White Paper

# Extending your Reach with High Power Microwave from DragonWave-X

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# Introduction

Point-to-point microwave solutions continue to play a critical role in providing backhaul for mobile networks globally, and this trend is not expected to change with the continuing rollout of larger and more advanced networks. The need to quickly and easily deploy reliable, economical, high-capacity transport presents a strong business case for microwave. This is not only applicable for mobile backhaul networks, but for many other segments, including private and enterprise networks, public safety and critical communications, as well as rural broadband connectivity initiatives.

Microwave has been used for over half a century, and the technology has enjoyed significant advancements over many generations, most of which center around migrating to all-IP, delivering more capacity, and providing longer reach and better performance. Additionally, building more intelligence into the equipment itself through integrated switching, advanced Ethernet features, and SDN-readiness allows the equipment to take on more roles in today's complex networks and deliver more product value.

DragonWave-X's flagship high-capacity product, the dual-carrier Harmony Enhanced[MC], has been ticking all of those boxes, providing industry-leading capacity and system gain, with a strong feature set of advanced RF and Ethernet capabilities.

With the new High Power Harmony Enhanced[MC], DragonWave-X has taken reach to a new level using GaN technology to offer an all-outdoor radio that delivers 18 GHz at an unparalleled 34 dBm transmit power.

# 18 GHz is the New 11 GHz

## Why 11 GHz is so Popular

The 11 GHz band has long been a workhorse frequency in the United States, as well as in many other regions. From a microwave planning perspective, lower frequencies (i.e. 6, 7/8 GHz) tend to have greater multipath fading, while with higher frequencies (i.e.15 GHz and up), rain fading is the dominant factor impacting link availability.

11 GHz sits nicely in between, overcoming some of the multipath limitations of the lower frequencies, while not suffering from rain fading to the same extent as higher frequencies. This has made it attractive for medium to long links, and with 40 MHz channels, it offers a respectable 300+ Mbps per channel at higher modulations, along with the ability to deploy 2ft. (~60cm) antennas compared to the minimum 3ft. (~90 cm) with 6 GHz.

With the relatively recent approval of 80 MHz (ANSI) channels in 11 GHz (as well as in 18 GHz), the 11 GHz band has become even more attractive, offering the same performance benefits with double the throughput. According to the 2017 FCC licensing data, there were as many 11 GHz licenses as all of 6, 18 and 23 GHz combined.

While operators continue to benefit from 11 GHz with 80 MHz channels (and in many cases, 2 x 80 MHz channels using dual-carrier solutions), the channels are becoming noticeably more difficult to coordinate in more congested markets. This drives the use of features such as cross-polarization interference cancellation (XPIC), high-performance antennas (e.g. ETSI Class 4), and other spectral efficiency techniques that help squeeze more channels into congested areas.

When dealing with congestion, moving to higher, typically less congested frequency bands presents a good alternative. This typically comes with trade-offs in terms of link availability, path reach, etc., but with the introduction of better system gains at higher frequencies, the reach trade-offs can be mitigated.

## The 6 to 23 GHz Deployment Spread

The most commonly used licensed frequency bands in the United States are 6, 11, 18, and 23 GHz. A general best practice in microwave network design is to use higher frequencies for shorter paths, and lower frequencies for longer paths, which helps optimize for reduced antenna sizes and overall better spectral efficiency. This usually translates to using the following frequency and antenna combinations in order of increasing path length based on the target link performance criteria:

- 23 GHz with 1ft. antennas
- 23 or 18 GHz with 1ft. or 2ft. antennas
- 18 GHz with 2ft. or 3ft. antennas
- 11 GHz with 2ft. to 6ft. antennas
- 6 GHz with 3ft. to 6ft.+ antennas

Figure 1 shows a snapshot of 6, 11, 18, and 23 GHz links active around Fresno, California, for example, and helps illustrate the frequency versus path length relationship.

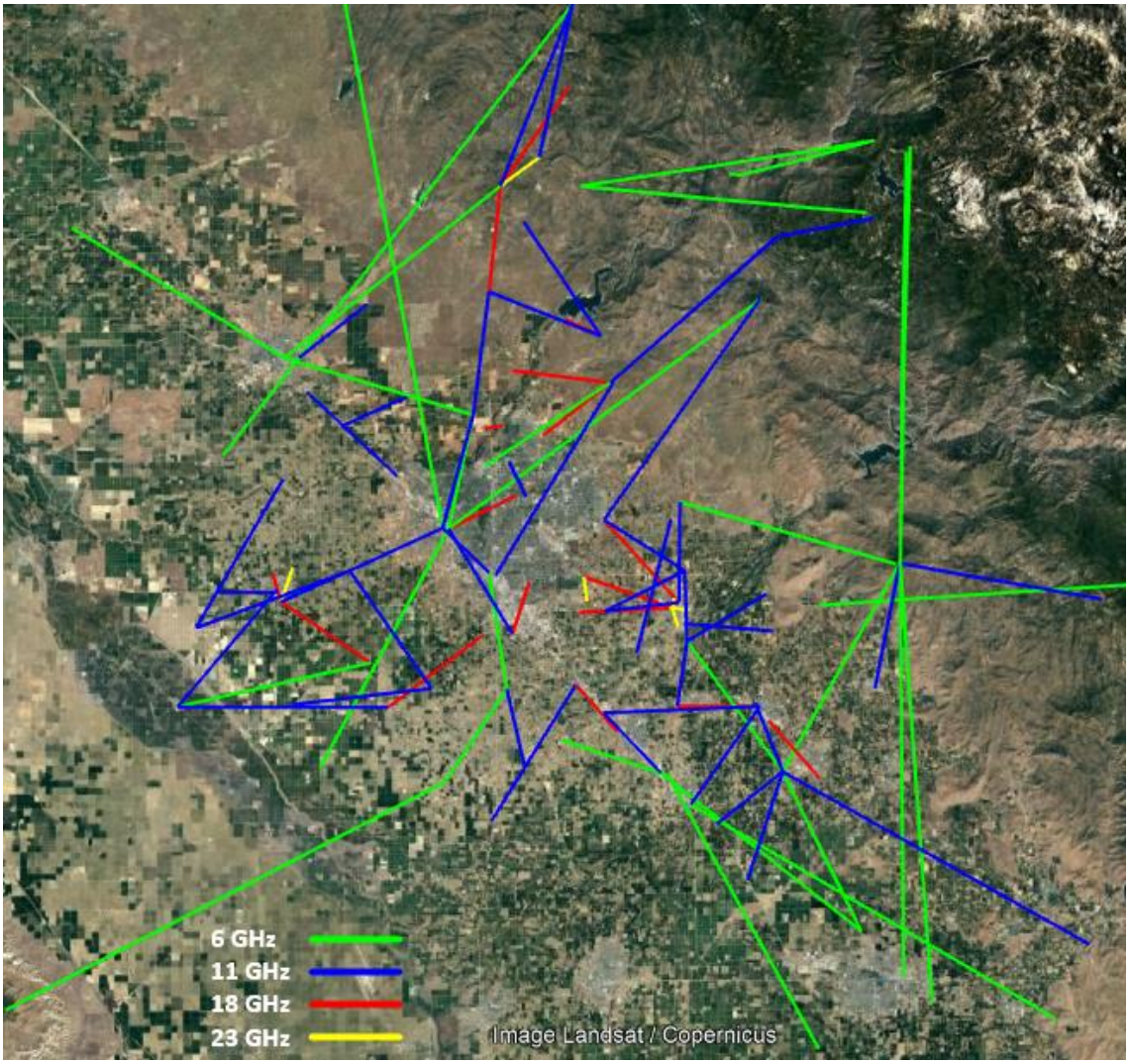


**Figure 1 – 6 to 23 GHz Deployment Sample**

## Do More with 18 GHz and High Power

With DragonWave-X's introduction of gallium nitride (GaN) power amplifier technology in the Harmony Enhanced[MC] product, first in 11 GHz, and now in 18 GHz, radios are available that offer significant transmit power improvements over what has previously been available. In 18 GHz this impact is even more evident, with upwards of **15 times** more output power than competing radios on the market.

More system gain is always a good thing in microwave planning, but with the growing consumption of spectrum in lower frequencies for longer, high-capacity paths, more significant is the improved applicability of 18 GHz to a larger number of microwave links. The 6 to 23 GHz deployment spread suddenly sees a shift towards using higher frequencies for more links, helping to alleviate congestion in the lower bands for longer paths.

Figure 2 shows a comparison of sample link reach values between 18 GHz High Power and traditional 11 GHz link budgets, across several populated areas in the United States, in order of increasing statistical rain intensity rates.

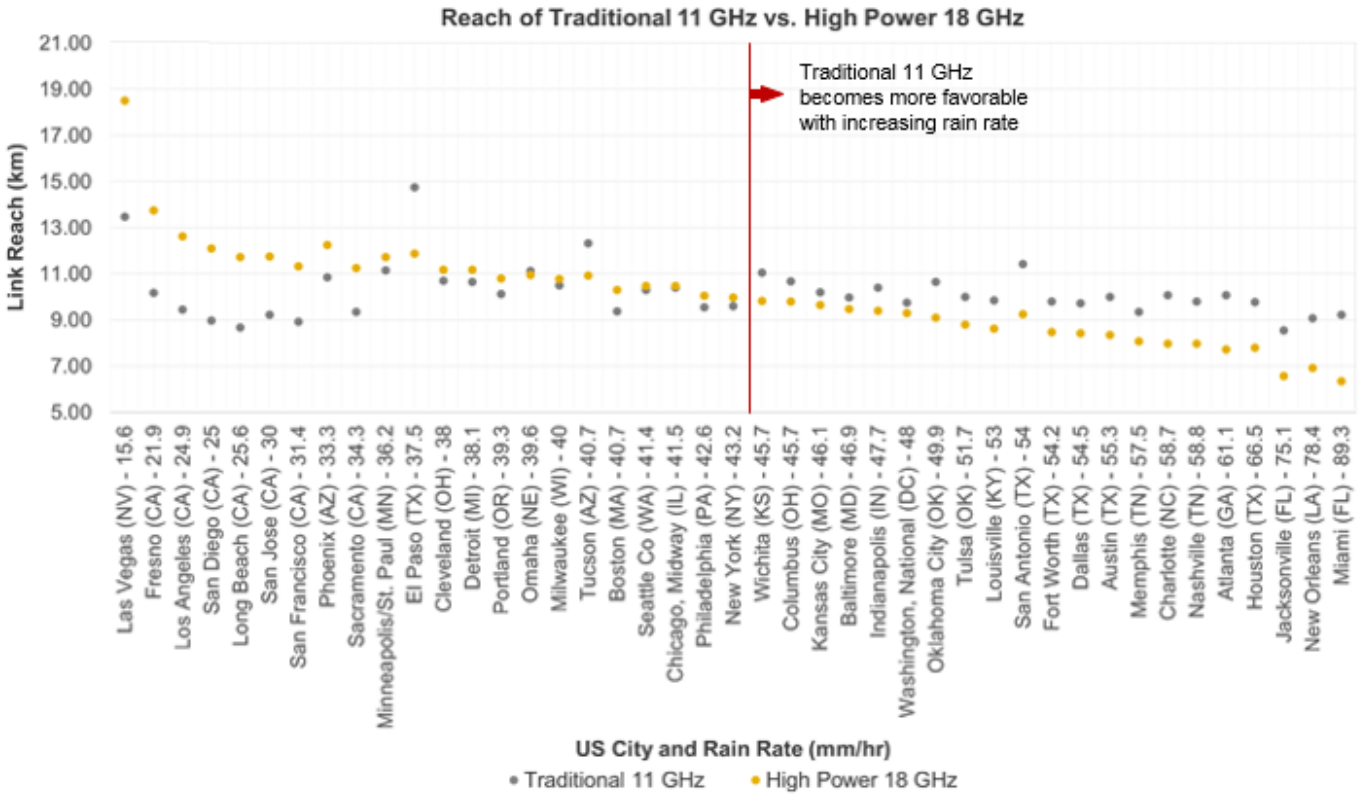


**Figure 2 – Traditional 11 GHz vs. High Power 18 GHz Reach in the United States**

*Reach Assumptions:*
*ITU-R P.530-13 Calculation Method*
*ITU-R P.837-3 Rain Data*
*Availability Target = 99.995% @ 512QAM in 80 MHz channels, with 2' antennas*
*11 GHz Traditional Tx Power @ 512QAM = 24 dBm*
*18 GHz High Power Tx Power @ 512QAM = 33 dBm*
*Field Margin = 2 dB*
*Values are predicted based on standard calculation methods and not guaranteed*

For cities in the middle 30-60 mm/hr range, the average achievable link distance for 18 GHz High Power is **within 5%** of the traditional 11 GHz link distances. In several of the California cities shown, for example, High Power 18 GHz even offers significantly better reach than traditional 11 GHz at the same modulation and antenna size due to the lower rain rates and higher antenna gain. In general, 18 GHz High Power can replace traditional 11 GHz systems in about half of the markets reviewed with similar (or in some cases, better) performance.

Combined with standard microwave features such as adaptive coding modulation (ACM) and automatic transmit power control (ATPC), High Power 18 GHz can offer reliable, high-capacity, medium range links using generally more obtainable spectrum than with traditional 11 GHz.

The use of High Power systems in both low and high frequencies offers a number of additional benefits:

- Reduce antenna sizes on existing link lengths, reducing site OPEX and tower construction costs
- Achieve higher order modulations and consequently more throughput per link
- Achieve higher overall link availabilities through improved link budgets and higher fade margins
- Streamline equipment sparing – replacing 11 with 18 GHz (as well as replacing traditional 6 GHz with High Power 11 GHz) reduces the number of variants, and DragonWave-X supports the entire FCC 18 GHz channel plan on one sub-band
- Offer an additional degree of freedom when trying to coordinate paths, improving the likelihood of obtaining channels in congested markets
- Reduce repeater site requirements, where traditional link length limitations require multiple hops to get from Point A to Point B

# There's More! The Other Benefits of Using Harmony Enhanced[MC]

While the industry-leading transmit power of the Harmony Enhanced[MC] is impressive in itself, the system was designed with additional value-based features and considerations in mind. These all contribute to a highly scalable microwave solution with many applications across many path lengths, not just medium to long-haul.

## Multi-Gigabit Solution

Harmony Enhanced[MC] is DragonWave-X's third-generation dual-carrier system, providing leading capacity and spectral efficiency.

Figure 3 highlights the capacity evolution towards achieving up to 8 Gbps on a single path, all while benefiting from the improved system gain provided at higher modulation levels. The main capacity improvements leverage increased modulations, wider channel implementation (80 and 112 MHz), as well as DragonWave-X's unique lossless bulk payload and header compression technology (Bandwidth Accelerator+) to deliver upwards of 8 Gbps across a single path.

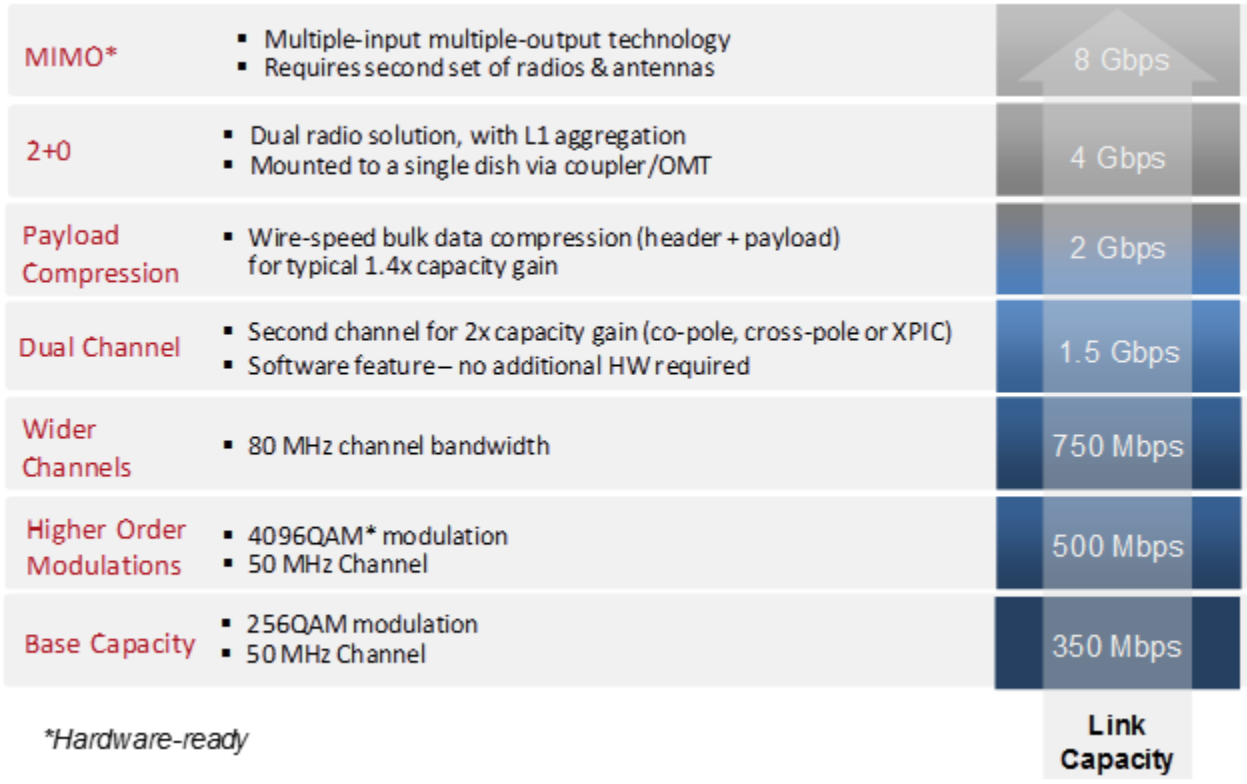


**Figure 4 – Harmony Enhanced[MC] Capacity Evolution**

## 10GE Connectivity

The inclusion of a 10GE port - an industry first on an all-outdoor microwave radio - further enables the multi-gigabit capabilities of the Harmony Enhanced[MC]. While other systems require multiple cables to support >1 Gbps, a single data cable can be used with the Harmony Enhanced[MC] for data + in-band management, including configurations that use multiple outdoor units to double the capacity and provide a single data handoff point. This offers additional cost savings and simplifies cabling requirements.

## Simple Configuration and Installation

Throughout the years, DragonWave-X has recognized that, while not necessarily a main purchasing factor up-front, installation ease (or pain) is a significant part of the solution experience that translates to deployment costs. The Harmony Enhanced$^{MC}$ was designed with that in mind, and uses a unique weatherized cable enclosure that simplifies cabling. The design uses standard RJ45 and LC-LC duplex fiber connections – no special glands or cable assemblies are required to maintain the seal. This solution reduces install complexity, saving time and cost, while maintaining IP66-rated ingress protection.

**Figure 5 – IP66-Rated Cable Entry**

The Harmony Enhanced$^{MC}$ also maintains the same clip-mount circular interface that has been used since DragonWave-X's original product lines, allowing for an easy upgrade path from legacy gear, and a "no tools required" radio installation. The integrated OMT means no intermediate adapters or transitions are required between the radio and the antenna for the default cross-pol configuration, making it the simplest XPIC system on the market!

**Figure 6 – Clip-Mount Circular Antenna Interface**

The built-in LinkView web-based management interface also simplifies the commissioning and initial setup of the link, allowing for quick configuration of **both** ends of the link from a single interface.

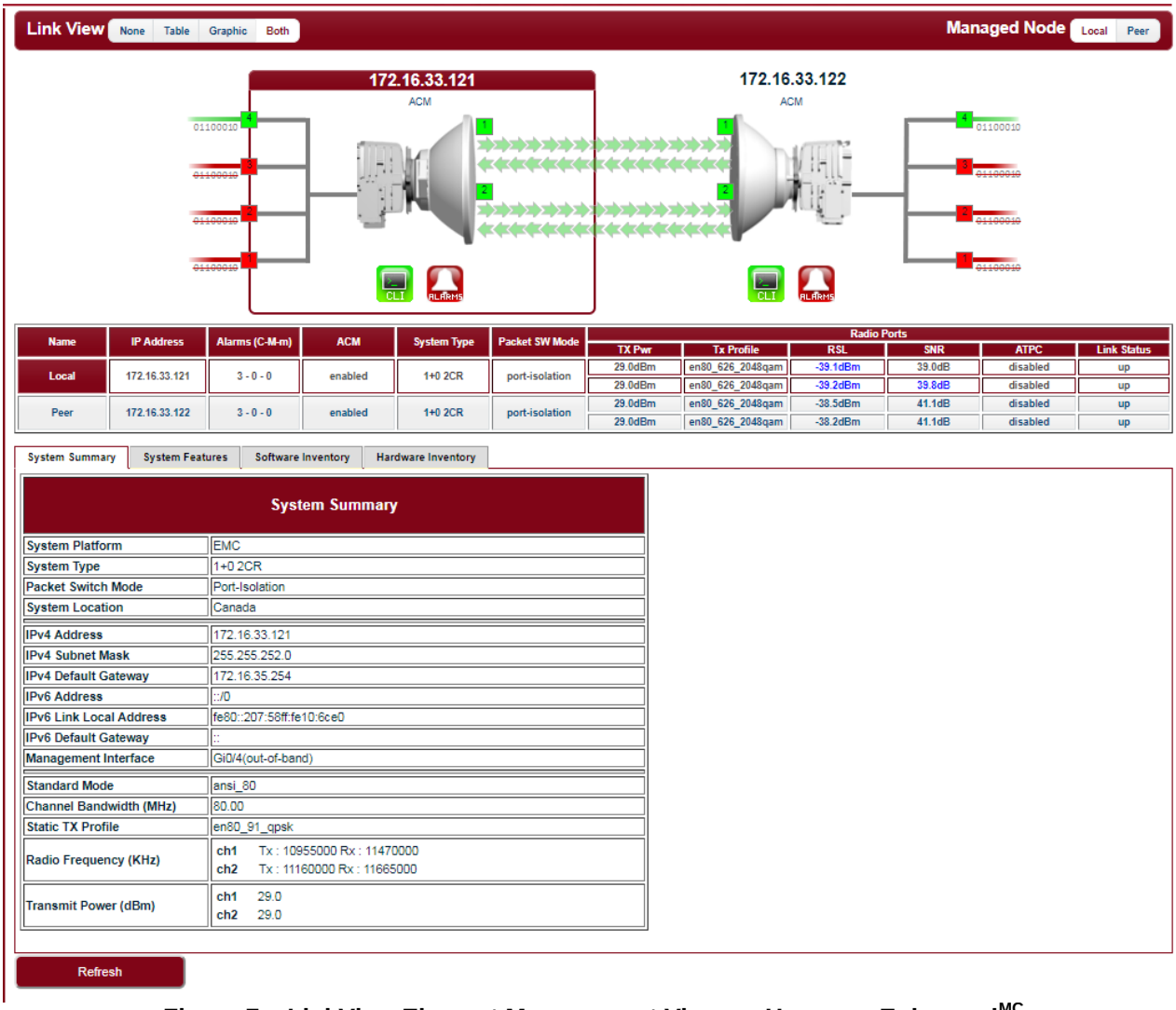


**Figure 7 – LinkView Element Management View on Harmony Enhanced[MC]**

The always-on BNC connection on the radio also provides a direct reading of the radio receive signal level in mV for ease of alignment. No translating or lookup tables required!

## Integrated Switching and Ethernet Features

An integrated 4-port Ethernet switch adds brains to the brawn, bringing switching functionality into the radio equipment as an additional CAPEX and OPEX reduction option. This helps to eliminate the need for switches at link aggregation points, applicable to chain, ring, and hub and spoke topologies. Advanced synchronization (1588TC, SyncE) and MEF capabilities, as well SDN-readiness also help make the Harmony Enhanced[MC] a future-proof solution.

## One Platform - Countless Applications

Whether it is reducing antennas sizes on a single hop, or forming the high-capacity backbone of a mission-critical network, Harmony Enhanced$^{MC}$ offers the versatility to tackle most microwave networking scenarios with a single, feature-rich platform. Take advantage of the high system gain for longer reach and higher availability, with the ability to quickly double link capacity with a simple feature upgrade, all without a tower climb.

Most importantly, the Harmony Enhanced$^{MC}$ builds upon years of experience delivering quality, carrier-grade solutions, only now with more OPEX- and CAPEX-saving benefits that help expand today's connected world!