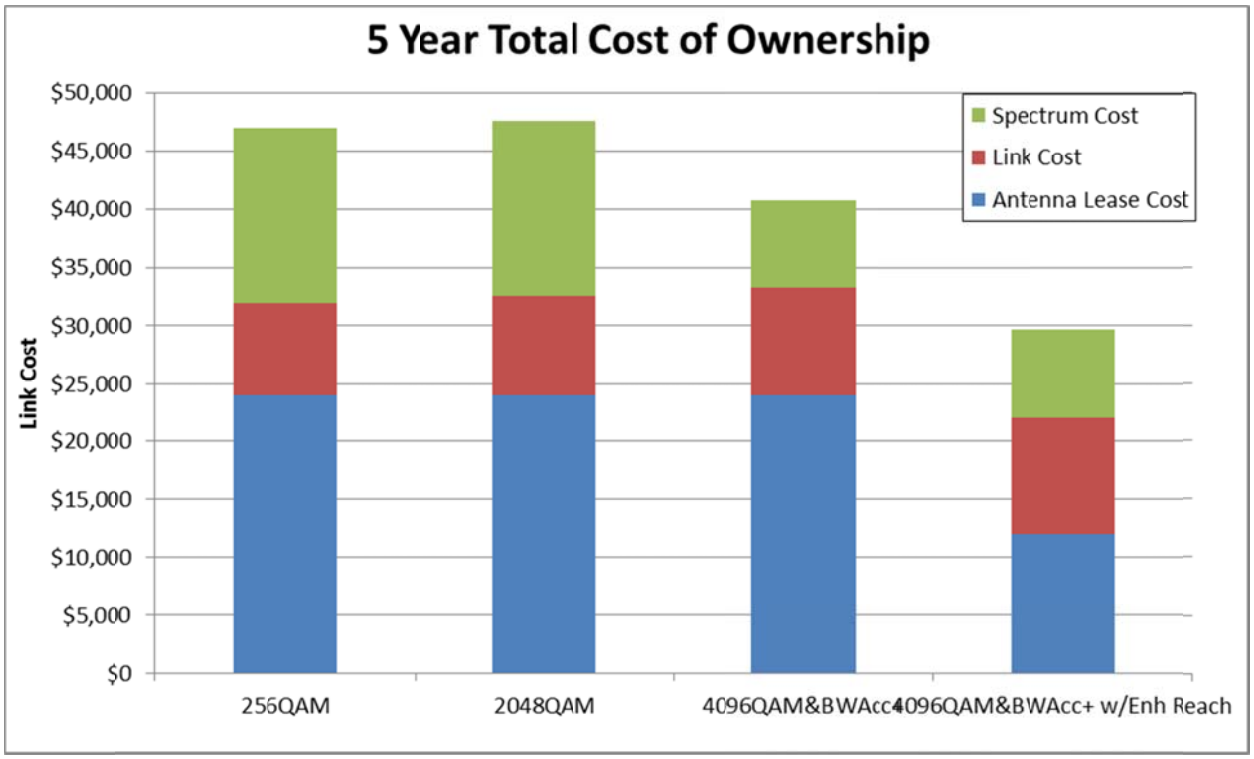

Figure 3 - 5 Year Total Cost of Ownership Comparison

CARRIER GRADE NETWORKING FEATURES

Backhaul for current and future mobile networks requires the latest carrier-class switching, synchronization, queuing, PMON and OAM features. Harmony ENHANCED employs the latest multi-port switching technology to deliver a full range of Ethernet features previously unavailable from wireless technology solutions. Further, the switching functionality is MPLS capable, allowing policing of literally thousands of virtual paths!

Harmony ENHANCED also delivers the range of synchronization, OAM and PMON features that operators have come to expect from DragonWave products. This includes full loop back facilities at the port, digital/modem layer and at RF (just behind the antenna interface), allowing maximized remote debug and fault isolation of the ODU. Key Harmony networking features include;

- Integrated Ethernet Switch with 4XGigE access ports
- MPLS-TP Upgradability
- Advanced OAM including 802.1ag, 802.3ah, Y.1731
- SynchE with ESSM
- 1588 Transparent and Boundary clock
- PMON and Advanced Logging
- MEF-compliant ELINE and ELAN service architectures
- Multiple Loopback points

ENERGY EFFICIENCY AND MINIMIZED CARBON FOOTPRINT

As networks scale, and cost of energy increases, there is an increasing focus on reducing the networking equipment energy consumption. Harmony ENHANCED addresses this important requirement with innovative" green" modes. As illustrated in Figure 44, Harmony ENHANCED is able to turn its DC consumption down when the RF path conditions allow. Since in the vast majority of the time (typically > 99%), the RF path conditions are compliant, Harmony ENHANCED can deliver "green" environmentally friendly benefits and significant energy-cost savings! In addition, 2+0 configuration, a "green" mode can be enabled to mute the second radio, when its capacity is not required, further minimizing power consumption.

Reduced power consumption translates into significant "carbon" footprint reductions. A large scale deployment[1] of Harmony ENHANCED operated with their advanced "green" modes can reduce emissions by tens of millions of Kg over an expected field life of 15 years!! …. Whilst saving the operator tens of millions of dollars[2] in reduced energy costs!!

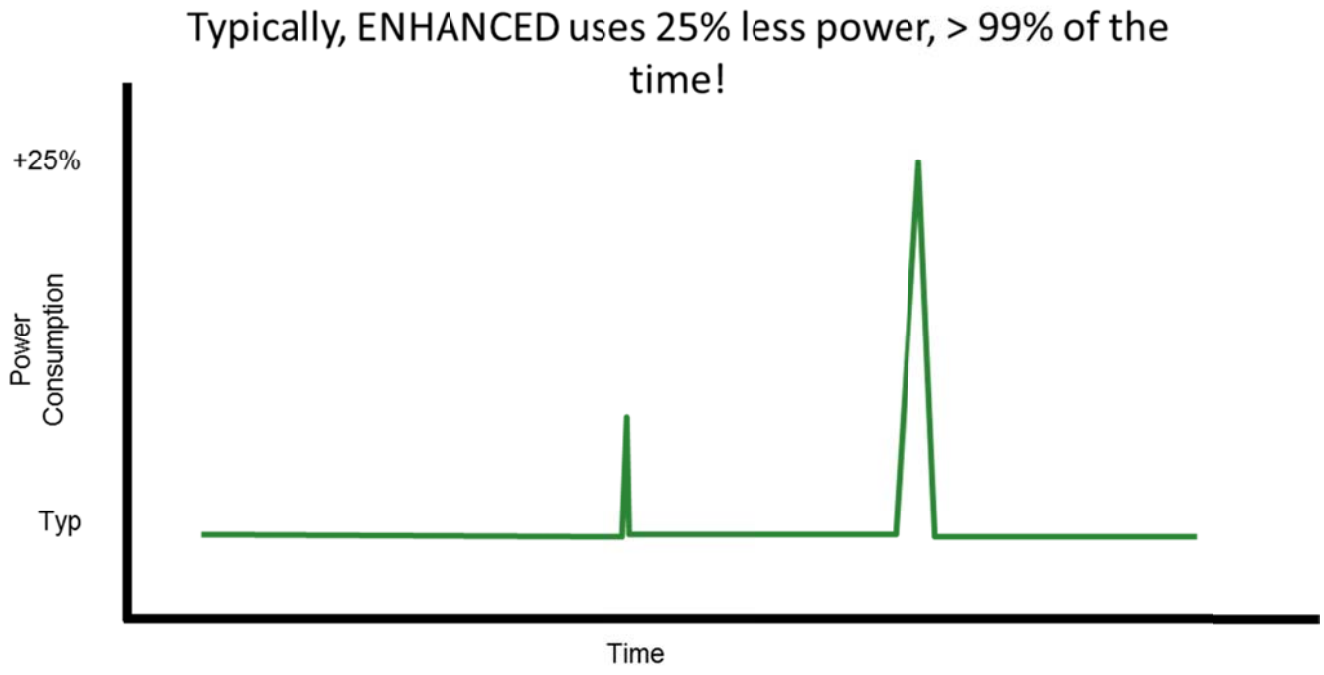

Figure 4 – Power Consumption Reduction in Harmony Enhanced

[1] Assumes 25,000 link deployment

[2] Assumes ~ 0.3USD/kwh electric energy costs

INSTALLATION INNOVATIONS

As equipment costs have reduced, and labor costs have increased, installation costs have become a major portion of the initial CAPEX costs, often exceeding the equipment costs. In addition to a wide range of cost saving features associated with all-outdoor installation that DragonWave pioneered in the wireless backhaul industry, Harmony ENHANCED also employs industry-unique connectorization (see Figure 55) This unique housing, eliminates, loose connector parts, complex installer instructions, on-tower connectorization, and custom cable. Harmony ENHANCED eliminates these complexities with a simple connector bay, which is intuitive and doesn't use complicated outdoor connectors. Its fast, easy, weather-proofing is assured, and additional ports can be connected without impact to existing services.

Accompanying Harmony ENHANCED 's innovative connectorization is DragonWave's user-friendly configuration and management tool set, which is easy to use, intuitive and fast. Connections to the ODU can be made in-band or out-band, encrypted or un-encrypted.

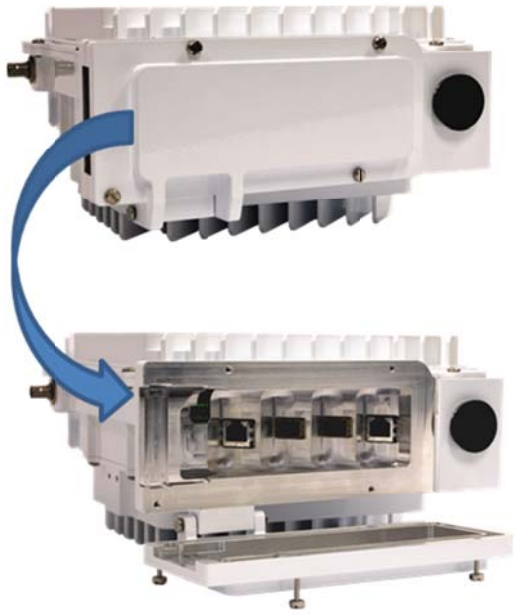

Figure 5 –Harmony Enhanced Innovative Connectorization