DragonWave

DRAGONWAVE
SALES GUIDE

DragonWave
Sales Guide

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Brochure

Public Safety

DragonWave

Whether protecting our cities, guarding our borders or monitoring critical infrastructure, public safety agencies provide the essential services that we all depend on. Despite ever increasing demands, these organizations are faced with difficult budget constraints. Rather than compromising their level of service, many agencies are investing in new communications technologies to improve their efficiency, increase coverage and improve the speed of critical decision making.

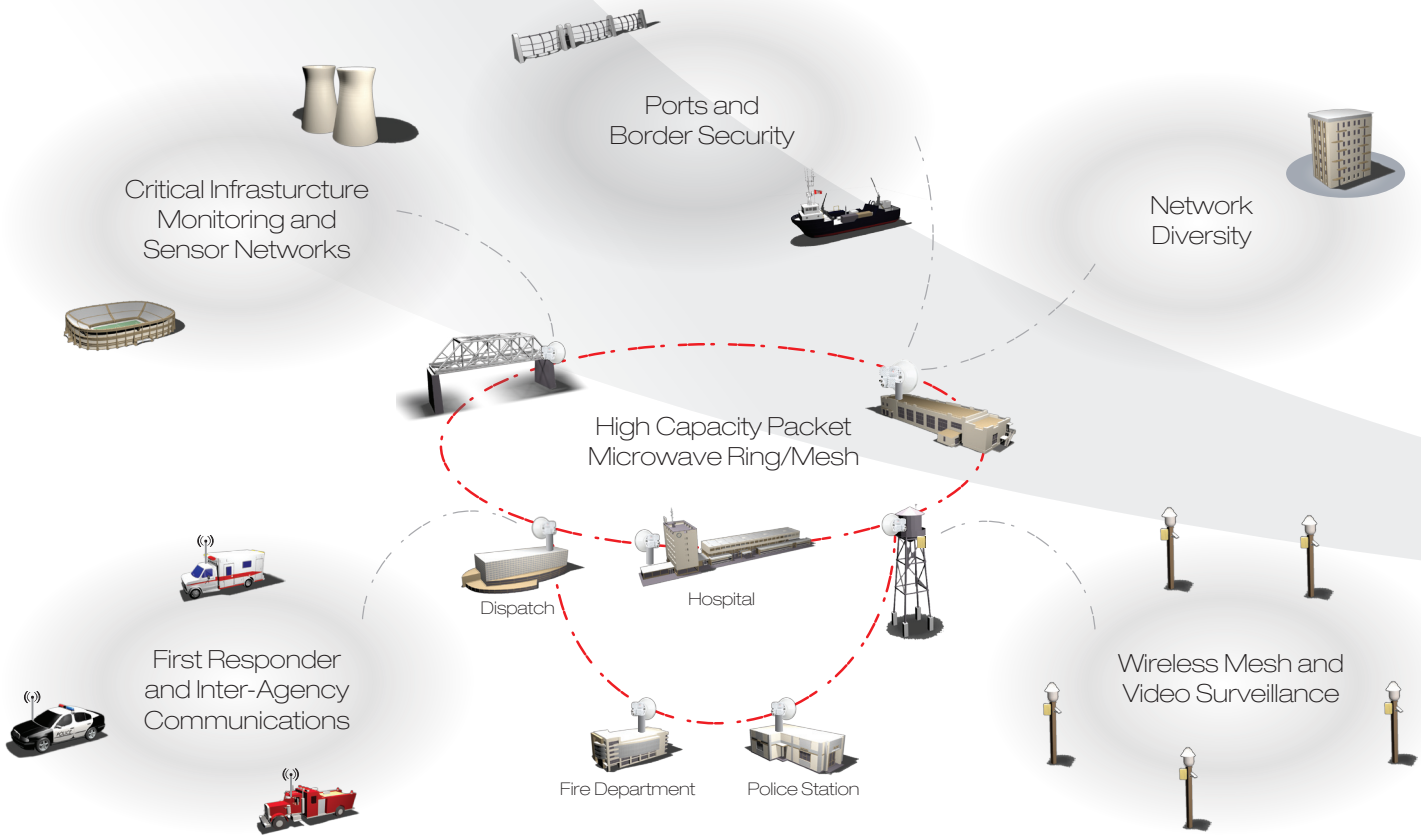
DragonWave has extensive experience building advanced packet microwave networks for critical communications in all areas of public safety including first responders (police, fire and medical), video surveillance, sensor networks, ports, utilities, and border security.

Our licensed point-to-point packet microwave solutions are recognized in the industry for their robust design, high level of security, and resilient architecture options, including ring and mesh for carrier-grade availability. DragonWave systems are available in all-outdoor, split-mount, or all-indoor configurations and can handle any combination of Ethernet and TDM traffic, while offering multi-gigabit scalability – delivering the capacity and flexibility required for ever-evolving bandwidth and traffic mix needs.

Solutions Highlights:

- Licensed and license-exempt packet microwave from 2.3 GHz to 60 GHz
- Dual channel operation and multi-gigabit capacity
- All outdoor deployment options
- Pure packet or converged TDM and Ethernet solutions for network evolution
- Simple migration to all-IP P25 systems
- Upgradable to 256 bit AES encryption
- Intelligent ring and mesh architecture for carrier-grade availability
- Pay-as-you-grow scalability
- Simple operations and remote management
- Rapid deployment for temporary links
- Lower Total Cost of Ownership

Our goal, from the initial planning and design stages of a network, through to its continued operation and maintenance, is ensuring that Public Safety officials have full confidence that their communication systems will deliver the information and performance they need, where and when they need it.



State and Local Government

DragonWave

Government agencies at all levels are faced with new demands driven by a multitude of next-generation applications and services. Video surveillance and traffic cameras, real-time infrastructure monitoring, digital records, first responder communications and broadband connectivity to schools and government offices all have the potential to enhance the lives of citizens and improve the efficiency of governments.

To make these applications a reality and to stay abreast of future demands, government organizations must put in place a scalable broadband infrastructure that is optimized for packet-based voice, video and data applications, while supporting a simple transition from legacy communications networks.

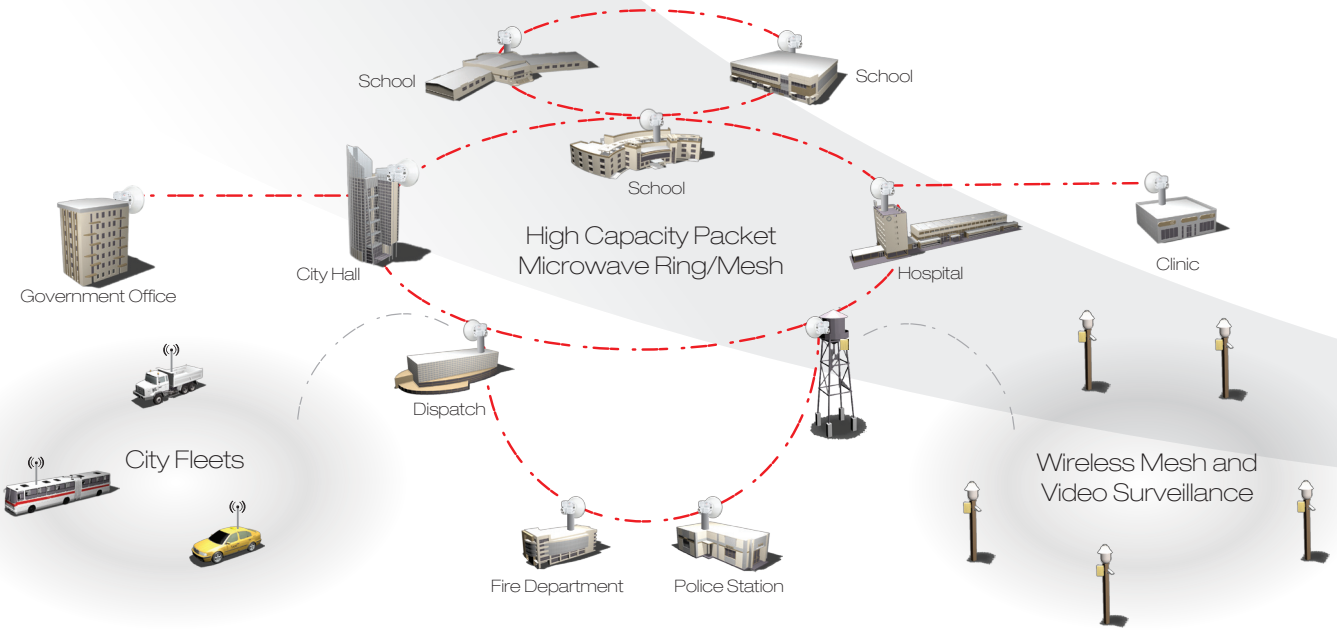
Tighter government budgets mean that any transport network solution must not only be cost effective to deploy, but it must also simplify processes and deliver new services and applications with greater efficiency than ever before.

Solutions Highlights:

- Licensed and license-exempt packet microwave from 2.3 GHz to 60 GHz
- Dual channel operation and multi-gigabit capacity (2 to 4 Gbps per link)
- Pure packet or converged TDM and Ethernet solutions for network evolution
- Upgradable to 256 bit AES encryption
- Pay-as-you-grow scalability
- All outdoor deployment options
- Intelligent ring/mesh architecture for carrier-grade availability
- Simple operations and advanced remote management
- Lowest Total Cost of Ownership

Adding capacity through stretched copper facilities is a short-term solution at best. Fiber is an excellent option in areas where it is readily available or easily extended. However, new fiber builds are not only extremely costly to deploy but they can also cause significant disruptions and suffer frequent delays.

Next generation point-to-point wireless systems can deliver multi-gigabit capacity without the worry of long delays and high deployment costs – making them an ideal solution for many operators. DragonWave's packet microwave solutions deliver the capacity, carrier-grade reliability and scalability needed for current and future applications at a fraction of the cost of wired alternatives. Our world-class services organization is engaged at every stage of the network lifecycle, ensuring that local and state government networks deliver the speed and reliability demanded by modern society.



Rural and Underserved Markets

DragonWave

Network operators in rural and underserved markets are faced with unique backhaul challenges that require innovative and cost effective solutions to ensure the long-term viability of their business models. Key rural issues include:

- Long link distances
- Limited site deployment options
- Long lead repair times
- Difficult deployment economics
- Short deployment timelines – particularly when broadband stimulus funding is provided

When evaluating backhaul alternatives, these considerations typically favor a wireless backhaul solution, as fiber and leased line options will often be eliminated on the basis of cost and deployment timelines.

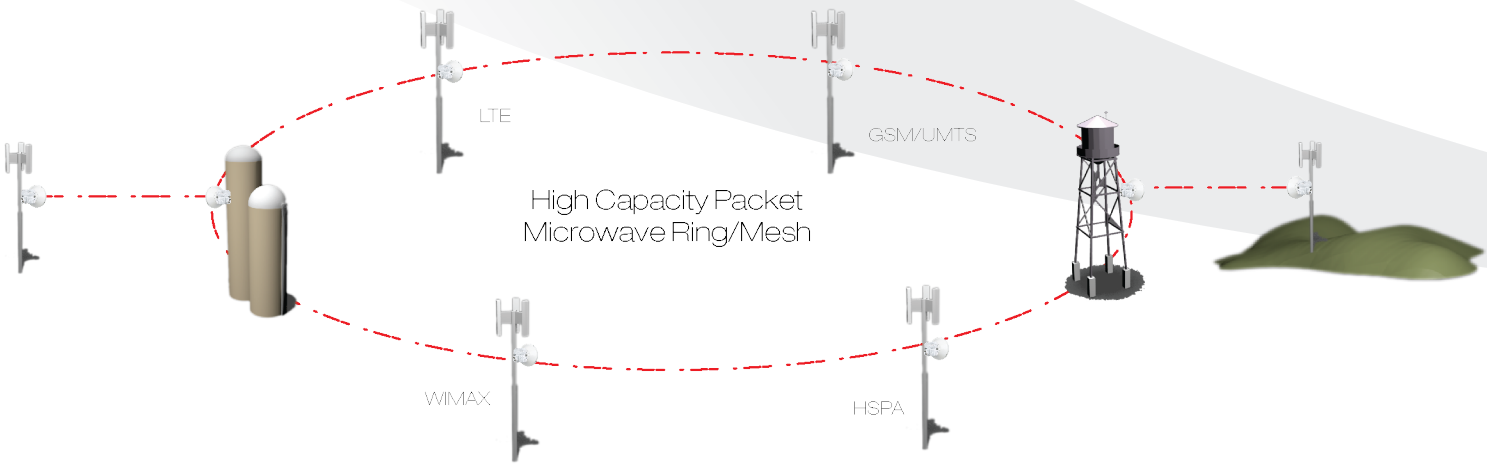
DragonWave's packet microwave solutions respond to the needs of rural operators with several important benefits:

- Rapid deployment times measured in days, not months
- >1 Gbps scalability
- Remote scaling with Flex bandwidth: offering simple, pay-as-you-grow capacity increases
- Automatic adaptive modulation, resulting in longer hops, higher capacity, and smaller antenna sizes
- All-outdoor deployment options
- Meets the key business plan requirements of rural broadband funding programs
- Self-healing mesh architecture resulting in fewer site visits
- Flexible remote network management options

The result is a solution that addresses both capital and operational issues, offering the lowest total cost of ownership backhaul for rural and underserved areas.

Solutions Highlights:

- Native Ethernet platform designed for next generation networks
- Remote, pay-as-you-grow scalability with Horizon Flex
  - Up to 800 Mbps with Horizon Compact
  - Up to 4 Gbps with Horizon Quantum
- Interference-Free using licensed spectrum
- Rapid, low-cost deployment option using near interference-free 24 GHz unlicensed spectrum
- 99.999% availability options with 1+1 redundancy and intelligent nodal Ring/Mesh switching
- Ultra-Low Latency (0.1 ms) supporting voice and video over IP
- Hitless Automatic Adaptive Modulation
- All outdoor deployment option with Horizon Compact zero footprint



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Application Note

Last Mile Fiber Extension

With the greatest demand for broadband services coming from within the core metro markets, Horizon solutions present an ideal complementary networking option to rapidly extend high speed IP services from locations that are already attached to the service provider's network. Key fiber extension applications include:

- Network hardening
- Disaster recovery
- Legacy TDM Services
- Native Ethernet transport

Engineered for the requirements of tomorrow's networks, DragonWave's Horizon solutions are optimized for next generation services and applications. Horizon packet microwave systems deliver up to 4 Gbps per link and offer sub 0.1 millisecond latency on a native Ethernet platform. In addition, intelligent nodal Ring/Mesh switching enables 99.999% availability, for carrier-grade SLAs.

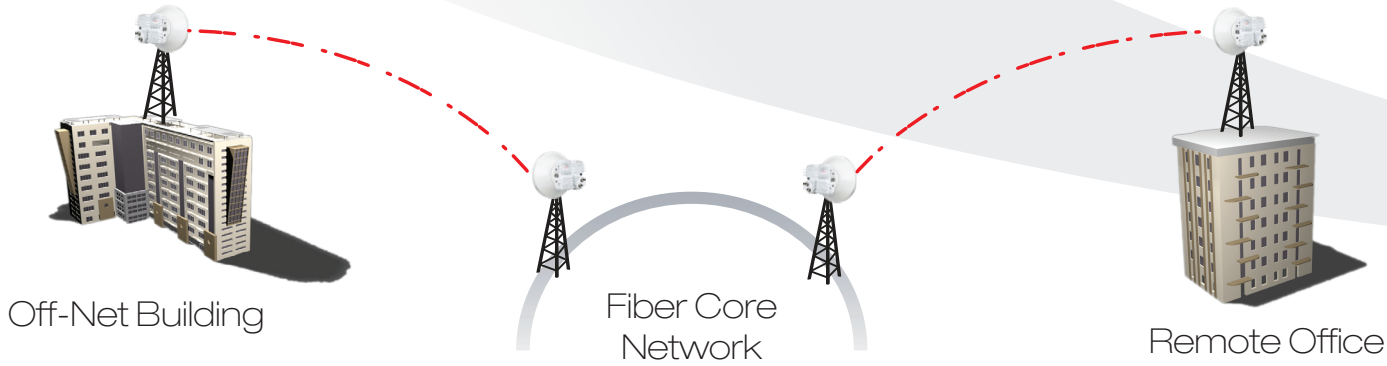
In order to ensure that the network is cost effective from day one, Horizon solutions offer Flex bandwidth, enabling networks to be scaled remotely via software update; a quick and simple, pay-as-you-grow solution. This, combined with all outdoor installation options, minimized spectrum usage and reduced antennas sizes delivers the lowest total cost of ownership solutions available.

Additionally, DragonWave's Service Delivery Unit (SDU) pseudowire solutions support T1/E1 services for legacy traffic types.

Typical customers include:
- IXC's
- CLEC's
- Utilities
- Independent Telcos

Solutions Highlights:

- DragonWave's Flex bandwidth feature enables remote, pay-as-you-grow scalability up to a market leading 4 Gbps
- 99.999% availability options with 1+1 redundancy and intelligent nodal Ring/Mesh switching
- T1/E1and Ethernet service support with Service Delivery Unit pseudowire systems
- Ultra-low latency (0.1 ms) supporting real-time applications such as voice and video over IP
- Ability to offer IP and Ethernet services
- Control over service levels
- All outdoor deployment option with Horizon Compact zero footprint
- Feature rich network management suite including SNMP, Web interface, and CLI
- Gigabit Ethernet interface
- Lowest total cost of ownership



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Application Note

Incentive for Approved DragonWave Customer Case Study

Not all case studies will qualify for this offer. Each application must be reviewed and approved by DragonWave before anything is offered to the customer.

Case Study Criteria:

Customer application must belong to one of the following market segments:

- Public Safety
- State and Local Government
- Rural Cellular
- Defense
- Utility
- Healthcare Facility / Hospital

Customer Input Requirements:

Complete case study input form (one page)
Participate in a brief information gathering conference call
Approve final case study (written by DragonWave)
Total time commitment should be less than 1 hour

Customer Incentive:

Free two-day installation and provisioning certification course

- DragonWave Part Number – S-TRN-IC-CS-2D
- Customer may be required to cover DragonWave T&E ($2,000) for on-site training

Process for Registration:

Send an email to Chris York at DragonWave (cyork@dragonwaveinc.com) with a high level description of the project
When a customer case study is approved by DragonWave Marketing you will receive a SHORT follow-up case study input form
DragonWave will contact the customer to schedule the training once the case study is finalized and approved
T&E can be paid to DragonWave directly or via distribution

DragonWave

New Jersey Turnpike Authority

DragonWave

Improving the Safety and Efficiency of Critical Toll Roads with DragonWave's Packet Microwave for Public Safety

Fast Facts

Customer:
- The New Jersey Turnpike Authority

Solution Provider:
- Pinnacle Wireless Communications

DragonWave Solution & Features:
- Horizon Compact
- Zero-footprint, all-outdoor
- Rapid deployment
- 400 Mbps scalability
- Fully protected links for carrier-grade reliability
- Ultra-low latency
- Advanced QoS support with 8 levels of prioritization

Customer

The New Jersey Turnpike Authority (NJTA) operates the Jersey Turnpike and Garden State Parkway – two of the busiest toll roads in the United States. Combined, these two highways support over 600 million drivers each year and comprise one of the highest volume segments of I-95. Since its opening in 1951, the turnpike has undergone a significant transformation, expanding from 118 miles to 148 miles and growing from 4 lanes to as many as 14 lanes in some areas.

The NJTA is also an important driver of economic activity with current projects employing over 20,000 construction and engineering personnel across the region.

Challenge

The NJTA's mission is to ensure "the safe, efficient movement of people and goods" across their vast highway system. To meet this challenge, the NJTA relies on several public safety systems to monitor traffic conditions, deliver information to drivers and respond to any emergencies rapidly by relaying critical information to first responders.

Keeping with the latest technology, the NJTA recently deployed over 100 high-resolution IP cameras and 220 full-color information signs. A 30 base station WiMAX network was also put in place to meet the new bandwidth requirements of these systems in addition to supporting their highway advisory radio, roadway weather information stations and thousands of traffic detection sensors. Additionally, pseudowire technology was adopted to transport new and legacy traffic over a converged packet network.

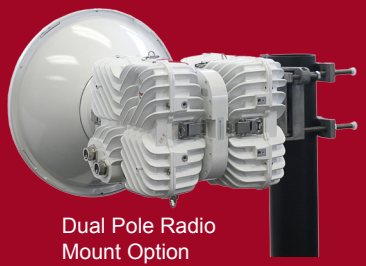
With an advanced access network in place, it became apparent that the existing transport network, including legacy microwave, did not provide the level of capacity or reliability needed to support existing requirements, let alone scale to meet future demands. A fiber network running along the toll routes provided some of the needed connectivity, but the cost to bring fiber to every node in the network – estimated at $100 million – combined with significant delays and traffic interruptions, made a wireless solution a much more attractive option.

"The NJTA's new communications network deployment is the largest of it's kind in the United States. Given the critical nature of the traffic carried over their network, and the increased bandwidth demands of their video delivery and information systems, it was critical that we select a backhaul solution with the highest levels of reliability and scalability.

- Mike Hayford, CEO, Pinnacle Wireless Communications

Case Study

The Horizon Compact, zero-footprint packet microwave system combines the radio and modem in a single integrated all-outdoor package, driving significant installation, cabling and ongoing site leasing savings compared to traditional microwave systems. With its packet based architecture and scalability up to 800 Mbps, the Compact is ready to meet the requirements of even the most demanding public safety organizations.



Dual Pole Radio Mount Option

Horizon Compact

Solution

Working closely with their systems integrator partner, Pinnacle Wireless Communications, the NJTA selected the Horizon Compact high-capacity packet microwave solution from DragonWave.

The Horizon Compact was the only system that met or exceeded all of the key requirements established by the NJTA. Some of the important benefits provided by this packet microwave solution include:

- High Reliability and Redundancy – multiple protection options including 1+1 and ring/mesh support for carrier-grade availability
- High Capacity Packet Architecture – Ethernet based platform is optimized for next-generation IP applications
- Remote Scalability – DragonWave's Flex bandwidth allows for simple remote on-demand scalability
- Rapid Deployment – simple installation without digging up streets or disrupting traffic
- Ultra-low Latency – ensures smooth delivery of real-time applications including voice and video

"Simple installation and operation, advanced radio features, and excellent reliability make the Horizon Compact our preferred packet microwave solution for public safety networks."

– Mike Hayford, CEO, Pinnacle Wireless Communications

Success Story

The NJTA has deployed 40 high-capacity links using DragonWave's Horizon Compact all-outdoor packet microwave system. Critical real-time information is now delivered across their public safety network faster and more reliability than ever before.

The bottom line for the NJTA and the motorists travelling across the Jersey Turnpike and Garden State Parkway is the improvement in safety and efficiency that this new solution brings.

Winnebago County, Illinois

DragonWave

Connecting Public Safety Facilities with Packet Microwave to Deliver Higher Capacity and Improved Reliability at a Lower Cost

Fast Facts

Customer:
- Winnebago County, Illinois

Solution Partner:
- Urban Communications, Inc. (URBANCOM.NET)

Application:
- High capacity redundant packet microwave ring transporting voice, data and video traffic for municipal and public safety facilities

DragonWave Solution & Features:
- Horizon Quantum
- Multi-gigabit capacity
- Ring/mesh support for carrier-grade reliability
- Ultra-low latency
- Advanced QoS support with 8 levels of prioritization

Customer

Part of the Rockford metropolitan area, Winnebago County is the third most populous region in Illinois. In addition to managing the local government and public safety facilities of the county, Winnebago County has an active economic development mandate to promote balanced growth and develop new industry beyond their traditional reliance on the manufacturing sector.

Challenge

Winnebago County operates a communications backbone network interconnecting several critical government and public safety facilities, including a 911 contact center, justice center, county courthouse, and county health department. An aging network infrastructure, comprised of unlicensed microwave and costly leased lines, was not providing the reliability or scalability needed to support the county's increasingly bandwidth intensive video and internet connectivity applications. With plans to upgrade additional facilities with the latest public safety infrastructure and applications, Winnebago County was in need of a significant overhaul to their transport network.

The new solution had to meet several important requirements established by the County. The first priority was to deploy a future-proof solution with scalability beyond 1 Gbps to ensure plenty of extra capacity to support future growth. The critical nature of their public safety network required a highly reliable carrier-grade solution. The County was also under pressure to deploy quickly with minimal disruption to their facilities and staff.

Given the capacity requirements, it was determined that either a fiber, microwave or eband solution would be needed. With links in excess of a mile, the eband solution was eliminated, and the cost and difficulty of adding to existing fiber facilities was considered a non-starter. Additionally, Winnebago County officials were impressed with the path diversity and redundancy that microwave could deliver.

"The demands on our network were increasing significantly every month. The unlicensed microwave systems and leased lines we had in place were becoming a major bottleneck that needed to be addressed quickly and cost effectively. Because much of our traffic is essential to public safety and the court system, we also needed a solution that would provide a high degree of resiliency and redundancy."

- August A. Gentner
  Chief Information Officer, Winnebago County Illinois

Case Study

"Whether deploying a customer link for high speed transit of data, voice or video surveillance, we have found that Dragonwave provides the most robust and reliable solution. The feature set of the Horizon Quantum line is unmatched by any other solution we have seen in the market. As a broadband carrier, designer and operator of private governmental microwave networks, we have found Dragonwave to be one of the most reliable and cost effective technologies we work with."

– **Ed Urban III, President & CEO, Urban Communications, Inc.**

Horizon Quantum

Solution

After a comprehensive evaluation process conducted by Winnebago County's network communications team, DragonWave's Horizon Quantum packet microwave solution was selected for its unique features and unmatched scalability.

High Availability	• Multiple protection options including 1+1 and ring/mesh architecture for carrier-grade availability
Scalability	• The Horizon Quantum with dual channel operation delivers multi-gigabit scalability
Bandwidth Acceleration	• DragonWave's Bandwidth Accelerator – the industry's only wire-speed bulk data compression technology – can boost throughput by up to 150%
Rapid Deployment	• Horizon systems can be deployed in weeks, compared to 6 months or longer for wired solutions
Ultra-low Latency	• Ideal for real-time applications including voice and video

Success Story

Looking for a turnkey provider, Winnebago County worked with Urban Communications, a platinum DragonWave partner, who completed the installation of the solution and is now managing the ongoing operation of the Winnebago County network.

Winnebago County now has more than 50-times the scalability of their previous transport solution. Their advanced packet microwave ring interconnects vital government and public safety facilities including a 911 contact center, justice center, courthouse, economic development center and county health department with expansion to additional locations being explored.

"After comparing several microwave solutions, it became clear to us that the Horizon Quantum delivered the best in terms of capacity, redundancy, reliability and cost per bit. We now have a robust gigabit speed system that rivals the reliability and speed of fiber and was deployed at a fraction of the cost of building out additional fiber on our network.

The thoughtfulness and precision demonstrated by our solutions provider, Urban Communications, demonstrated great acumen in the wireless microwave business segment. The Winnebago County Department of Information and Technology and myself are very pleased with the support and skill provided by Urban Communications."

– August A. Gentner
Chief Information Officer
Winnebago County Illinois

Honolulu Board of Water Supply

DragonWave

DragonWave Packet Microwave Solutions Helping to Ensure Safe and Dependable Water Delivery for Oahu Residents

Fast Facts

Customer:
- Honolulu Board of Water Supply

Solution Provider:
- CACI International

DragonWave Solution & Features:
- Horizon Compact & Horizon Quantum high-capacity packet microwave systems
- Highly resilient all-outdoor deployment options
- Multi-gigabit capacity for critical video surveillance, data communications, SAN mirroring and disaster recovery
- Lowest total cost of ownership transport

Customer

The Honolulu Board of Water Supply (BWS) manages the municipal water resources for Honolulu and the island of Oahu, which is Hawaii's most populous island, sustaining a population approaching one million people.

After years of shortages and improper management of the islands water resources throughout the early twentieth century, the BWS was established in 1929 with an immediate mandate to modernize the water delivery system, meter all water distribution and to seal all faulty, leaking artesian wells in an effort to halt the waste of fresh water. After successfully meeting these goals, the BWS set its focus on ensuring the long-term availability of safe and dependable water service at a reasonable cost.

Challenge

Like many other public safety organizations, the BWS had been adopting new technologies to safeguard its critical infrastructure – including their potentially vulnerable water storage and transportation facilities.

After completing a significant upgrade to high definition surveillance cameras across their many sites, the BWS was in need of a high capacity transport network to handle the extra data traffic generated by these IP-based cameras. Additionally, the board was dealing with increased capacity requirements for other key operations, including: inter-facility links, internet connectivity, field communications, SCADA systems, SAN mirroring and disaster recovery.

The BWS initially evaluated unlicensed microwave systems but found the overall performance of these solutions to be quite poor with low throughput and unreliable service. Leased services were costly and offered only a fraction of the required capacity. Connecting all BWS facilities with fiber would only have been possible using aerial runs at significant cost and with questionable resiliency to the region's many tropical storms. Wireless was clearly the technology of choice but the BWS needed a high capacity, highly reliable multi-gigabit system that could span relatively long distances. Additionally, due to the lack of suitable indoor facilities at many sites, the solution had to offer the benefit of all-outdoor deployment.

"With the increase in security risks after 9/11, the Board of Water Supply was under pressure to modernize all of its surveillance and communications systems to ensure the highest degree of safety and security for its essential infrastructure.

- Daniel Schwarz, Lead Engineer/Project Manager, CACI International

Case Study

HORIZON COMPACT

The Horizon Compact and Horizon Quantum are the most advanced licensed packet microwave systems in the industry, offering unmatched capacity, reliability and deployment flexibility. Simple installation and operations, combined with all-outdoor deployment options, ensure the lowest total cost of ownership.

HORIZON QUANTUM

SOLUTION

The Board of Water Supply (BWS), along with CACI International, evaluated several licensed microwave systems but found that DragonWave's Horizon Compact and Horizon Quantum packet microwave systems delivered the highest capacity and scalability as well as the flexibility of all-outdoor deployment. Additionally, DragonWave's extensive experience with over 75,000 packet microwave units in service, provided assurance that these were highly field-proven solutions.

The Horizon Compact and Quantum offer several unique benefits to the BWS:

High Reliability and Availability	• Field proven, hardened systems with multiple protection and redundancy options for carrier-grade performance
Multi-Gigabit Capacity	• The Horizon Quantum scales to 1.6 Gbps capacity with additional capacity of up to 4 Gbps achievable with DragonWave's Bandwidth Accelerator
All-Outdoor Operation	• Horizon Compact is a single all-outdoor unit offering simple installation and unmatched performance • Horizon Quantum also provides all-outdoor deployment options
Ultra-Low Latency	• Ensures smooth delivery of real-time applications including voice and video
Low Power	• The low power consumption of the Horizon Compact allows the BWS to use solar and battery backup systems

SUCCESS STORY

With its high capacity wireless packet network in place, the BWS now has the scalability and performance to handle all of its current and future requirements. While its previous network could handle basic communications, the DragonWave solution now forms the backbone for all of the Board's critical data transport including: high-definition surveillance video, inter-facility links, internet connectivity, field communications, SCADA communications, SAN mirroring. The new network has resulted in greater operational efficiency and the enablement of a robust disaster recovery system.

The most fundamental benefit of the DragonWave solution has, however, been a vast improvement in the BWS' ability to monitor and manage sensitive water facilities, ensuring a safer and more dependable water distribution service.

> **"DragonWave's packet microwave systems deliver much more capacity than we have seen in any other wireless solution. These systems have also proven to be extremely reliable and resilient in even the most extreme weather conditions."**
>
> – Daniel Schwarz
> Lead Engineer/Project Manager,
> CACI International

DragonWave

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Case Study

Toronto Transit Commission

DragonWave

DragonWave solution improves the Capacity and Reliability of Critical Public Transit Systems

Case Study

Background

Established in 1954, the Toronto Transit Commission (TTC) is a public transport authority that operates subways, buses, streetcars and rapid transit lines in Toronto, Canada.

With average daily ridership exceeding 1.5 million passengers, the TTC operates the third most heavily-used urban mass transit system in North America (behind only the New York City Transit Authority and the Mexico City Metro). The TTC currently oversees 69 subway stations as well as 180 connecting surface routes and employs approximately 11,000 personnel.

Challenge

As the fastest growing urban center in Canada, the City of Toronto's population has grown from 1.1 million to 5.1 million since the TTC was initially established. Over this time, the TTC has continued to evolve and modernize much of its infrastructure. Unfortunately, the incumbent service provider's aging copper plant had become increasingly unreliable, leading to network outages. In addition, these legacy facilities simply could not scale to meet the TTC's communication requirements which include traditional as well as critical public safety communications.

As a result, the TTC commenced a program in 2009 to improve and modernize their communications infrastructure in order to support rapid deployment of public transit applications and to improve the integration of applications and network infrastructure. This new platform had to provide a high level of reliability for their essential systems, including the Communication Information System (CIS) – a real-time, mission-critical Automatic Vehicle Locating tracking system that provides route management and dispatch functions for surface revenue vehicles and is utilized for emergency response, dynamic scheduling, management reporting, and a passenger information system tool.

The TTC was looking for a highly scalable, carrier-grade solution that offered low latency, high security, rapid and flexible deployments, and the lowest total cost of ownership.

The original consideration was to leverage extensive right of way assets, such as subway tunnels, to deploy a fiber network. Yet, despite this advantage, pulling fiber proved to be an extremely costly and time consuming endeavor. This led the TTC to examine a range of wireless solutions including 802.16d WiMAX point-to-point and Ethernet bridges, operating in the 5.4, 5.8 GHz, and public safety 4.9 GHz RF bands as well as licensed and unlicensed microwave Ethernet systems in 18 and 24 GHz spectrum.

Driven by a comprehensive modernization program, the Toronto Transit Commission has selected the most advanced technologies, in both its transportation fleet, and its communications network.

DragonWave Horizon products operate in both licensed and unlicensed radio frequencies between 6 and 38 GHz and deliver the capacity, reliability and latency to support the current and future requirements of enterprise networks.

Horizon Compact Solution

Solution

After a thorough evaluation process, the TTC selected DragonWave's Horizon® Compact packet microwave solution for several 18 GHz licensed links in the 18 GHz band and unlicensed links in the 24 GHz band.

This solution delivered on all of the TTC's essential requirements including:

A Highly Scalable Packet Architecture	• The Horizon Compact remotely scales up to 800 Mbps per link.
Zero Footprint, All-Outdoor Solution	• An all-outdoor design results in simplified operations, reduced cabling, minimized power consumption and a significant reduction in site leasing costs.
Owned and Managed Infrastructure	• Provides the TTC with much greater flexibility than a leased infrastructure from the incumbent.
Rapid Deployment	• The Horizon Compact can be deployed in days, compared to 6 months or longer for wired solutions.
High Reliability	• DragonWave's packet microwave systems can be engineered to deliver 99.999% availability.

By leveraging and combining the capacity of existing optical fiber assets with the ubiquity, reliability and cost-effectiveness of wireless networks, the Commission is creating a "wireless fiber" platform for the support and creation of emerging and future applications and services. Utilizing the strength and benefits of both fiber-optics and microwave backhaul, this network provides all the performance of wired links – at a fraction of the cost.

Success Story

The DragonWave solution represents a significant improvement in the ROI when compared to fully fiber-based solutions, while providing the scalable level of throughput required by the TTC.

After a successful pilot project, the TTC anticipates moving towards full scale deployment of wireless solutions handling mission critical communications.

"The DragonWave wireless Ethernet bridge solution met the TTC's technical, physical and environmental requirements. The all outdoor DragonWave radio design is small and compact – everything in one box, delivering high capacity, scalability, reliability, manageability and maintainability, while reducing cabling and streamlining the delivery of traffic."

- Robert Miller, IT Project Manager at the Toronto Transit Commission

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Palm Springs Unified School District

DragonWave

Enabling Vital Learning Applications With Licensed Packet Microwave

Case Study

Fast Facts

Customer:
- Palm Springs Unified School District

Application:
- High capacity site connectivity for 28 schools and office locations

DragonWave Solution & Features:
- Horizon Duo
- Packet-based architecture
- 1.6 Gbps capacity with pay-as-you-grow scalability
- Advanced ring/mesh support
- Ultra-low latency for video and other real-time applications
- Advanced QoS support with 8 levels of prioritization

Background

The Palm Springs Unified School District (PSUSD) represents over 24,000 students and faculty at 28 school campuses spread across 6 different communities in southern California. This technologically advanced school district first started deploying DragonWave's packet microwave systems in 2005 and has continued to evolve their network to the latest technology in order to meet its surging bandwidth demands.

Challenge

With a mandate to offer the most advanced educational tools available, the school district's communications network is a critical component in delivering advanced applications including:

- Distance learning
- Video conferencing
- High-speed internet access and file sharing
- A host of social networking and other emerging applications

As the school district's tech-savvy student and faculty began adopting these new bandwidth intensive applications, their existing communications links–10 Mbps legacy microwave connections–were no longer up to the task.

The PSUSD needed a scalable, high-capacity, IP-optimized solution to interconnect its 28 sites. The school district also had to deploy in a matter or months in order to provide uninterrupted service for its key distance learning applications. While fiber-based solutions presented an attractive option, it was immediately apparent that the extremely high deployment costs, coupled with long delays, made this an unlikely candidate. Cable and DSL links did not provide the required levels of reliability and scalability. In addition to this, the PSDSD wanted to own and manage its own infrastructure.

DragonWave's licensed packet microwave systems proved to offer the greatest combination of performance, operational simplicity and return on investment for the PSUSD.

"We considered a variety of other possibilities for broadband connectivity: dark fiber, spread spectrum, leased lines, cable modem, digital subscriber line, and other point-to-point wireless systems. The DragonWave solution promised the quickest return on investment (ROI) and the simplest, most cost-effective migration path."

- Rick Corl, Technical Director with the Palm Springs Unified School District

Horizon Duo Solution

DragonWave Horizon products operate in both licensed and unlicensed radio frequencies between 6 and 38 GHz and deliver the capacity, reliability and latency to support the current and future requirements of enterprise networks.

Solution

After its initial deployment, the school district has continued to evolve their network, most recently upgrading to DragonWave's Horizon Duo in order to have the ability to scale up to 1.6 Gbps per link.

The PSUSD currently connects 28 different sites with high-capacity packet microwave links operating in 18 and 23 GHz licensed frequencies. Three hub sites provide aggregation before linking back to the head office.

The DragonWave solution offers several important benefits to the PSUSD:

A Highly Scalable Packet Architecture	• The Horizon Duo remotely scales up to 1.6 Gbps per link.
Owned and Managed Infrastructure	• Non-recurring cost associated with an owned infrastructure was a key consideration to the PSUSD.
Rapid Deployment	• Horizon systems can be deployed in weeks, compared to 6 months or longer for wired solutions.
High Reliability	• DragonWave's packet microwave systems can be engineered to deliver 99.999% availability.
Pay as You Grow	• With FLEX user scalable bandwidth, the PSUSD only pays for the capacity it needs.

Success Story

The PSUSD now possesses one of the most advanced communications networks of any school district in country, giving them the confidence that they can handle any future demands on their network.

> "We have deployed a high-performance, highly reliable infrastructure that can easily be upgraded for the Districts future requirements."
>
> - Rick Corl, Technical Director with the Palm Springs Unified School District

DragonWave

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Clearwire

DragonWave

Enabling a Nationwide 4G Network with North America's Largest Microwave Backhaul Deployment

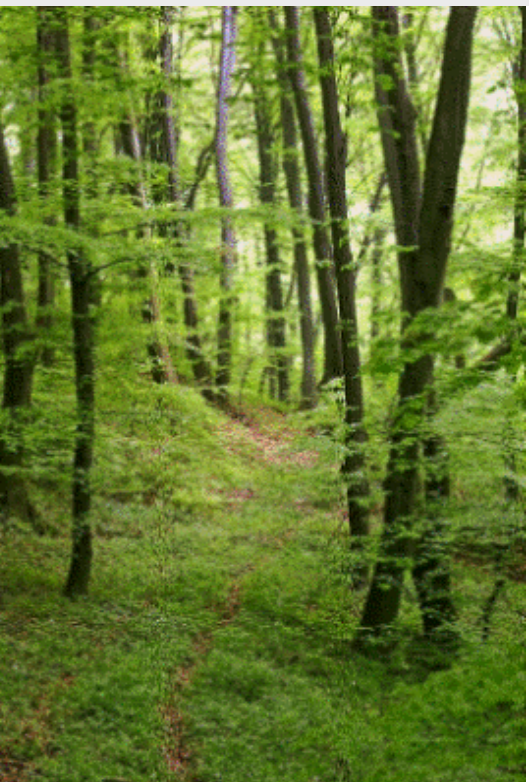
Case Study

Background

A 4G pioneer, Clearwire has deployed the first 4G network in the United States and currently covers over 130 million people in 70 markets.

Clearwire's state-of-the-art flat-IP network enables advanced fixed digital voice and high-speed mobile Internet service at speeds several times faster than 3G networks.

With more than 90% of their backhaul powered by packet microwave, Clearwire has achieved dramatic cost and time to market efficiencies over traditional deployments.



Challenge

Clearwire recognized early on that 4G would be the first wireless technology to enable a true ubiquitous broadband experience, allowing connectivity for a multitude of new high-bandwidth online services and applications that users rely on more and more in their daily life. The need for people to stay connected at high speed, regardless of location, was clear.

In order to meet this demand, Clearwire set out to pioneer the first nationwide 4G network in the United States – and it planned to do so at a much lower cost yet with much greater capacity than traditional cellular networks.

A key enabler of their strategy was the use of a cost effective backhaul solution that was simple to install and manage. Deploying fiber would have resulted in immense capital costs, while leased lines would have meant large monthly expenses, and in many cases would still fail to deliver the capacity that Clearwire needed. It became apparent that a microwave option was the backhaul solution of choice, offering an optimal combination of capacity, reliability and cost efficiency.

Building a greenfield microwave backhaul network afforded Clearwire the flexibility to select microwave radios that met the following key requirements:

- Packet-based, all-IP solution to ensure greater efficiency and compatibility with next generation applications and services
- High capacity and scalability
- Low latency supporting real-time applications including voice and video over IP
- Rapid deployment
- Carrier-grade reliability utilizing Clearwire's advanced ring architecture

An extensive assessment of microwave vendors led Clearwire to select DragonWave as one of its microwave radio suppliers.

"It's what I call the elephant in the room that nobody talks about. The backhaul is probably the highest cost of deploying the network... Anyone who wants to roll out a real wireless broadband network nationwide needs a cheaper solution."

- Dr. John Saw, Chief Technology Officer at Clearwire

HORIZON DUO

DragonWave Horizon products operate in both licensed and unlicensed radio frequencies between 6 and 38 GHz and deliver the capacity, reliability and latency to support the current and future requirements of 4G networks.

HORIZON QUANTIUM

Solution

SOLUTION

Clearwire is currently deploying Horizon® Duo microwave systems in its high-capacity backhaul network ring architecture. Clearwire is also currently evaluating DragonWave's next generation microwave radio and modem products – the Horizon Quantum – for potential deployment in its network. DragonWave's solution offers the following benefits to Clearwire:

- **High Capacity Packet Architecture** – The simplified all-IP Horizon architecture meets the needs of Clearwire's WiMAX network and the applications it will support.
- **Automatic, Remote Scalability** – Dragon-Wave's Flex bandwidth allows capacity to scale automatically based on subscriber growth.
- **Greatly Reduced Operating Costs** – The exclusion of leased lines produces a dramatic reduction in recurring costs for Clearwire.
- **Enabling 4G Applications** – Horizon's low latency and advanced priority queuing, meets the requirements of future 4G applications.

SUCCESS STORY

Clearwire is currently operating the world's largest wireless 4G microwave backhaul network in dozens of markets across the United States. Remarkably, the deployment has cost approximately 50 percent less – both in terms of capital expenditures and time – relative to traditional cellular implementations. This is due primarily to the flat-IP architecture and a backhaul network that is over 90 percent microwave.

Not only has Clearwire shattered existing network cost models, but it has done so with a solution that offers 100 times greater capacity than traditional leased line backhaul networks.

As the service provider expands its network, it will continue to deploy advanced packet microwave backhaul solutions: "...to meet the growing demand for high-speed mobile connectivity, we need increasingly powerful, intelligent and cost-efficient solutions to capitalize on demand for bandwidth intensive and runtime sensitive applications," said Dr. John Saw, Chief Technology Officer at Clearwire.

> **"Recurring costs for backhaul facilities are where the savings are. Once the radio equipment is installed and running, the recurring cost is relatively mild, representing annual fees for microwave licenses."**
>
> - Dr. John Saw, Chief Technology Officer at Clearwire

DragonWave

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Public Safety

What does Public Safety include?

Public Safety applications often fall under “video surveillance” or data infrastructure for organizations servicing the general public (fire, police, military, municipal, county or state)

Industry Trends

Many existing public safety networks require modernization (existing equipment is out of date)
The vast majority of new applications require high capacity Ethernet backhaul
2.4GHz/5.8GHz and 4.9 GHz often fail to meet the backhaul requirements

Who should you be talking to?

Transport and/or Backhaul Engineering
IT staff
Public safety integrators

What applications should you be looking for?

Video backhaul or surveillance
Inter-building connectivity
Upgrades for old analog MW to “digital MW”
Critical infrastructure sensor network backhaul
First responder communications
Wireless mesh network backhaul

Why will they care?

Traditional backhaul methods don’t have enough bandwidth and/or cost too much
Packet Microwave offers high capacity and the lowest total cost of ownership
High Return On Investment (ROI)

Example DragonWave Customers

City of Boston
Port of Baltimore, Port of New Orleans
NY City police department
Honolulu Water District
Cumberland County

DragonWave Value Proposition

#1 licensed MW backhaul vendor in terms of number of links deployed since 2008
Low cost entry point for TDM and/or Ethernet backhaul
Over 1Gbps solution
99.999+ available solutions
256 AES encryption
All outdoor design allows the equipment to be deployed in unique locations very cost effectively

DragonWave

Federal and State Government

What does state and local government include?

DragonWave associates the term “government” with municipalities, counties, state organizations (example Department of Transportation (DOT)) or federal departments (Homeland security)
Government institutions and facilities including schools and hospitals

Industry Trends

Many government networks require modernization (existing equipment is out of date)
The vast majority of new applications require Ethernet backhaul
Traditional TDM applications are not being phased out. This results in a need for T1s

Who should you be talking to?

Transport Engineering, Backhaul Engineering , IT staff
School board communications director/CIO
Hospital communications director/CIO

What applications should you be looking for?

Inter-building connectivity
Video surveillance, 2-way radio solutions
Sensor and mesh network backhaul

Why will they care?

Existing Microwave Equipment is discontinued or is going to be discontinued
High Return On Investment (ROI)
Application migration to IP
Packet microwave offers the lowest Total Cost of Ownership

Example DragonWave Customers

NY, NJ, NH, WA DOT
City of Barrie, NYC
Cumberland County

DragonWave Value Proposition

#1 licensed MW backhaul vendor in terms of number of links deployed since 2008
Low cost entry point for TDM and/or Ethernet backhaul
256 AES encryption
All outdoor design allows the equipment to be deployed in unique locations very cost effectively

Stadard / Requirement	Horizon Compact	Horizon Compact+	Horizon Quantum	Horizon Harmony
TAA	Yes	Yes	Yes	Yes
GSA	Yes	2012 addition	Yes	2012 addition
FIPS 140-2	No	Yes – Q1 2012	Yes – Q1 2012	Yes – Q1 2012

Rural Cellular

What is a Rural Cellco?

Typically servicing Tier III & IV and rural markets
Cellular network comprises of 25 to ~1000 base stations
Often are network affiliates with Verizon, ATT (T-mobile) or Sprint

- Potentially sublease spectrum from one of the tier I players
- Sometimes will have a wireline business unit. Example: Shentel and Shentel Wireless

Rural Cellular Industry Trends:

Vast majority of their BTS are located on copper fed towers
Many companies are trying to keep up with their affiliates service offerings (VZW,ATT,Sprint)
Growing pressure from users as a result of rapid device evolution and adoption
More capacity at a lower cost

Who are the decision makers?

Director of Network Planning or RF Network Backhaul Manager
Microwave Engineer/Interconnection Engineer/Backhaul Engineer

What are the key applications?

2G/3G/3G+/4G cell backhaul
Mobile Switching Centers (MSC) interconnection
Leased line replacement
Unlicensed MW upgrades

Why will they care?

Business case of T1s doesn't work
Adding T1s from the incumbents is painful, slow (3-6months) and sometimes impossible
Fiber is often cost prohibitive due to long spans
Microwave delivers fiber-like performance at a fraction of the cost – not sensitive to distance

Example DragonWave Customers

Shentel (VA)
NorthEast Wireless (Maine)
BlueGrass Cellular
AT&T Alaskcom

DragonWave Value Proposition

#1 licensed MW backhaul vendor in terms of number of links deployed since 2008
Low cost entry point for TDM and/or Ethernet backhaul
Creative packaging the simplifies MW deployments to a handful of commands and a single unit
Wide variety of frequency (6-38GHz), capacities (1 T1 to >1.6Gbps of Ethernet), all indoor, all outdoor of split configuration
Network design support and "first licensed MW" get started packages

DragonWave

DragonWave Product Selection Guide

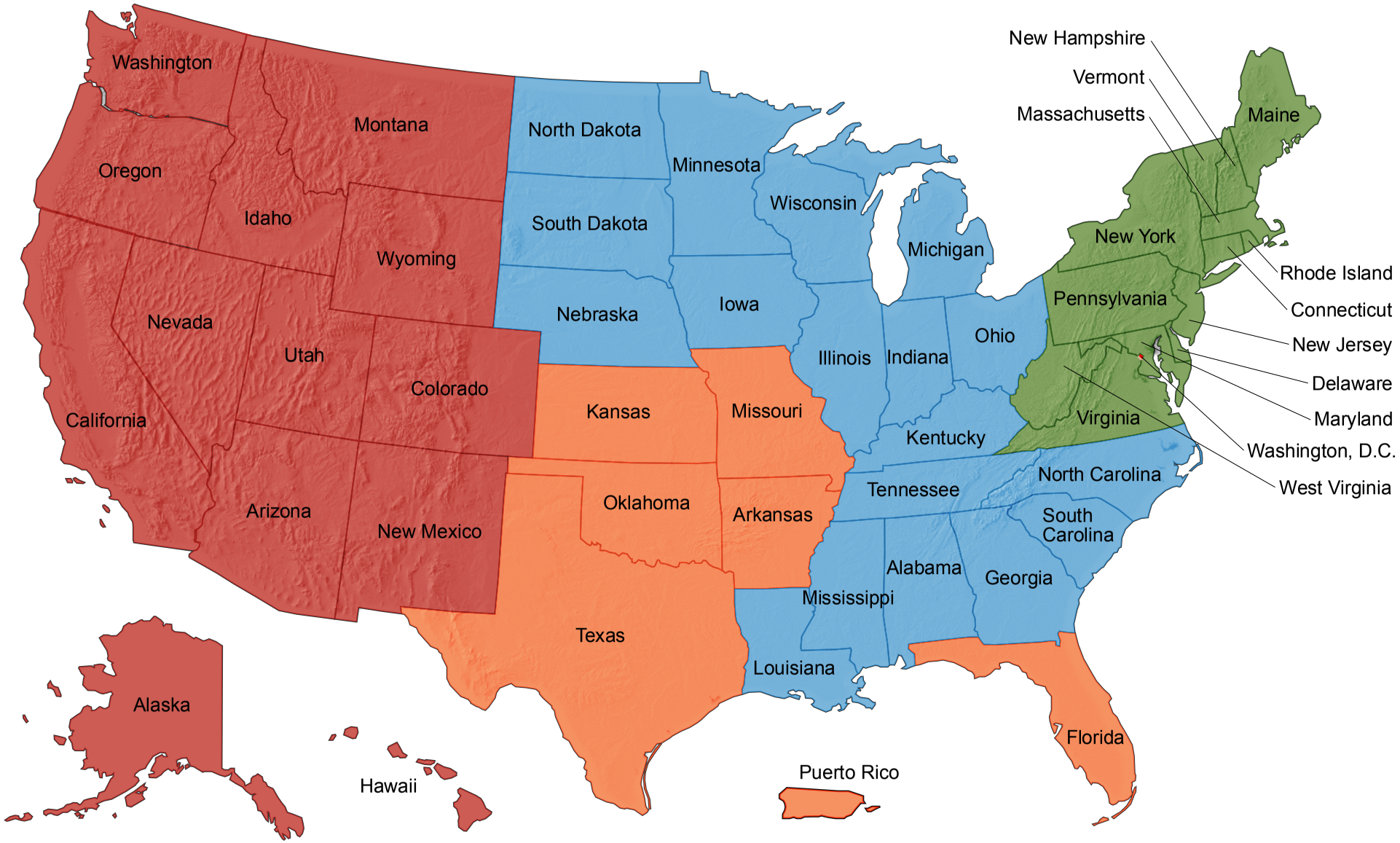
	Horizon Compact+	Horizon Quantum	Harmony (Radio, Hub 800, First Mile 200)
Frequencies	6 to 60GHz	6 to 38GHz	3.5 to 42 GHz
Modulation	QPSK to 2048QAM	QPSK to 1024QAM	QPSK to 256QAM
Architecture	All Outdoor	Split-Mount	All-Outdoor (Packet Only) or Split-Mount (TDM + Packet)
Ethernet Only	YES	YES	NO
Ethernet + TDM	With Fusion	With Fusion	YES
Min / Max Capacity	10 Mbps / 800 Mbps*	50 Mbps / 1.6 Gbps*	10 Mbps / 1 Gbps*
Capacity with Bandwidth Accelerator	Up to 2 Gbps	Up to 4 Gbps	N/A
Ethernet Interfaces	2 x GbE or 1 x GbE + 2 x 10/100bT or 4 x 10/100bT (software configurable)	2 x optical GbE + 6 x 10/100/1000bT	4 x 100/1000BaseT and 2 x SFP Ethernet Interfaces (with IDU)
TDM Interfaces	N/A	N/A	Up to 48 x T1 and 4 x OC-3 TDM ports
Protection	1:0, 1+1 or 2:0	1:0, 1+1, 2:0, 4:0, ring, mesh	1:0, 1+1, 2:0, 2+2 4:0, ring, mesh

*With dual-pole ratio mount

	Horizon S-Series	Horizon E-Series
Frequencies	2.3 to 6 GHz	70/80 GHz
Architecture	All Outdoor	All Outdoor
Ethernet Only	No	Yes
Ethernet + TDM	Yes	With Fusion
Min / Max Capacity	10–100 Mbps (200 Mbps Aggregate)	1 Gbps (Aggregate)
Ethernet Interfaces	10/100BaseT (Additional ports with Optional IDU)	2 x 100/1000Base-T (RJ45) 2 x 1000Base-X (SFP)
TDM interfaces	Up to 16 T1	N/A
Protection	1:0, 1+1 or 2:0	1:0, 1+1 or 2:0

DragonWave Sales Regions

West & South	South	Central and South East	North East and Canada
Sarah Kahahane	Paul Frazier	Paul Lefebvre	Bill Paulsen
Sarah.Kahahane@dragonwaveinc.com	Paul.Frazier@dragonwaveinc.com	Paul.Lefebvre@dragonwaveinc.com	Bill.Paulsen@dragonwaveinc.com
1-650-868-6581	1-972-333-6971	1-613-299-9674	1-613-795-9912



FCC Licensing Process

1. FCC licensing PO is submitted to DragonWave with the following documents:
   - Customer information form
   - Site information form for every site
   - Detailed link information summary
   - Customer contact information

2. Within 5 days of submitting a information package, the end customer will receive a "draft PCN document" to review and approve. If the original information submitted is incomplete the end customer will be contacted for clarification.

3. Once the draft PCN is approved by the end user the PCN will be issued.

4. In approximately 30 days the customer will receive notification that the PCN has been approved and that they must log into their account and pay for the license. Note: From the time this notification is received, the customer only has 5 days to pay for the license or the license will be cancelled.

5. Notify DragonWave that the link has been constructed. Once this is done DragonWave will submit the 601 form to the FCC. This must be completed within 18 months or the license will be canceled.

DragonWave

VAR Program Snapshot

Discount Structure:

	Silver	Gold	Platinum
Discount	**20%**	**30%**	**37%**
Applies to	General system integrators and VARs	Accounts purchasing $100k in DragonWave equipment (~10 links)	Accounts purchasing >$350k in DragonWave equipment

Deal Registration:

The registration process is done via the Deal Registration Application Form (Word document)

Criteria for a successful registered deal:
- Deal must be at least $25k (min of 3 links)
- Completion of the online or word document form

Silver/Gold partners will receive a bonus 5% discount
- Sliver – Discount will be 25%
  - Distribution receives a bonus 3%
- Gold – Discount will be 30%
  - Distribution receives a bonus 3%

Platinum partners will receive a bonus 2% discount
- Platinum – Discount will be 39%
  - Distribution **receives a bonus 2%**

Guidelines:

Deal registration approval is at the sole discretion of DragonWave. General guidelines are:

End customer must not have purchased any DragonWave links within the last 24 months
Must not be an already registered project, or one DragonWave is already in negotiations with
If project goes through a tender process, registration must be done before the start of the tender process
Deal must be at least $25k (min of 3 links)
Deal must be awarded within 6 months of registration
Completion of the online or word document form required
Registration Application must be completed before DragonWave receives the PO
DragonWave to provide acceptance within 5 business days of receipt
Deals that fall outside of the guidelines are subject to approval from PLM and Sales representative

DragonWave

VAR Program Snapshot

Discount Structure:

	Silver	Gold	Platinum
Discount	**20%**	**30%**	**37%**
Applies to	General system integrators and VARs	Accounts purchasing $100k in DragonWave equipment (~10 links)	Accounts purchasing >$350k in DragonWave equipment

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DragonWave

VAR Program Snapshot

Discount Structure:

	Silver	Gold	Platinum
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  - Distribution **receives a bonus 2%**

Guidelines:

Deal registration approval is at the sole discretion of DragonWave. General guidelines are:

End customer must not have purchased any DragonWave links within the last 24 months
Must not be an already registered project, or one DragonWave is already in negotiations with
If project goes through a tender process, registration must be done before the start of the tender process
Deal must be at least $25k (min of 3 links)
Deal must be awarded within 6 months of registration
Completion of the online or word document form required
Registration Application must be completed before DragonWave receives the PO
DragonWave to provide acceptance within 5 business days of receipt
Deals that fall outside of the guidelines are subject to approval from PLM and Sales representative

DragonWave

HORIZON COMPACT+

ALL-OUTDOOR HIGH CAPACITY PACKET MICROWAVE

SERVICE PROVIDERS CAN NOW DO MORE OUTDOORS WITH THE ZERO FOOTPRINT HORIZON COMPACT+ FROM DRAGONWAVE.

This high capacity packet microwave system delivers big performance in a small package. Because the radio and modem are integrated into a single highly compact outdoor unit, Horizon Compact+ is a zero footprint solution – eliminating rack congestion and minimizing collocation space. Equipped with DragonWave's Bandwidth Accelerator technology, the Horizon Compact+ achieves the highest degree of spectral efficiency, delivering more capacity per channel than any other all-outdoor microwave system.

With unmatched radio performance, simple installation and operation, as well as sophisticated remote management capability, the Horizon Compact+ delivers significant lifecycle cost savings for service providers and enterprises alike.

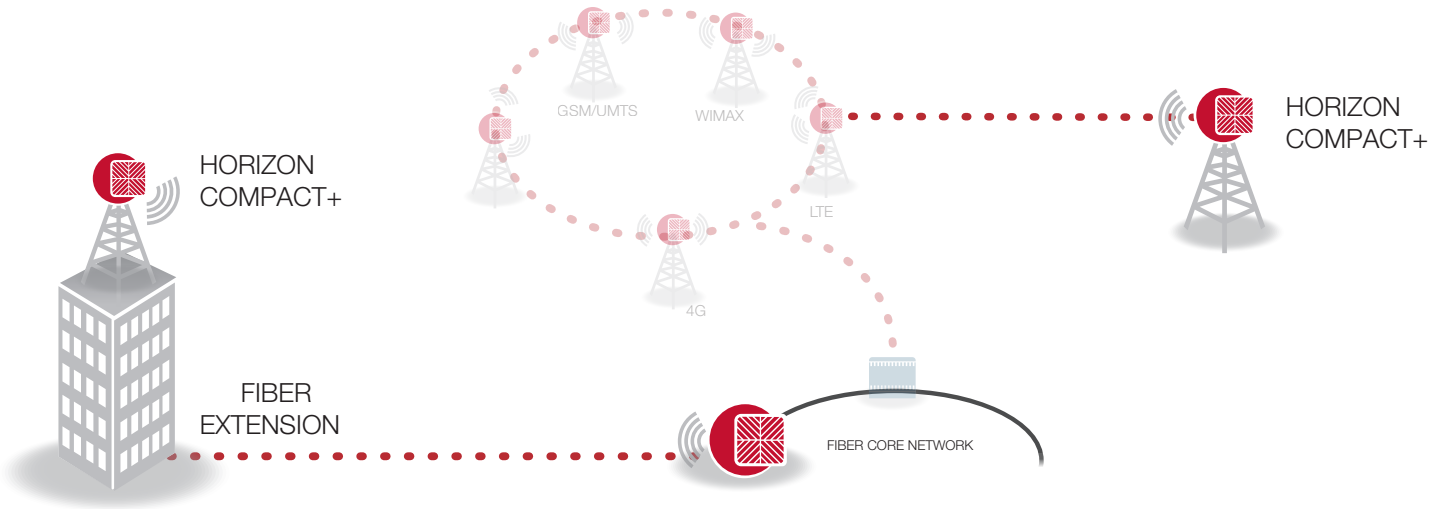
This innovative, carrier-grade packet microwave solution operates in licensed or unlicensed spectrum from 6 to 60 GHz.

SOLUTION HIGHLIGHTS

- Zero footprint, fully integrated all-outdoor unit
- 1 to 2 Gbps capacity with DragonWave's Bandwidth Accelerator
- Industry first XPIC in an all-outdoor microwave system
- Service aware Hitless Automatic Adaptive Modulation (HAAM)
- SyncE support and optimized transport of 1588v2
- Pay-as-you-grow with automatic remote scalability
- Advanced security with integrated 256-bit AES encryption
- Comprehensive Ethernet OAM support (802.3ah, 802.1ag, Y.1731)
- Advanced QoS support with 8 levels of prioritization
- Comprehensive management and provisioning with DragonVision NMS
- Lowest total cost of ownership solution

KEY APPLICATIONS

- Mobile Backhaul
- Leased Line Replacement
- Last Mile Fiber Extension
- Private and Enterprise Networks



Product Sheet

HORIZON COMPACT+

PRODUCT SPECIFICATIONS

FREQUENCIES

6 GHz	FCC/IC/ETSI/ITU
7 GHz	ETSI/ITU/MX
8 GHz	ETSI/ITU
11 GHz	FCC/IC/ETSI/ITU
13 GHz	ETSI/AUS/NZ/ITU
15 GHz	IC/ETSI/AUS/NZ/MX/ITU
18 GHz	FCC/IC /ETSI/AUS/NZ/ITU
23 GHz	FCC/IC/ETSI/AUS/NZ/ITU/MX
24 GHz UL	FCC/IC/ETSI
24 GHz DEMS	FCC/IC
26 GHz	ETSI
28 GHz	FCC/ETSI
32 GHz	ETSI
38 GHz	FCC/ETSI/AUS/NZ/MX
60 GHz	UNLICENSED

FEATURES

Capacity w/Accelerator	Variable from 10 to 1000 Mbps full duplex CIR 2x capacity up to 2 Gbps with Dual Pole Radio Mount (DPRM)
Base Capacity	Variable from 10 to 400 Mbps full duplex CIR 2x capacity up to 800 Mbps with DPRM
Interface	Software selectable: 2xGE or 4 x10/100bT or 1xGE + 2x10/100bT
Latency GigE	120µs @ 256QAM. 50 MHz
Packet Size	64 to 9600 Bytes
Flow Control	Yes
Prioritization	8 levels served by 8 hardware queues, based on 802.1p/q, MPLS, DSCP ToS Bits
Modulations	QPSK to 2048QAM
Modulation Shifting	Yes, Hitless
Loopback	Yes, Radio loopback
XPIC	Yes, enables co-channel cross polarization
Synchronization	Synchronous Ethernet ready
Encryption	Integrated 256-bit AES encryption

POWER

Input	-40.5 VDC to -56 VDC or +40.5 VDC to +56 VDC	
Optional Adapter	110/240 VAC	
Consumption*	6 GHz	55W
	7/8 GHz	80W
	13/15 GHz	47W
	18 GHz	49W
	23 GHz	48W
	38 GHz	43W

*Measured at the radio with 30M of CAT5E cable and 48V input to PonE.

MECHANICAL

Radio/Modem (without antenna)	10.2 cm x 24.3 cm x 22.1 cm; 3.4 kg 4" x 9.6" x 8.7"; 7.5 lbs
Power Adapter	15 cm x 7 cm x 3.5 cm 5.91" x 2.76" x 1.38"
Antenna Wind Loading	112 kph (70 mph) operational, 200 kph (125 mph) survival
Antenna Mount Adjustment	+/- 45° Azimuth; +/- 22° Elevation

CONNECTIONS

Power	-48V, Power on Ethernet
Payload (+ Inband NMS)	RJ45 or optical LC
NMS (when out-of-band)	RJ45

NETWORK MANAGEMENT (NMS)

Alarm Management	SNMP Traps, Enterprise MIB
NMS Compatibility	Any SNMP based network manager; SNMP v1, v2c and v3
Security	3 Level Authentication
EMS	Web Based Management, SSL HTTP, SSH, Radius, Telnet

ENVIRONMENTAL

Operating Temperature	-40°C to + 60°C (-40°F to +140° F)
Humidity	100 % Condensing
Altitude	4500 m (14,760 ft)
Water Tightness	Nema4X, IP66 (directed hose test)
Operational Shock	ETSI 300-019-1-4; 5g 11ms
Operational Vibration	ETSI 300-019-1-4 Class 4m5, NEBS GR-63
Earthquake	NEBS GR-63

82-000057-01-13

DragonWave

www.dragonwaveinc.com

HORIZON COMPACT

HIGH CAPACITY PACKET MICROWAVE SYSTEM

GET THE HIGH PERFORMANCE TO SUPPORT NEXT-GENERATION NETWORK APPLICATIONS AND SERVICES IN THIS SIMPLE TO DEPLOY AND OPERATE ALL-OUTDOOR SYSTEM.

Horizon Compact is a high-capacity, packet microwave system with improved efficiency and simplified operations. Because the radio and modem are integrated into a single outdoor unit, Horizon Compact is a zero footprint solution – eliminating rack congestion and minimizing collocation space.

Horizon Compact's 800 Mbps capacity per link, Hitless Automatic Adaptive Modulation, and ring/mesh support mean maximum performance and throughput. Add simple installation and operation, as well as sophisticated remote management and troubleshooting, and you gain significant lifecycle cost savings.

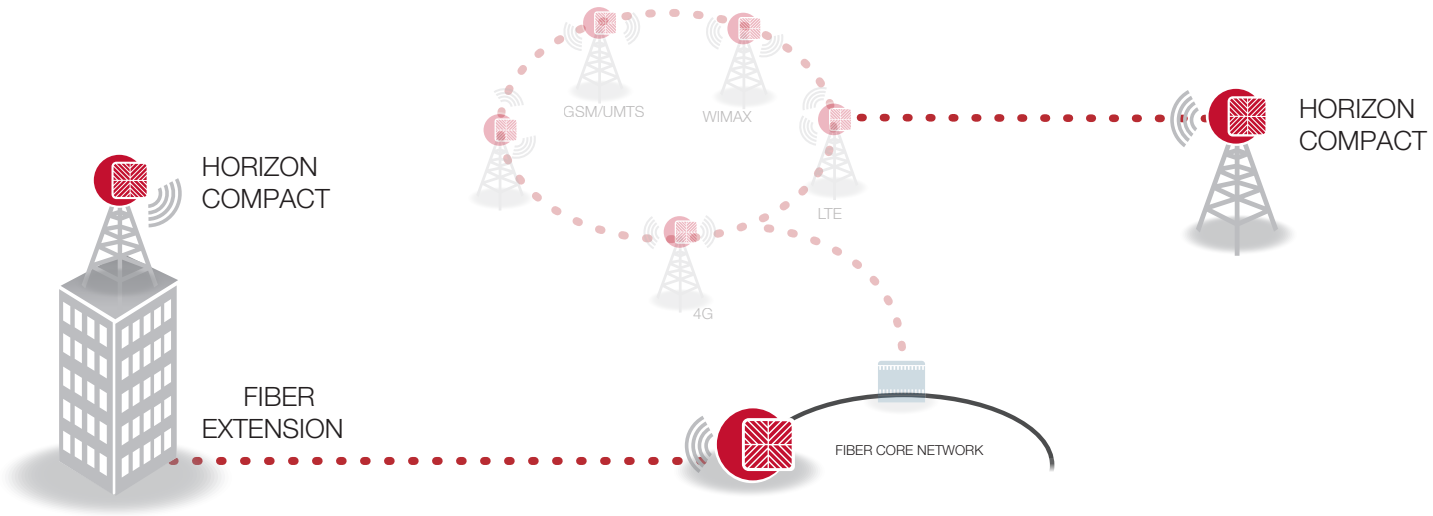
This highly integrated, carrier-grade packet microwave solution operates in licensed or unlicensed spectrum from 6 to 38 GHz.

SOLUTION HIGHLIGHTS

- Zero footprint, fully integrated all-outdoor unit
- 400 Mbps per radio, 800 Mbps with dual radio mount
- Service aware Hitless Automatic Adaptive Modulation (HAAM)
- Pay-as-you-grow with automatic remote scalability
- Comprehensive Ethernet OAM support (802.3ah, 802.1ag, Y.1731)
- Advanced QoS support with multiple levels of prioritization
- Comprehensive management and provisioning with DragonVision NMS
- Lowest total cost of ownership solution
- 6 to 38 GHz frequency support

KEY APPLICATIONS

- Mobile Backhaul
- Leased Line Replacement
- Last Mile Fiber Extension
- Private and Enterprise Networks



FREQUENCIES

6 GHz	FCC/IC/ETSI/ITU
7 GHz	ETSI/ITU/MX
8 GHz	ETSI/ITU
11 GHz	FCC/IC/ETSI/ITU
13 GHz	ETSI/AUS/NZ/ITU
15 GHz	IC/ETSI/AUS/NZ/MX/ITU
18 GHz	FCC/IC /ETSI/AUS/NZ/ITU
23 GHz	FCC/IC/ETSI/AUS/NZ/ITU/MX
24 GHz UL	FCC/IC/ETSI
24 GHz DEMS	FCC/IC
26 GHz	ETSI
28 GHz	FCC/ETSI
32 GHz	ETSI
38 GHz	FCC/ETSI/AUS/NZ/MX

POWER

Input	-40.5 VDC to -56 VDC
Optional Adapter	110/240 VAC
Consumption	25 Watts (per link end) 54 Watts High Power (per link end)

MECHANICAL

Radio/Modem (without antenna)	12 cm x 23.6 cm x 23.6 cm; 5.2 kg 4.75 in x 9.3 in x 9.3 in; 11.5 lbs
Power Adapter	15 cm x 7 cm x 3.5 cm 5.91 in x 2.76 in x 1.38 in
Antenna Wind Loading	112 kph (70 mph) Operational, 200 kph (125 mph) Survival
Antenna Mount Adjustment	+/- 45° Azimuth; +/- 22° Elevation

CONNECTIONS

Power	-48V, Power on Ethernet
Payload (+ Inband NMS)	RJ45 or optical LC
NMS (when out-of-band)	RJ45
CTL Port	RJ45 (RS232)

NETWORK MANAGEMENT (NMS)

Alarm Management	SNMP Traps, Enterprise MIB
NMS Compatibility	any SNMP based network manager; SNMP v1, v2c and v3
Security	3 Level Authentication
EMS	Web Based Management, SSL HTTP, SSH, Radius, Telnet

ENVIRONMENTAL

Operating Temperature STD Pwr With heat shield	-40°C to + 50°C (-40°F to +122° F) -40°C to + 60°C (-40°F to +140° F)
Humidity	100 % Condensing
Altitude	4500 m (14,760 ft)
Water Tightness	Nema4X, IP56 (directed hose test)
Operational Shock	ETSI 300-019-1-4; 5g 11ms
Operational Vibration	ETSI 300-019-1-4 Class 4m5, NEBS GR-63
Earthquake	NEBS GR-63

DragonWave
www.dragonwaveinc.com

HORIZON QUANTUM

HIGH CAPACITY PACKET MICROWAVE

THE HORIZON QUANTUM ALLOWS SERVICE PROVIDERS AND ENTERPRISES TO SATISFY RAPIDLY INCREASING CAPACITY NEEDS IN A SIMPLE, COST EFFECTIVE AND TIMELY FASHION.

Delivering from 2 to 4 Gbps per link, Horizon Quantum represents the next generation in packet microwave technology and sets a new benchmark for performance. With dual-channel capability, this split-mount system is a step change in spectral efficiency, capacity, nodal intelligence, and operational simplicity; all while occupying only half a rack unit and consuming the lowest power per bit of any solution today. In addition, the Horizon Quantum's integrated switching means that it can provide aggregation and restoration in a single unit.

With this level of performance – in a packet microwave system that is remarkably simple to install and operate – operators can now avoid the high cost and long delays associated with fiber deployments, yet achieve the capacity and reliability they require for all of their future applications and services.

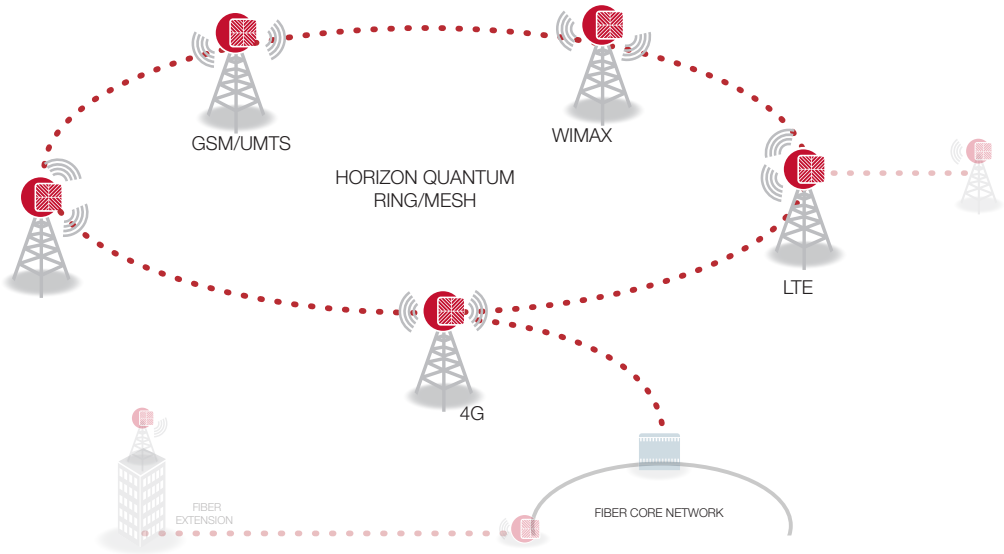
This Horizon Quantum, carrier-grade packet microwave system operates in licensed spectrum from 6 to 38 GHz.

SOLUTION HIGHLIGHTS

- 2 to 4 Gbps capacity with DragonWave's Bandwidth Accelerator
- 8 GbE ports with intelligent nodal ring and mesh switching for carrier-grade reliability
- Highest spectral efficiency
- Advanced radio features including service aware Hitless Automatic Adaptive Modulation (HAAM) and XPIC
- SyncE support and optimized transport of 1588v2
- Pay-as-you-grow with automatic remote scalability
- Advanced security with integrated 256-bit AES encryption
- Comprehensive Ethernet OAM support (802.3ah, 802.1ag, Y.1731)
- Advanced QoS support with 8 levels of prioritization
- Comprehensive management and provisioning with DragonVision NMS
- Lowest total cost of ownership solution

KEY APPLICATIONS

- Mobile Backhaul
- Leased Line Replacement
- Last Mile Fiber Extension
- Private and Enterprise Networks



HORIZON QUANTUM

PRODUCT SPECIFICATIONS

FREQUENCIES

6 GHz	FCC/IC/ETSI/ITU
7 GHz	ETSI/ITU/MX
8 GHZ	ETSI/ITU
11 GHz	FCC/IC/ETSI/ITU
13 GHz	ETSI/AUS/NZ/ITU
15 GHz	IC/ETSI/AUS/NZ/MX/ITU
18 GHz	FCC/IC /ETSI/AUS/NZ/ITU
23 GHz	FCC/IC/ETSI/AUS/NZ/ITU/MX
24 GHz UL	FCC/IC/ETSI
24 GHz DEMS	FCC/IC
26 GHz	ETSI
28 GHz	FCC/ETSI
38 GHz	FCC/ETSI/AUS/NZ/MX

FEATURES

Capacity w/Accelerator	Variable from 10 to 2000 Mbps full duplex CIR 2x capacity up to 4 Gbps with Dual Pole Radio Mount (DPRM)
Base Capacity	Variable from 10 to 800 Mbps full duplex CIR 2x capacity up to 1.6 Gbps with DPRM
Interface	6X 10/100/1000bT + 2 SFP Ports
Packet Size	64 to 9600 Bytes
Flow Control	Yes
Prioritization	8 levels served by 4 queues, based on 802.1p/q, MPLS, DSCP ToS Bits
Modulations	QPSK to 1024QAM
Modulation Shifting	Yes: Hitless
Loopback	Yes: IF, Modem, Microwave loopback
XPIC	Yes, enables Co-Channel Cross Polarization
Synchronization	SynchE support and optimized transport of 1588v2
Encryption	Integrated 256-bit AES encyption

POWER

Input	-36 VDC to -60 VDC or +36 VDC to +60 VDC
Optional Adapter	110/240 VAC
Typical Consumption:	
Single Channel, Single Radio	91 Watts
Dual Channel, Single Radio	105 Watts
Dual Channel, Dual Radio	146 Watts

MECHANICAL

Modem (IDU)	4.3 cm x 32 cm x 22 cm; 2.4 kg 1.7 in x 12.75 in x 8.6 in; 5.3 lbs
Radio (without antenna)	20 cm x 20 cm x 9 cm; 3.2 kg 7.8” x 7.8” x 3.6”; 7 lbs
Antenna Wind Loading	110 kph (70 mph) Operational 200 kph (125 mph) Survival
Antenna Mount Adjustment	+/- 45° Azimuth; +/- 22° Elevation

CONNECTIONS

Power	Dual Feed 48V
Data	6XRJ45 (100/1000bT) + 2XSFP
IF Cable	N-Type female connector
CTL Port	RJ45 (RS232)

NETWORK MANAGEMENT (NMS)

Management Access	In or out of band
Alarm Management	SNMP Traps, Enterprise MIB
NMS Compatibility	DragonVision NMS; any SNMP based network manager; SNMP v1, v2c and v3
Security	3 Level Authentication, Radius, SSL, SSH
EMS	Web based management system
Ethernet OAM Support	802.3ah, 802.1ag, Y.1731
Logging	Syslog, alarms logging, bandwidth logging and performance logging

ENVIRONMENTAL

Radio Operating Temp. Std Power & Solar Shield	-40°C to +60°C (-40°F to +140° F)
IDU Operating Temp.	0°C to +50°C (32°F to +122° F)
Extended IDU Operating Temp.	-40°C to +60°C (-40°F to +140° F)
ODU Humidity	100 % Condensing
IDU Humidity	95% Non-Condensing
Altitude	4500 m (14,760 ft)
NEB-3 Compliant	Yes

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DragonWave

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HORIZON E-SERIES

GIGABIT ETHERNET WIRELESS SOLUTION

DELIVER MORE CAPACITY AT A LOWER COST USING LICENSED E-BAND SPECTRUM WITH THE HORIZON E-SERIES FROM DRAGONWAVE.

Operating in the uncongested 71-76 GHz licensed E-Band frequencies, the Horizon E-Series is a next generation all-outdoor, millimeter-wave Ethernet backhaul system that can deliver up to 1 Gbps capacity. The Horizon E-Series offers advanced networking capabilities for carrier-grade operation and enhanced Adaptive Bandwidth, Coding & Modulation to ensure maximum spectral efficiency.

With its unique all-silicon design, the E-Series has fewer components, resulting in greater reliability and pricing that is up to 80% lower than comparable radio systems. This light-weight zero-footprint solution offers flexible deployment options and is simple to install and manage.

Designed with strenuous carrier wireless backhaul demands in mind, the Horizon E-Series is equally capable in mobile backhaul, enterprise or Ethernet service provider network applications.

SOLUTION HIGHLIGHTS

- Up to 1 Gbps throughput
- 71-76 GHz licensed E-band spectrum
- Advanced hitless/errorless Adaptive Bandwidth, Coding and Modulation (ABCM)
- Bandwidth-aware QoS, service management and OAM
- Advanced timing over packet handling (SyncE, 1588v2)
- Carrier class availability and resiliency with advanced ring, mesh and link aggregation (1+1, 2+0)
- 256-bit AES encryption
- Green design with ultra low power consumption and zero-footprint
- Use a single cable for both power and data with PoE
- All-outdoor solution is simple to install and maintain

KEY APPLICATIONS

- Microcellular Networks
- Mobile Backhaul
- Leased Line Replacement
- Last Mile Fiber Extension
- Private and Enterprise Networks

CAPACITY

		250 MHz Channel Mode			500 MHz Channel Mode		
Mode	Modulation	Bandwidth (MHz)	L1 Rate (Mbps) (1,2)		Bandwidth (MHz)	L1 Rate (Mbps) (1,2)	
			Minimum	Maximum		Maximum	Minimum
0	QAM 64	250	514	477	500	1028	955
1	QAM 16	250	349	321	500	699	642
2	QPSK	250	182	160	500	365	320
3	QPSK	125	42	39	250	85	79
4	QPSK	62.5	10	9	125	20	19

Notes:
(1) Aggregated capacity. Capacity may be divided at an downstream-upstream ratio of: 50%-50%, 75%-25% or 90%-10%.
(2) Capacity increases when divided asymmetrically (75%-25%, 90%-10%).
(3) Capacity varies according to packet size.

RADIO SPECIFICATIONS

Standards	ETSI, FCC
Operating Frequency Range	71-76 GHz
Air Interface	TDD, OFDM
Channel Size	500 MHz, 250 MHz
RF Channel Arrangement	500 MHz: 71375 + n x 500 MHz, n=0…8 250 MHz: 71250 + n x 250 MHz, n=0...18
RF Channel Selection	Via EMS/NMS/CLI
Transmit Power (typical)	+5 dBm
Adaptive Bandwidth, Coding and Modulation Dynamic Range	21 dB
Typical link distance (1)	Up to 2,500 m. (8,200 ft.)

ETHERNET INTERFACES

Supported Ethernet Interfaces	2 x 100/1000Base-T (RJ45) 2 x 1000Base-X (SFP)
Supported SFP Types	1000Base-LX (1310 nm), SX (850 nm)

CARRIER ETHERNET FUNCTIONALITY

Latency over the radio link (typical) (2)	350 µsec @ highest mode of operation
Jumbo frames support	Up to 9,200 Bytes
Carrier Ethernet Switch	4096 active VLANs MAC address learning with 4K MAC addresses IEEE 802.1ad Provider Bridge (QinQ) IEEE 802.1d Transparent Bridging IEEE 802.1ag Ethernet Service OAM (CFM) ITU-T Y.1731 OAM functions and mechanisms for Ethernet based networks IEEE 802.3ah Ethernet Link OAM (EFM) ITU-T G. 8032 Ethernet Ring Protection ITU-T G. 8031 Ethernet Linear Protection IEEE 802.3ad Link Aggregation Link state propagation
Quality of Service	Advanced CoS classification and prioritization Per interface CoS based packet queuing / buffering (8 CoS served by 8 queues) Flexible scheduling schemes (SP/WFQ/ Hybrid) Traffic shaping Traffic policing
Synchronization	G.8262, G.8264 Synchronous Ethernet IEEE 1588v.2 Timing-over-packet optimized transport
Performance Monitoring	Per Ethernet port statistics Per VLAN statistics Per queue statistics Enhanced radio Ethernet statistics
Encryption	AES 128, AES 256

NETWORK MANAGEMENT, DIAGNOSTICS, STATUS AND ALARMS

Network Management System	DragonVision NMS
NMS Interface Protocol	SNMP v1/v2/v3
Element Management	Web-based EMS, CLI
Management Channels & Protocols	SSH, HTTPS
Authentication, Authorization & Accounting	User access control SYSLOG
Management Interface	Via the Ethernet interfaces
RSSI Indication	Accurate power reading available at ODU and EMS

MECHANICAL

Dimensions		
ODU (H x W x D):	24.5cm x 22.5cm x 5cm	
Antennas:	(9.7” x 8.9” x 2”)	
26 cm, 10.3” (Dia. x Depth):	26 cm x 10 cm; (10.3” x 3.9”)	
31 cm, 12.2” (Dia. x Depth):	31 cm x 11 cm; (12.2” x 4.3”)	
65 cm, 25.6” (Dia. x Depth):	65 cm x 37 cm; (25.6” x 14.6”)	
Weights:		
ODU+ antenna (26 cm, 10.3”):	3 kg	(6.6 lbs)
ODU+ antenna (31 cm, 12.2”):	3.5 kg	(7.7 lbs)
ODU:	2 kg	(4.4 lbs)
Antenna (26 cm, 10.3”):	1 kg	(2.2 lbs)
Antenna (31 cm, 12.2”):	1.5 kg	(3.3 lbs)
Antenna (65 cm, 25.6”):	8 kg	(18 lbs)
Mounting kit	EH-MK-1ft (26 / 31 cm antenna)	

ENVIRONMENTAL

Operating Temperature	-45° to +55°C (-49° to +131°F)
Relative Humidity	0 to 100%
Ingress Protection Rating	IP67
Altitude	4,500 m. (14,765 ft.)

POWER INPUT AND CONSUMPTION

Standard Input	±48 VDC, ±24 VDC
DC Input Range	±21 to ±57 VDC
Power over Ethernet Input	IEEE 802.3at-2009
Power Consumption (typical)	25W

STANDARD COMPLIANCE

CE	CE Marked
RF	EN 302 217-3 1.3.1, FCC 47 CFR part 101:2009
EMC	EN 301 489-4, FCC 47 CFR part 15
Safety	UL 60950
Operation	EN 300 019-1-4 Class 4.1E
Storage	EN 300 019-1-1 Class 1.2
Transportation	EN 300 019-1-2 Class 2.2

Notes:
(1) Max. 4,500 m. (max. 14,765 ft.)
(2) Latency varies according to packet size and load

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HORIZON S-SERIES

ALL-OUTDOOR SUB-6 GHZ TDD MICROWAVE SYSTEM

THIS ALL-OUTDOOR BACKHAUL SOLUTION DELIVERS NON-LINE-OF-SIGHT PERFORMANCE IN SUB-6 GHZ FREQUENCIES.

DragonWave's Horizon S-Series packet microwave systems deliver up to 100 Mbps full duplex (200 Mbps aggregate) capacity and long range performance operating in licensed and licensed-exempt frequencies. Supported bands include: 2.302-2.472, 2.496-2.700, 3.300-3.800 and 4.400-6.060 GHz. When combined with an optional indoor unit, this highly robust system provides Ethernet and Native TDM (up to 16 E1s/T1s) to enable a seamless migration from TDM to all-IP networks.

The Horizon S-Series support multiple frequency bands on the same platform, providing operators with the flexibility to select the optimal transmission band. Systems incorporate state-of-the-art technologies including MIMO and OFDM. Unique air interface capabilities secure performance optimization, enabling high spectral efficiency and robust performance in dense radio environments and multipath conditions. In addition, this system supports advanced networking capabilities such as QoS, VLAN Tagging / Un-Tagging and Q in Q.

Supporting multiple architecture options, the Horizon S-Series can be deployed in point-to-point and multiple point-to-point topologies, employing TDD synchronization between co-located links and GPS based synchronization between remote links. To ensure maximum service availability in case of equipment failure or link drop, Horizon radios incorporate built-in 1+1 redundancy and ring protection functionality.

The Horizon S-Series systems comply with worldwide regulations and standards and are deployed globally by leading carriers, service providers and public and private networks requiring high-capacity connectivity.

SOLUTION HIGHLIGHTS

- Up to 100 Mbps full duplex (200 Mbps asynchronous)
- Optional integrated antenna
- Long range – up to 120 km/75 miles
- Asymmetric capacity; fixed or dynamic channel allocation
- Extremely robust in harsh weather conditions
- Operating in non-line-of-sight and dense environments
- Advanced OFDM & MIMO technologies
- QoS and VLAN capabilities
- Carrier-grade Ethernet service protection through 1+1 and ring topology
- Gigabit Ethernet support
- FIPS 197 compliant AES-128 encrypted traffic
- Low (typical) Latency <3msec
- Extremely simple to install and maintain

KEY APPLICATIONS

- Microcellular Networks
- Mobile Backhaul
- Leased Line Replacement
- Last Mile Fiber Extension
- Private and Enterprise Networks

Horizon S-Series Integrated Antenna

Horizon S-Series Back

CONFIGURATION

Architecture	ODU: Outdoor Unit with Integrated Antenna or Connectorized Unit for External Antenna
IDU to ODU Interface	Outdoor CAT-5e cable; Maximum cable length: 100m for 100BaseT and 75m for 1000BaseT

RADIO

Range	Up to 120 Km / 75 miles
Frequency Bands	2.302 - 2.472 GHz (S100) 2.496 - 2.700 GHz (S100) 3.300 - 3.800 GHz (S100) 4.400 - 6.060 GHz (S25 & S100)
Channel Bandwidth	S25: 5/10/20 MHz S100: 5/10/20/40 MHz
Max Throughput	S25: 25 Mbps Full Duplex / 50 Mbps Asymmetric S100: 100 Mbps Full Duplex / 200 Mbps Asymmetric
Maximum Tx Power	25 dBm @ 2.49-2.7; 3.3-3.8; 4.4-6.06 GHz 26 dBm @ 2.3-2.47 GHz
Adaptive Modulation & Coding	Supported
Automatic Channel Selection	Supported
Bandwidth Allocation	Symmetric or Asymmetric
Diversity	Polarization and Spatial diversity supported
Spectrum View	Built-in spectrum analyzer
Duplex Technology	TDD
Radio Modes	MIMO/Diversity/Single
Encryption	AES-128 (FIPS 197 compliant)
TDD Synchronization	Intra-site and inter-site GPS based

ETHERNET INTERFACE

Number of Ports	IDU-C and IDU-E: 2 ports 10/100BaseT and 10/100/1000BaseT in IDU-C E0 PoE Device: 1 port 10/100BaseT or 10/100/1000BaseT or 16xT1/E1
Connector	RJ-45
SFP Port	Supported in IDU-C type FE
Service Protection	Built in support: 1+1 and Ring topology

ETHERNET BRIDGING

VLAN	802.1Q, 802.1P and QinQ Tagging
QoS	4 levels supported
Maximum Frame Size	2048 bytes
Latency	< 3msec

POWER

Power Feeding	-20 to -60 VDC (dual feed); 100-240 VAC, 50/60 Hz
Power Consumption	20-35W (ODU+IDU); 5-15W (ODU+PoE device)

TDM INTERFACE

Number of Ports	Up to 16 E1s/T1s
Framing	Unframed (Transparent)
Timing	Independent timing per port, Tx and Rx
Connector	RJ-45
Standards Compliance	ITU-T G.703, G.826
Line Code	E1: HDB3 @ 2.048 Mbps; T1: B8ZS/AMI @ 1.544 Mbps
Latency	Configurable: 5-20 msec (default: 8 msec)
Impedance	E1: 120Ω, balanced; T1: 100Ω, balanced
Jitter & Wander	According to ITU-T G.823, G.824

MANAGEMENT

Protocol	SNMP and Telnet

MECHANICAL

ODU with Integrated Antenna	37.1cm(w) x 37.1cm(h) x 11cm(d); 3.5 kg / 7 lbs
ODU Connectorized (Embedded antenna)	19.5cm(w) x 27.0cm(h) x 8.0cm(d); 1.8 kg / 3.6 lbs
Optional IDU	43.6cm(w) x 4.4cm(h) x 21cm(d); 1.5 kg / 3.3 lbs

ENVIRONMENTAL

Operating Temperatures	ODU: -35°C to 60°C / -31°F to 140°F; IDU: 0°C to 50°C / 32°F to 122°F
Humidity	ODU: 100% condensing, IP67 (totally protected against dust and immersion up to 1m); IDU-C: 90% non-condensing

RADIO REGULATIONS

FCC	47CFR, Part 15 Subparts C&E; Part 90 Subpart Y 47CFR, Part 27
IC (Canada)	RSS-210, RSS-111 RSS 192, issue-3
EN (ETSI)	300 328; 301 893; 302 502, 302_326-2,
WPC (India)	GSR-38
MII (China)	5.8 GHz Band Regulation

SAFETY

FCC/IC (cTUVus)	UL 60950-1, UL 60950-22, CAN/CSA C22.2 60950-1, CAN/CSA C22.2 60950-22
ETSI	EN/IEC 60950-1, EN/IEC 60950-22

EMC

FCC	47CFR Class B, Part15, Subpart B
ETSI	EN 300 386, EN 301 489-1, EN 301 489-4
CAN/CSA	CISPR 22-04 Class B
AS/NZS	CISPR 22:2004 Class B
MII (China)	5.8 GHz Band Regulation

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AVENUE LINK

MICROCELLULAR BACKHAUL

SOLVE YOUR MICROCELL BACKHAUL CHALLENGE WITH THE AVENUE LINK – AN INTEGRATED ZONING-FRIENDLY PACKET MICROWAVE SOLUTION OPTIMIZED FOR URBAN ENVIRONMENTS.

The Avenue Link is an all-outdoor microcellular backhaul solution that combines a high capacity packet microwave system, flat-mini antenna and system cover in a small, zoning-optimized form factor. The aesthetic design and physical specifications of the Avenue Link ensure compliance with strict city-zoning regulations and ensure that the unit blends perfectly into the urban landscape.

Engineered to provide the greatest flexibility for mobile operators, the Avenue Link can be deployed to any number of structures including street lamps, traffic light poles, or building sides. Installation is fast, simple and easily managed by a single installer without the use of heavy equipment, ensuring virtually no disruption to city operations.

The Avenue Link can deliver 400 Mbps per hop and up to 1 Gbps with DragonWave's Bandwidth Accelerator – the industry's only wire-speed bulk data compression technology.

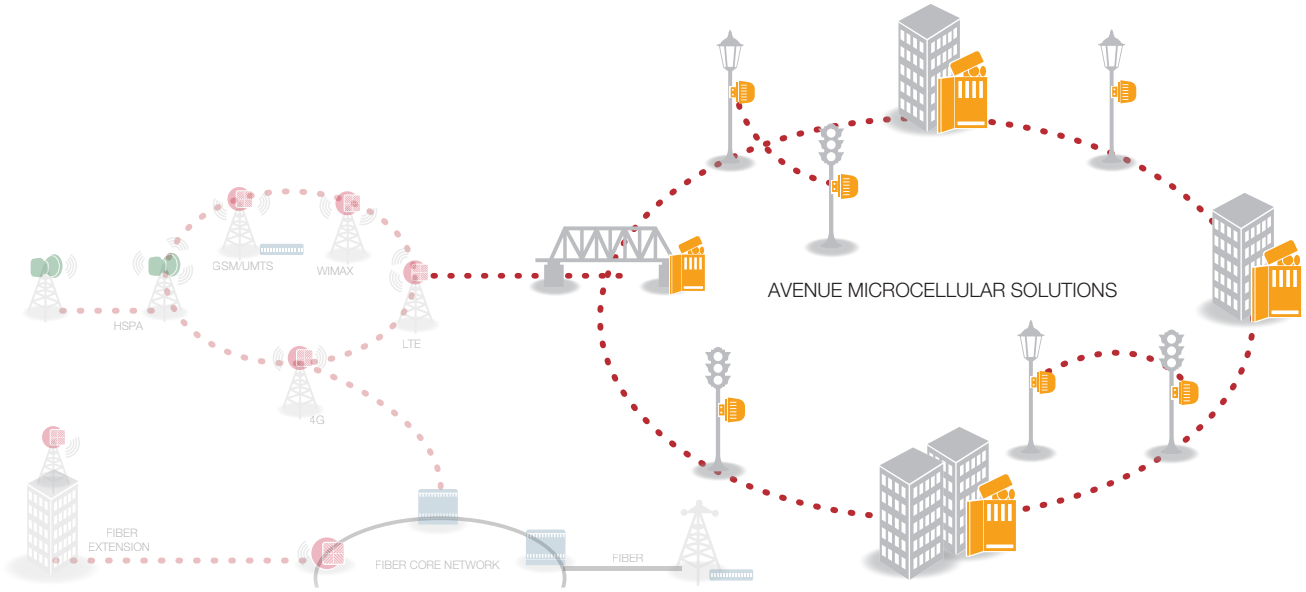
Completely interoperable with other DragonWave systems, the Avenue Link operates in 24, 26, 28, 31, 38 and 60 GHz bands.

SOLUTION HIGHLIGHTS

- Microcellular-optimized backhaul
- Integrated flat-mini antenna
- Zoning-friendly, environmentally hardened enclosure
- Flexible mounting options
- Unparalleled backhaul performance:
  - Pay-as-you-grow bandwidth scalability
  - 400 Mbps capacity per hop
  - Bandwidth Accelerator for 25-150% bandwidth increase
  - Service-aware Hitless Automatic Adaptive Modulation
  - Advanced QoS with 8 levels of prioritization
  - SyncE support and optimized transport of 1588v2
  - Integrated 256-bit AES encryption
  - 1+1 (hot standby), 2:0, Ring, and Mesh protection options
  - Comprehensive management and provisioning with DragonVision NMS

KEY APPLICATIONS

- Microcellular Network Backhaul
- Leased Line Replacement
- Last Mile Fiber Extension
- Public Safety Networks
- Private and Enterprise Networks



Product Sheet

AVENUE LINK

PRODUCT SPECIFICATIONS

FREQUENCIES

24 GHz DEMS	FCC/IC
26 GHz	ETSI
28 GHz	FCC/ETSI
31 GHz	FCC/ETSI
38 GHz	FCC/ETSI/AUS/NZ/MX
60 GHz	UNLICENSED

FEATURES

Antenna	Integrated flat-mini antenna
Capacity w/Accelerator	Variable from 10 to 1000 Mbps full duplex
Base Capacity	Variable from 10 to 400 Mbps full duplex CIR
Interface	Software selectable: 2xGE or 4 x10/100bT or 1xGE + 2x10/100/bT1000
Latency GigE	120µs @ 256QAM. 50 MHz
Packet Size	64 to 9600 Bytes
Flow Control	Yes
Prioritization	8 levels served by 8 hardware queues, based on 802.1p/q, MPLS, DSCP ToS Bits
Modulation Shifting	Yes, Hitless
Loopback	Yes, Radio loopback
Synchronization	SyncE support, optimized transport of 1588v2
Encryption	Integrated 256-bit AES encryption

POWER

Input	-40.5 VDC to -56 VDC
Optional Adapter	110/240 VAC
Consumption (per link end)	55 Watts / 45 Watts for 28, 38 GHz

MECHANICAL

All Hardware in Enclosure	18 cm x 27 cm x 27 cm; 7.7 kg 7" x 10.5" x 10.5"; 17 lbs
Wind Loading	112 kph (70 mph) Operational 200 kph (125 mph) Survival
Backhaul Beam Adjustment	+/- 360° Azimuth; +/- 22° Elevation
Antenna Mount Adjustment	+/- 45° Azimuth; +/- 22° Elevation

CONNECTIONS

Power	-48V, Power on Ethernet (RJ45)
Payload (+ Inband NMS)	RJ45 or optical LC
NMS (when out-of-band)	RJ45

NETWORK MANAGEMENT (NMS)

Alarm Management	SNMP Traps, Enterprise MIB
NMS Compatibility	DragonVision NMS; any SNMP based network manager; SNMP v1, v2c and v3
Ethernet OAM Support	802.3ah, 802.1ag, Y.1731
Security	3 Level Authentication
EMS	Web Based Management System, SSL HTTP,SSH, Radius, Telnet

ENVIRONMENTAL

Operating Temperature	-40°C to +60°C (-40°F to +140° F)
Humidity	100 % Condensing
Altitude	4500 m (14,760 ft)
Water Tightness	Nema4X, IP56 (directed hose test)
Operational Shock	ETSI 300-019-1-4; 5g 11ms
Operational Vibration	ETSI 300-019-1-4 Class 4m5, NEBS GR-63
Earthquake	NEBS GR-63

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DragonWave

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AVENUE SITE

INTEGRATED MICROCELLULAR PLATFORM

THE AVENUE SITE IS A ZONING-FRIENDLY MICROCELLULAR PLATFORM THAT ENABLES WIRELESS OPERATORS TO RAPIDLY EXPAND THEIR MOBILE PRESENCE, IMPROVE IN-BUILDING COVERAGE AND INCREASE NETWORK CAPACITY.

This all-outdoor microcellular platform integrates high capacity packet microwave backhaul, Ethernet switching, power supply, battery backup and optional 3G/4G microcellular base station. All of these elements are housed within a single environmentally hardened enclosure that is optimized for street-level deployment in urban environments.

Engineered to provide the greatest flexibility for mobile operators, the Avenue Site can be deployed to various structures including street lamps, traffic light poles, or building sides. The physical dimensions and appearance of the Avenue Site is designed to meet size, weight and aesthetic requirements set by city zoning officials, allowing the units to blend into urban environments. Unlike traditional macro-cellular deployments, the Avenue Site can be installed rapidly without costly civil engineering and site preparation.

With integrated switching and up to 3 independently alignable microwave backhaul beams, a single Avenue Site unit supports ring, hub, linear and daisy-chain architectures. Aggregate backhaul capacity is an unmatched 1.2 Gbps, with significantly higher throughput achievable with DragonWave's Bandwidth Accelerator.

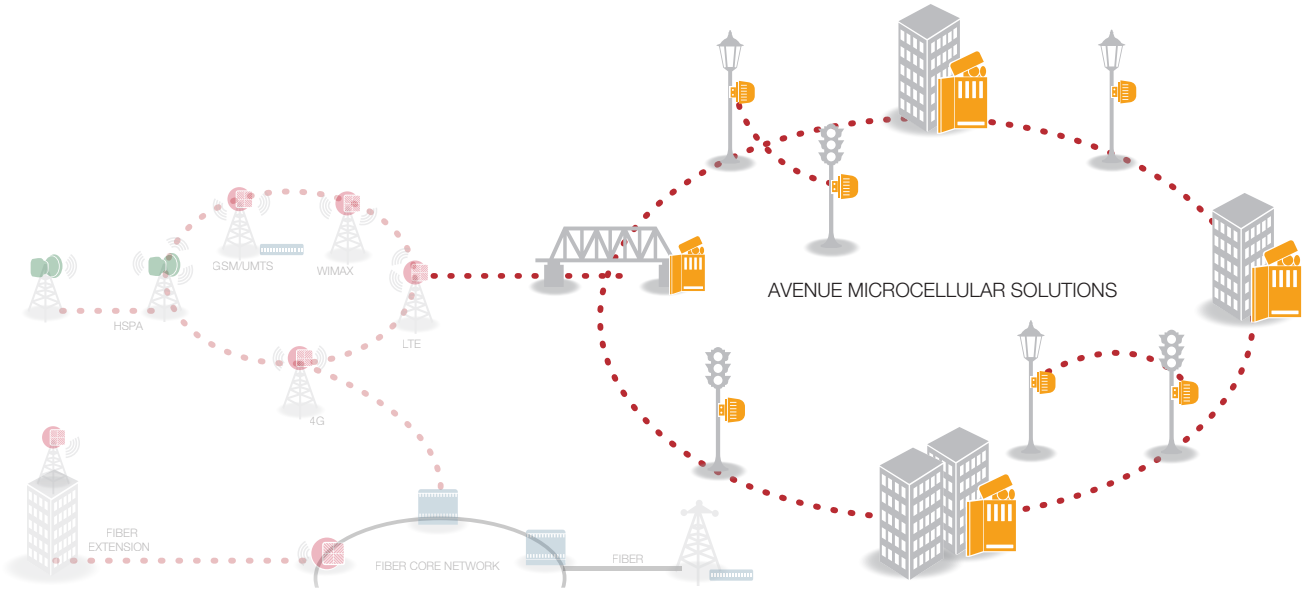
Completely interoperable with other DragonWave systems, the Avenue Site operates in 24, 26, 28, 31, 38 and 60 GHz bands.

SOLUTION HIGHLIGHTS

- Integrated microcellular platform including:
  - High capacity backhaul with up to 3 independently aligned packet microwave radios
  - Integrated backhaul antenna array with up to 3 simultaneous backhaul beam paths
  - Battery backup
  - Power supply
  - Ethernet switching
  - Zoning-friendly, environmentally hardened enclosure
  - Slot for 3G/4G microcellular base station, utilizing external RAN antennas
- Unparalleled backhaul performance and flexibility:
  - Pay-as-you-grow bandwidth scalability
  - 1.2 Gbps aggregate backhaul capacity plus Bandwidth Accelerator for 25-150% bandwidth increase
  - Service-aware Hitless Automatic Adaptive Modulation
  - Advanced QoS with 8 levels of prioritization
  - SyncE support and optimized transport of 1588v2
  - Integrated 256-bit AES encryption
  - 1+1 (hot standby), 2:0, Ring, and Mesh protection options
  - Comprehensive management and provisioning with DragonVision NMS

KEY APPLICATIONS

- Microcellular Networks
- Public Safety Networks
- Private and Enterprise networks



BACKHAUL FREQUENCIES

24 GHz DEMS	FCC/IC
26 GHz	ETSI
28 GHz	FCC/ETSI
31 GHz	FCC/ETSI
38 GHz	FCC/ETSI/AUS/NZ/MX
60 GHz	UNLICENSED

BACKHAUL FEATURES

Backhaul	Up to 3 backhaul beam paths
Antennas	Integrated backhaul antenna array
Base Capacity	1.2 Gbps (400 Mbps per radio) full duplex CIR
Capacity w/Accelerator	Up to 3 Gbps (1000 Mbps per radio) full duplex
Latency GigE	120µs @ 256QAM. 50 MHz
Packet Size	64 to 9600 Bytes
Flow Control	Yes
Prioritization	8 levels served by 8 hardware queues, based on 802.1p/q, MPLS, DSCP ToS Bits
Modulation Shifting	Yes, Hitless
Loopback	Yes, Radio loopback
Synchronization	SyncE support, optimized transport of 1588v2
Encryption	Integrated 256-bit AES encryption
Networking options	Ring, ring-spur, hub-spoke, linear, daisy-chain

SWITCHING FREQUENCIES

Ethernet Switching	Integrated multipoint, multi-gigabit, non-blocking
Access Interface	4 x RJ-45 10/100/1000TX 5 x Gigabit Combo (RJ-45/SFP)
Fast Ethernet Ring Switching	Yes

POWER

Input	120 or 240 VAC, IEC 60320 C14 connector
Battery backup	1 to 4 hrs (variable based on number of backhaul links and inclusion of optional RAN unit)

MECHANICAL

Fully-integrated Single Enclosure

With RAN unit	28 cm x 40.6 cm x 122 cm; 50 kg* 11" x 16" x 48"; 110 lbs*
Without RAN unit	28 cm x 40.6 cm x 66 cm; 32 kg* 11" x 16" x 26"; 71 lbs*
	*Based on single backhaul link. Add 7 lbs (3.2kg) per additional link.
Wind Loading	112 kph (70 mph) Operational 200 kph (125 mph) Survival
Backhaul Beam Adjustment	+/- 360° Azimuth; +60°/-5° Elevation
Antenna Mount Adjustment	+/- 45° Azimuth; +/- 22° Elevation

OPTIONAL RADIO ACCESS NETWORK SLOT

Max power	230 Watts, 48 Volts
Max weight	50 lbs; 22.7 kg
Max dimensions	33 cm x 18 cm x 48 cm 13" x 7" x 19" (w,d,h)
External RAN antenna support	Yes
Integrated GPS feed	Yes, optional

NETWORK MANAGEMENT (NMS)

Alarm Management	SNMP Traps, Enterprise MIB
NMS Compatibility	DragonVision NMS; any SNMP based network manager; SNMP v1, v2c and v3
Ethernet OAM Support	802.3ah, 802.1ag, Y.1731
Security	3 Level Authentication
EMS	Web-Based, system, SSL HTTP, SSH, Radius, Telnet
Remote Monitoring	Backhaul, switching, power supply, battery backup, thermal, site security

ENVIRONMENTAL

Operating Temperature	-40°C to +60°C (-40°F to +140° F)
Humidity	100 % Condensing
Altitude	4500 m (14,760 ft)
Water Tightness	NEMA 3R
Operational Shock	ETSI 300-019-1-4; 5g 11ms
Operational Vibration	ETSI 300-019-1-4 Class 4m5, NEBS GR-63
Earthquake	NEBS GR-63

DragonWave
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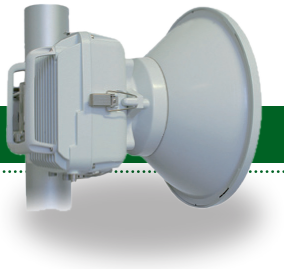


HARMONY RADIO

HYBRID/PACKET MICROWAVE

THIS COMPACT, ALL-OUTDOOR UNIT DELIVERS HIGH PERFORMANCE BACKHAUL WITH SIMPLE MIGRATION OPTIONS FROM HYBRID TO FULL-PACKET.

Offering the industry's only software-selectable evolution from hybrid to all-IP packet networks, Harmony is the intelligent solution for operators looking to future-proof their network investment.

This unique platform can operate in both hybrid and full-packet traffic modes, enabling a simple migration path from TDM to All-IP backhaul with true "zero-touch" on the existing hardware. This results in simplified operations, reduced capital cost and significant savings in total cost of ownership, while meeting the most stringent network requirements for highly time-sensitive applications.

With the ability to operate either standalone or with the Harmony First Mile or Hub indoor units, the Harmony Radio can be optimized for each site, saving on capital and operations by reducing the number of elements in the network.

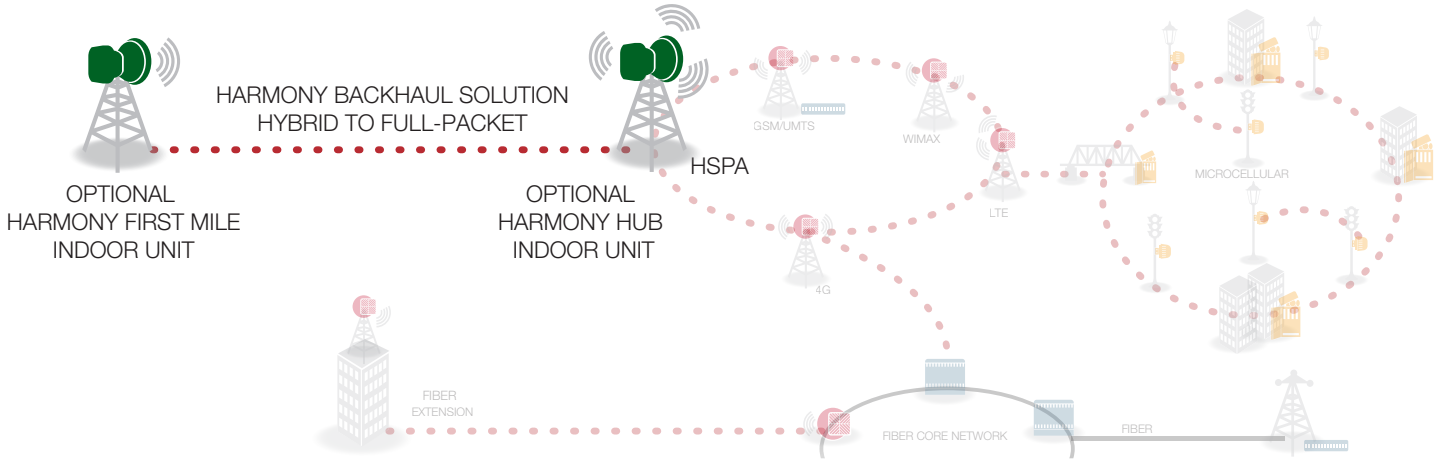
Designed to meet the advanced requirements of mobile, fixed, and private transport network operators, this reliable and flexible microwave radio unit provides broad frequency coverage from 3.5 to 42 GHz.

SOLUTION HIGHLIGHTS

- Software-selectable hybrid and/or full packet air interface
- Pay-as-you-grow scalability with software-programmable capacity up to 1 Gbps in 56 MHz channel
- Supports 3.5 to 56 MHz channel bandwidths
- IEEE 1588-2008 (ToP) and Synchronous Ethernet support
- XPIC for double capacity in the same channel bandwidth
- Standard electrical Ethernet interface enabling interoperability with bridges, routers and BTS or NodeB
- Service-aware radio to support differentiated QoS with up to 8 hardware queues
- Space and frequency diversity with multiple protection options
- RSTP/MSTP, G.8031, G.8032 Ethernet ring protection
- 3.5 to 42 GHz frequency coverage

KEY APPLICATIONS

- Mobile Backhaul with Mixed TDM/Packet Traffic
- Leased Line Replacement
- Last Mile Fiber Extension
- Private and Enterprise Networks



Product Sheet

HARMONY RADIO

PRODUCT SPECIFICATIONS

FREQUENCIES

3.5 GHz	ETSI
6 GHz	ETSI/FCC/IC
7 GHz	ETSI
8 GHz	ETSI
10 GHz	ETSI
11 GHz	ETSI/FCC/IC/ARIB
13 GHz	ETSI
15 GHz	ETSI/ARIB
18 GHz	ETSI/FCC/IC/ARIB
23 GHz	ETSI/FCC/IC
26 GHz	ETSI
28 GHz	ETSI
32 GHz	ETSI
38 GHz	ETSI
42 GHz	ETSI

FEATURES

Capacity	Variable up to 1 Gbps full duplex
Data Compression	Overhead/header compression
Interfaces	1xGE ODU-ODU RSSI Antenna IF Power supply
Packet Size	64 to 10240 Bytes
Flow Control	Yes
Prioritization	8 queues based on MAC Address, EtherType, VLAN ID, 802.1p, ToS/DSCP, MPLS
Adaptive Modulation	Yes: from maximum modulation to configurable minimum modulation
Modulation Shifting	Errorless & hitless
Loopback	PHY loopback & RF loopback
Synchronization	Synchronous Ethernet (ITU-T G.8261)
Modulations Supported	QPSK to 256QAM (all frequencies)
Bandwidth supported (MHz)	7, 14,28, 40, 56 (ETSI); 10, 20, 30, 40 50 MHz (NAM/JAPAN)
System Gain	Up to 123 dBm
ATPC	Range: 25dB Speed: 100 dB/sec

POWER

Input	-48 VDC + 20%
Consumption (per end)	35 to 40 W (depending on RF band)
Connection	Power on Ethernet or power supply interface

MECHANICAL

Radio/Modem (without antenna)	23.8 cm x 23.8 cm x 16.8 cm; 5 kg 9.4” x 9.4” x 6.6”; 11 lbs
Wind Loading	<200 kph (70 mph) Operational 200 kph (125 mph) Survival

NETWORK MANAGEMENT (NMS)

NMS Compatibility	DragonVision 5.0, SNMPv2, SNMPv3
Ethernet OAM Support	Y.1731 (PM), 802.1ag (connectivity FM)
EMS	WebLCT, SSL HTTP, FTP, Telnet

ENVIRONMENTAL

Operating Temperature	-40°C to +55°C (-40°F to +131° F)
Humidity	8 to 100 %
Altitude	Up to 3000m (9843 feet) ASL
Water Tightness	IP65
Operational Shock	EN 60068-2-27
Operational Vibration	EN 60068-2-27
Earthquake	EN 60068-2-27

IDU OPTIONS

Harmony Hub

Harmony First Mile

ENVIRONMENTAL

1 + 0

1 + 1 Space Diversity / Frequency Diversity

1 + 1 HSBY (with/without IDU support)

2 + 0 FD/XPIC (with load sharing; with/without IDU support)

2 + 0 Drop/Insert and Forwarding

2 + 2 FD/XPIC

4 + 0 FD/XPIC (with load sharing)

DragonWave

www.dragonwaveinc.com

HARMONY FIRST MILE 200

FLEXIBLE EVOLUTIONARY SWITCH

THE HARMONY FIRST MILE 200 DELIVERS BOTH PERFORMANCE AND VALUE IN A FLEXIBLE PERIPHERAL SWITCH.

Part of the Harmony microwave solution, this reliable switch is optimized for tail and chain sites where 3G and LTE base stations are co-located with 2G base stations. This system also aggregates TDM and packet traffic locally.

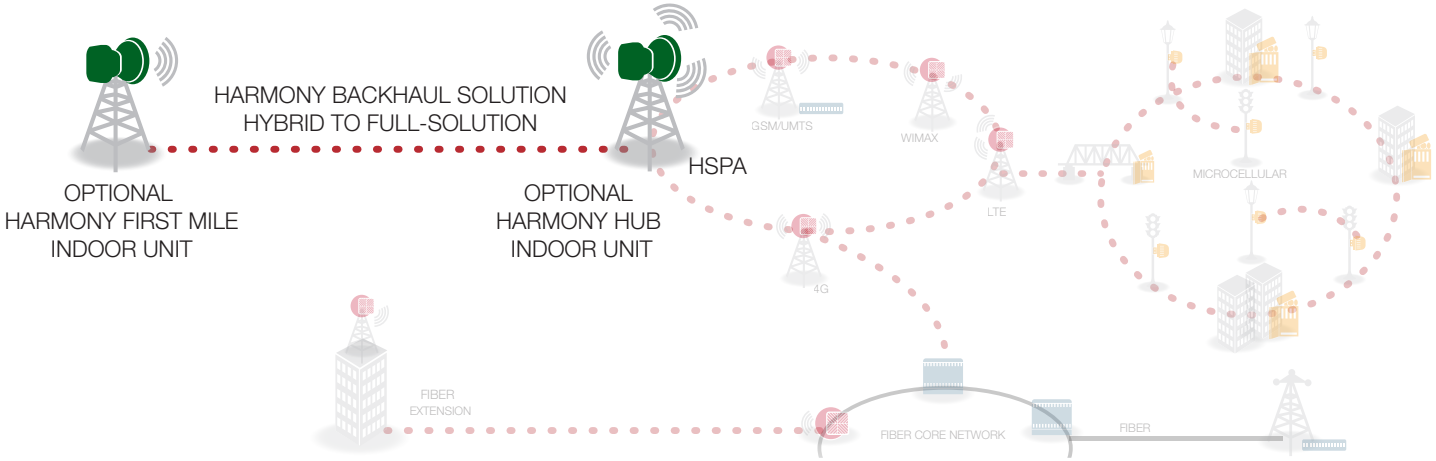
The Harmony First Mile 200 delivers 8 Gbps switching capacity, combined with E-LINE and E-LAN services, advanced QoS mechanisms, performance monitoring, fault detection and robust clock recovery.

With its extended operating temperature range and compact size, the Harmony First Mile 200 can be deployed within an outdoor base station housing or within its own enclosure, providing zero-footprint site installation.

The Harmony First Mile 200's access interfaces, which can be used to power the Harmony Radio, include Fast and Gigabit Ethernet and E1/T1.

SOLUTION HIGHLIGHTS

- 802.1ad provider bridging and 802.1Q bridging
- E-LINE and E-LAN services
- Advanced QoS with 8 priority queues, policing, shaping and weighted random early detection (WRED)
- Ethernet OAM: 802.1ag and ITU-T Y.1731
- Advanced clock synchronization with Synchrounous Ethernet, Adaptive Clock Recovery and Differential Clock Recovery
- Low power consumption (min. 15W)
- Power over Ethernet support for Harmony Radio
- RSTP/MSTP, G.8031, G.8032 network protection
- 8 x E1/T1 TDM ports
- 6 x 10/100/1000 Base-TX Ethernet Ports



Product Sheet

HARMONY FIRST MILE 200

PRODUCT SPECIFICATIONS

SWITCHING CAPACITY

8 Gbps

ETHERNET PORTS

4 x 10/100/1000Base-T + 2 x GE SFP ports;
RJ-45 connectors (2 ports with embedded power to Harmony Radio)

1 local management port + 1 DCN port

2 in and 2 out dry contacts

TDM PORTS

8 E1/T1 TDM ports; RJ-48C connectors

SERVICES

E-Line and E-LAN service

E1/T1/J1 CESoPSN (RFC5086)

E1 SAToP (RFC4553)

BRIDGING AND VLAN MANIPULATION

E1/T1/J1 SAToP (RFC4553)

IEEE 802.1Q bridging

MAC table size: 8K

Support for Static MAC

VLAN insertion and translation

QUALITY OF SERVICE (QoS)

Traffic classification and mapping based on port, MAC, VLAN ID, VLAN priority bits, IP address, DSCP, etc.

Policing on port, VLAN, and queue

8 priority queues per port

Scheduler: Strict Priority, WDRR, WRR

Congestion Control: sRED

Per-port and per-queue traffic shaping

PERFORMANCE MONITORING

Packet counters according to RFC2819 RMON MIB, RFC2863

Y.1731 performance measurement

FAULT DETECTION

Y.1731/802.1ag

PROTECTION

xSTP based network protection

1+1 hot-standby (HSBY) nodal protection

LAG

G.8031, G.8032

50ms CES 1+1 linear protection

CLOCK SYNCHRONIZATION

Adaptive Clock Recovery (ACR)

Differential Clock Recovery (DCR)

Synchronous Ethernet with and without SSM

Clock sources:	Network clock via ACR/DCR/158v2 Line clock from any E1/T1 port Synchronous Ethernet SSM Internal free-run clock

SUPPORTED ODU CONFIGURATIONS:

1+0

1+1 HSBY

POWER

Supply:	Up to 48V DC
Consumption:	Min. 15W

ENVIRONMENTAL

Operating Temperature Range:	-40°C to + 65°C / -40°F to 149°F

DIMENTIONS & WEIGHT

44.2 cm x 21 cm x 32 cm; 1 kg

16.6” x 8.3” x 12.6”; 2.2 pounds

82-000070-01-01 Version 2

DragonWave

www.dragonwaveinc.com

HARMONY HUB 800

ADAPTABLE MULTI-SERVICE NODAL SWITCH

DESIGNED FOR BOTH SMALL AND LARGE MICROWAVE HUBS, THE HARMONY HUB 800 PROVIDES ADVANCED MULTI-SERVICE AGGREGATION AND ETHERNET SERVICES.

Part of DragonWave's Harmony backhaul solution, the Harmony Hub 800 is a compact indoor unit which provides maximum flexibility for 2G, 3G and LTE traffic aggregation. The Harmony Hub 800 is the perfect backhaul node for Harmony Radio systems, with 16 Gbps switching capacity, and support for up to 12 radio directions in a single unit.

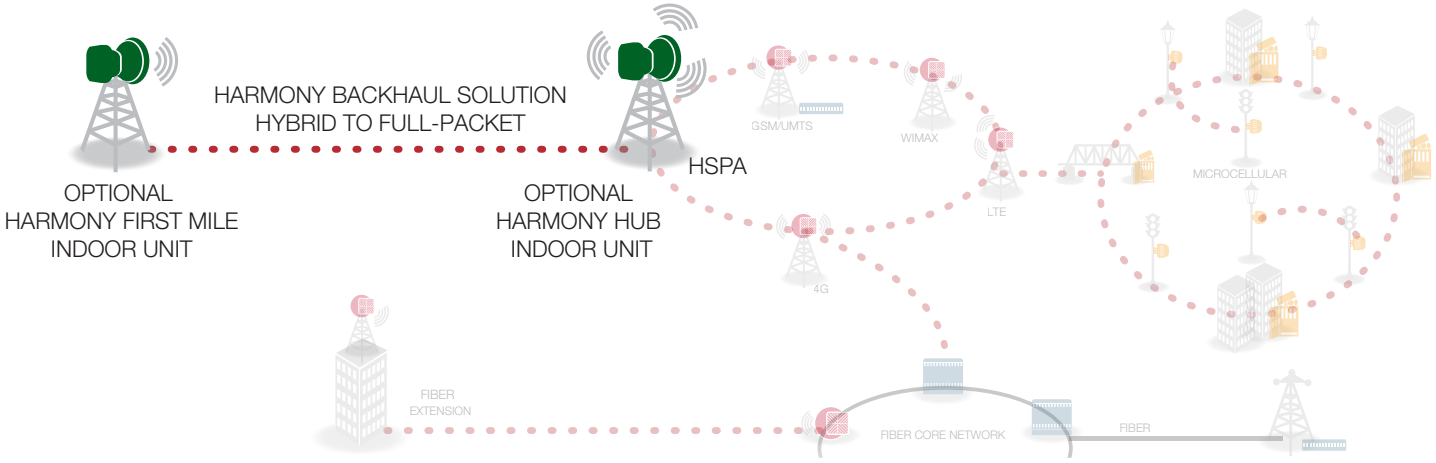
In addition to supporting advanced Ethernet processing features, the Harmony Hub 800 can carry TDM traffic natively or via circuit emulation – a simple and cost effective solution for operators moving to converged packet networks.

Optimized for mobile network evolution, the Harmony Hub 800 supports advanced clock synchronization and recovery mechanism including Synchronous Ethernet, 1588v2 boundary clock, Adaptive Clock Recovery (ACR) and Differential Clock Recovery (DCR).

The Harmony Hub 800's high density TDM and Ethernet access interfaces include Fast and Gigabit Ethernet, E1/T1, and channelized STM-1/OC-3.

SOLUTION HIGHLIGHTS

- High density node supporting up to 12 directions and 16 Gbps switch throughput
- 802.1ad provider bridging and 802.1Q bridging
- E-LINE and E-LAN services
- Advanced QoS with 8 priority queues, policing, shaping and weighted random early detection (WRED)
- Ethernet OAM: 802.1ag and ITU-T Y.1731
- Advanced clock synchronization with SyncE and 1588v2
- Multi-service platform with CESOP, SATOP, ATM/IMA PWE, MLPPP termination and Ethernet over SDH
- Power over Ethernet support for Harmony Radio
- Multiple protection configurations
- RSTP/MSTP, G.8031, G.8032 Network protection
- Up to 48 x E1/T1 and 4 x STM-1/OC-3 TDM ports
- 4 x 100/1000BaseT and 2 x SFP Ethernet interfaces



Product Sheet

HARMONY HUB 800

PRODUCT SPECIFICATIONS

SWITCHING CAPACITY

16 Gbps

ETHERNET PORTS (MAIN BOARD)

4 x 10/100/1000 Base-T, two of which have embedded power (Power over Ethernet)

2 x SFP (can be configured as 100/1000 Base-Fx or STM-1)

TDM PORTS (MAIN BOARD)

16 x E1/T1/J1

2 x SFP (can be configured as 1000 Base-FX or STM-1)

EXPANSION SLOTS

4-port GE card (optical or electrical)

16 x E1/T1/J1 CES/MLPPP card

2-port STM-1 card

2-port Power Injector card (providing 2 x PoE ports)

2-port FlexBus card

SYSTEM PORTS

1 x 10/100/1000 Base-T out-of-band management port

1 x 10/100/1000 Base-T DCN management port

1 x dry contact (2-in and 2-out)

1 x ToD output port

SERVICES

E-Line and E-LAN service

E1/T1/J1 CESoPSN (RFC5086)

E1 SAToP (RFC4553)

STM-1 CESoPSN and SAToP

n x E1 ATM IMA

STM-1 ATM IMA

64Kbps grooming for E1 CES

NETWORK MANAGEMENT (NMS)

Packet-based microwave

Hybrid microwave

TDM and packet transport networks

n x E1 MLPPP

BRIDGING AND VLAN MANIPULATION

IEEE802.1ad provider bridging

IEEE 802.1Q bridging

MAC table size: 16K

Support for Static MAC

VLAN insertion and translation

QUALITY OF SERVICE (QoS)

Traffic classification and mapping based on port, MAC, VLAN ID, VLAN priority bits, IP address, DSCP, etc.

Policing on port, VLAN, and queue

8 priority queues per port

Scheduler: Strict Priority, WDRR, WRR

Congestion Control: sRED

Per-port and per-queue traffic shaping

PERFORMANCE MONITORING

Packet counters according to RFC2819 RMON MIB, RFC2863

Y.1731 performance measurement

FAULT DETECTION

Y.1731/802.1ag

PROTECTION

xSTP based network protection

1+1 hot-standby (HSBY) nodal protection

LAG

G.8031, G.8032

50ms CES 1+1 linear protection

IDU redundancy

CLOCK SYNCHRONIZATION

Adaptive Clock Recovery (ACR)

Differential Clock Recovery (DCR)

Synchronous Ethernet with and without SSM

IEEE 1588v2 Slave Mode

Clock sources:	Network clock via ACR/DCR/158v2 Line clock from any E1/T1 port Synchronous Ethernet SSM Internal free-run clock

SUPPORTED ODU CONFIGURATIONS

1+0

1+1 space diversity/frequency diversity, 1+1 HSBY

2+0 FD/XPIC (with load sharing), 2+0 drop/insert and forwarding

POWER

Supply:	-40.5 to -57.6 VDC (two inputs)
Consumption:	Typical: 35W, Maximum 45W

ENVIRONMENTAL

Operating Temperature Range:	-5°C to + 55°C / 23°F to 131°F

DIMENSIONS & WEIGHT

44 cm x 24 cm x 44.5 cm; 2.3 kg

17.3" x 9.4" x 17.5"; 5.1 pounds

82-000071-01-01 Version 2

DragonWave

www.dragonwaveinc.com

HARMONY TRUNK

LONG HAUL MICROWAVE SYSTEM

DRAGONWAVE'S HARMONY TRUNK IS A LONG HAUL TRUNKING MICROWAVE SYSTEM THAT OFFERS A SMOOTH, SOFTWARE-DEFINABLE MIGRATION FROM LEGACY SDH NETWORKS TO HYBRID SDH/IP AND ALL-IP.

The rapid evolution occurring in mobile networks is driving the need for a new generation of point-to-point radio systems for trunk applications, offering a simple expansion and reduced footprint. Handling existing traffic, while meeting the increasingly data-centric demands of mobile networks, requires a trunk system that can support both TDM and Ethernet traffic seamlessly.

The Harmony Trunk delivers native TDM and native IP transmission within the same hardware platform, providing multiple hybrid modes via a simple software selection.

The system's compact design and flexibility enables rapid and simple installation and fast network roll-out with simple civil works and an outage-less expansion/upgrade process. The competitive features of the Harmony Trunk strongly position this solution for backbone applications in addition to spur, access and aggregation layer communications.

Adaptive modulation from 4QAM to 256QAM with Low Density Parity Check (LDPC) coding ensures the highest throughput and efficiency. Alternated pattern and co-channel operation with XPIC equalization, provides double the spectral efficiency of the system. A power boost option allows operators to increase the Harmony Trunk's Tx power up to +35dBm.

As with all Harmony solutions, the Trunk offers multiple protection options including N+1 Radio Protection Switching (RPS) up to 15+1, which is implemented on the radio side using a single controller card. Hitless switching, with very early warning detection and multiple switching criteria, is implemented in response to propagation impairments such as multipath fading. Line side, (1+1) multiplex section protection can be implemented for the STM-1 interface, while dual line interface with RSTP protection and line LAG is available for Gigabit Ethernet.

SOLUTION HIGHLIGHTS

- Smooth migration from legacy SDH to partial SDH/IP to full-IP via software setting on existing hardware
- Best in class footprint (16 channels in one ETSI rack)
- Double Terminal single-rack (up to 8xWG node in a rack)
- Full digital self-commissioning
- Wide band tunability for maintenance optimization
- Flexible modulation from 4QAM to 256QAM with LDPC coding
- XPIC support
- High Power and extra boost up to +35dBm (software upgradable)
- ATPC and RTPC/MTPC 20dB range
- Diversity available: FD, RX SD, TX+RX SD, Hybrid SD
- 2x(1+1) HSBY co-channel supported within the same subrack
- Multi-baseband interface: STM-1 electrical, STM-1 optical , STM-4 and Gigabit Ethernet can co-exist in the same terminal
- Gigabit Ethernet interface supported with NxRFcarriers mapping and adaptive load balancing (L1 byte-by-byte radio bonding)
- Fully outdoor version available up to 7+1/8+0 for site cost optimization

HARMONY TRUNK

PRODUCT SPECIFICATIONS

FREQUENCIES

4 GHz

U4 GHz

5 GHz

L6 GHz

U6 GHz

L7 GHz

U7 GHz

W7 GHz

L8 GHz

8 GHz

11 GHz

13 GHz

MODULATION

Native SDH mode	64 QAM LDPC (40MHz)
	128 QAM LDPC (28-30MHz)
Native IP mode	4 QAM LDPC 16 QAM LDPC 32 QAM LDPC 64 QAM LDPC 128 QAM LDPC 256 QAM LDPC

BB INTERFACE

Native SDH mode	STM-1 electrical STM-1 optical S-1.1 STM-1 optical L-1.1 STM-4 optical S-4.1 STM-4 optical L-4.1
Native IP mode	1000BaseT 1000BaseSX 1000BaseLX

AUX CHANNELS

Native SDH mode	2x2Mbps wayside/STM-1 1xEOW 64kbps (E1 byte) up to 3x64kbps user chs (G.703/V.11/VF)
Native IP mode	1x2Mbps wayside/carrier 1xFE 10/100BaseT up to 3x64kbps user chs (G.703/V.11/VF)

ALARM REPORT

External alarms	16 station alarms 8 remote controls
Equipment alarms	general alarm with reset function severity Critical/Major/Minor/Warning

POWER CONSUMPTION

4-to-8GHz:	+33dBm TX: max 80W/carrier +30dBm TX: max 60W/carrier
11GHz:	+30dBm TX: max 80W/carrier +27dBm TX: max 60W/carrier
13GHz:	+27dBm TX: max 80W/carrier +24dBm TX: max 60W/carrier

MECHANICAL

Subrack	30 cm x 60 cm x 180 cm
with 1+1DTI subrack	30 cm x 60 cm x 220 cm

ENVIRONMENTAL

Single protection	N+1 ACAP/ACCP/CCDP up to N=15
Double protection	N+1/M+1 ACAP/ACCP/CCDP up to N+M=14
Method	two errorless and hitless criteria with early warning detection

SYSTEM GAIN

TX output power	up to +35dBm @ 4-to-8GHz up to +32dBm @ 11GHz up to +29dBm @ 13GHz
RX Treshold BER10-6	4-to-8GHz: -86dBm @ 4QAM -82.5dBm @ 16QAM -79dBm @ 32QAM -75.5dBm @ 64QAM -72dBm @ 128QAM -68dBm @ 256QAM 11GHz: 1dB worse than 4-to-8GHz 13GHz: 2dB worse than 4-to-8GHz

DragonWave

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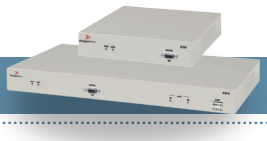
DragonWave



FUSION A10

PSEUDOWIRE ACCESS GATEWAY

FOR MOBILE BACKHAUL AND VOICE/DATA INTEGRATION OVER PACKET NETWORKS

THE DRAGONWAVE FUSION A10 IS A CUSTOMER-LOCATED OR POINT OF PRESENCE (POP) PSEUDOWIRE ACCESS GATEWAY DESIGNED TO ENABLE COST-EFFECTIVE CELL SITE VOICE AND DATA BACKHAUL AS WELL AS VOICE AND DATA CONVERGENCE OVER A PACKET-BASED NETWORK.

With the Fusion A10, service providers can convert any packet access network (Carrier Ethernet, broadband wireless, cable HFC, xDSL, PON, etc.) into a full-service alternative to TDM access and Layer 2 services, such as Frame Relay, ATM and HDLC.

- Mobile service providers can significantly reduce their operational expenses by replacing costly leased line access and avoiding multiple overlay networks.
- Wireline service providers can preserve customer revenue from traditional services while migrating to next generation networks.
- Carrier Ethernet service providers gain immediate new revenue opportunities by offering profitable traditional services such as T1/E1 private line and PBX voice backhaul, as well as advanced Ethernet services.

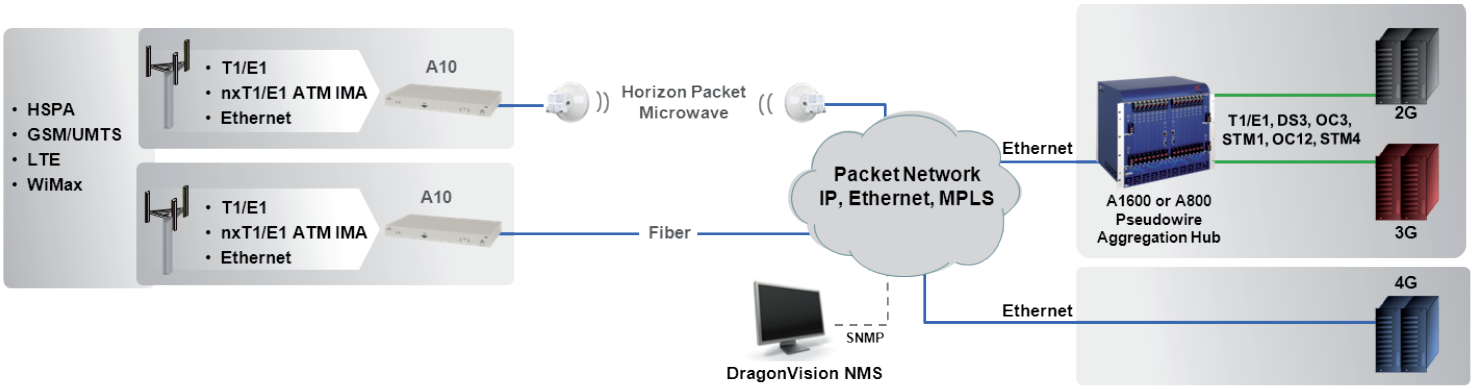
By offering the full range of voice and data services over a single, unified, packet-based infrastructure, providers can cut costs, increase revenues and expand their market, while preserving investments in existing equipment, thereby ensuring a non-disruptive migration path to packet-based networks.

SOLUTION HIGHLIGHTS

- IETF PWE3-based capabilities – Circuit Emulation Service (CES), ATM, FR and HDLC
- Industry-leading CES with enhanced jitter management
- High Precision Clock Recovery (HPCR®) – the industry's most robust adaptive clock recovery technology
- Extensive Ethernet capabilities – port-based VLAN tagging and switching and Ethernet OAM
- Advanced QoS mechanisms – port-based rate limiting, DiffServ and Ethernet VLAN 802.1Q/P
- Extended temperature range
- Optional field replaceable, redundant power supply
- Seamless interoperability with all generations of mobile wireless base stations
- Remote management capabilities through DragonWave's CLI and DragonVision NMS

KEY APPLICATIONS

- 2G / 3G / 4G mobile backhaul
- T1/E1 circuit emulation for TDM leased-line replacement
- PBX-to-PSTN backhaul and PBX-to-PBX (tie-line) connectivity
- ATM Services including ATM IMA
- HDLC virtual leased lines for X.25/SNA/IPX transport



PHYSICAL INTERFACES

E1

- Number of Ports: 4 or 8
- Bit Rate: 2.048 Mbps ± 50 ppm
- Standards Compliancy
  - ITU G.703, G.704, G.706, G.732
- Framing
  - Unframed, FAS, FAS with CRC4,
  - MFAS with CAS, MFAS with CAS and CRC4
- Line Code: AMI
- Zero Suppression: HDB3
- Jitter and Wander Performance
  - ITU G.823, G.8261
- Connectors
  - Balanced RJ-45, 120 Ω
  - Unbalanced BNC 75 Ω connectors via an optional adapter cable

T1

- Number of Ports: 4 or 8
- Bit Rate: 1.544 Mbps ± 32 ppm
- Standards Compliancy
  - ANSI T1.403, Telcordia TR-62411
- Framing: Unframed, D4, ESF
- Line Code: AMI
- Zero Suppression: B8ZS
- Jitter and Wander Performance
  - Telcordia TR-62411, ITU G.824, G.8261
- Connectors: Balanced RJ-45, 100 Ω

ETHERNET

- Number of Ports: 5
  - 3x 10/100BaseTx (User or Network)
  - 2x 1000BaseX (User or Network) or
  - 2x 100BaseFx (User or Network)
- Standards Compliancy
  - 802.3 (Fixed settings, auto-negotiation)
  - 802.1q/p
- Connectors
  - 10/100BaseTx – RJ-45
  - 100BaseFx – LC duplex (SFP)
  - 1000BaseX – LC duplex (SFP)
  - SFP transceivers should be ordered separately

MANAGEMENT INTERFACE

- Type: RS-232
- Connector: DB-9, female

INDICATORS

- Power: Green – Active
- PS-1 / PS-2 (A10-R)
  - Green – On
  - Red – Failure
  - Off – Not powered / not connected
- Alarm
  - Off – No alarms
  - Orange – Minor alarm
  - Red – Major alarm
- Ethernet
  - Link: Green - On
  - Activity: Amber - On
- T1/E1
  - LOS (Red)
  - RAI (Orange)

POWER OPTIONS

- DC Power (A10): ±18 to ±72 VDC
  - Nominal: ±24, ±48, ±60 VDC
- DC Power (A10-R): ±18 to ±60 VDC
  - Nominal: ±24, ±48 VDC
- AC Power (A10/A10-R): 90 to 264 VAC
  - Nominal: 100 - 240 VAC
- Field replaceable power supply (A10-R)
- Redundant power supply (A10-R)

POWER CONSUMPTION

- A10
  - DC: 9W to 14W
  - AC: 10W to 16W
- A10-R
  - DC: 11W to 17W
  - AC: 12W to 18W

PHYSICAL DIMENSIONS

- A10
  - Inches: 1 RU (h) x 9.41 (d) x 8.2 (½ RU) (w)
  - Cm: 4.45 (h) x 23.0 (d) x 20.8 (w)
- A10-R
  - Inches: 1 RU (h) x 9.41 (d) x 17.25 (1 RU) (w)
  - Cm: 4.45 (h) x 23.0 (d) x 43.8 (w)

PSEUDOWIRE SERVICES

TDM-CES

- Framed (CESoPSN)
  - n x DS0 (1=< n =< 31)
- Unframed (SAToP)

ATM

- Cell based (AAL0)
  - VPC, VCC and VCC Bundle modes
- Frame based (AAL5)
- ATM cell concatenation: single or multiple cells encapsulated per Pseudowire frame
- ATM VP/VC cross connect
- DS1/E1 UNI
- ATM IMA UNI
  - Up to 8 ports per group
  - Up to 2 groups

HDLC/PPP

- Port mode

FRAME RELAY

- One-to-One mode
- Port mode

IP SERVICE INTERWORKING

- HDLC IP Service Interworking
- Frame Relay IP Service Interworking
- PPP IP Service Interworking

ETHERNET SERVICES

- Bridging/Forwarding between Ethernet interfaces
- Port-based VLAN tagging
- Rate limiting (per port)
  - Up to 1 Mbps – 512 kbps steps
  - 1 Mbps up to 100 Mbps – 1 Mbps steps
  - 100 Mbps up to 1000 Mbps – 10 Mbps steps

ETHERNET OAM

- Ethernet Link OAM (IEEE 802.3ah)
- Ethernet Service OAM (IEEE 802.1ag / ITU-T Y.1731)

DIAGNOSTICS

- Terminal (Local) loopback
- Facility (Remote) loopback
- In-band loopback

PERFORMANCE MONITORING

- T1 / E1 (G.826)
  - 5 X 24-HOUR INTERVAL
  - 96 X 15-MINUTE INTERVAL
  - ES, SES, UAS

ALARMS

- T1
  - Alarm Indications Signal (AIS)
  - Remote Alarm Indication (RAI)
  - Loss of Signal (LOS)
  - Loss of Framing (LOF)
- E1
  - Alarm Indications Signal (AIS)
  - Remote Alarm Indication (RAI)
  - Loss of Signal (LOS)
  - Loss of Framing (LOF)
  - Loss of Multiframing (LOM)
  - Remote Loss of Frame Indication (RAIM)

TIMING

- Adaptive Clock Recovery (ACR)
- High Precision Clock Recovery (HPCR®; optional)
  - Telcordia TR-62411, ITU G.823, G.824, G.8261
- Internal: ±25 ppm (non-HPCR)
- Loopback timing

QOS MANAGEMENT

- 4 Levels of Prioritized Queuing (SP)
- Layer 3 Marking – DiffServ
- Layer 2 Marking – VLAN 802.1Q/P
- Jitter buffer – programmable up to 256 msec

MANAGEMENT SPECIFICATIONS

- In-band or out-of-band
- SNMP
- Syslog
- Command Line Interface (RS-232 / Telnet / SSH2)
- DragonVision NMS
- Remote Software Upgrade

DragonWave
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DragonWave

FUSION A20

MULTI-SERVICE PACKET NODE

UNIQUE, VERSATILE, COMPACT, AND COST-EFFECTIVE

THE DRAGONWAVE FUSION A20 SIMPLIFIES THE TRANSPORT OF MULTI-GENERATION VOICE AND DATA TRAFFIC OVER PACKET NETWORKS, FOR VERSATILE, COST-EFFECTIVE MOBILE BACKHAUL AND BUSINESS SERVICES DELIVERY.

The A20 is the only solution that combines legacy services, Ethernet services, and Ethernet demarcation capabilities in a single 1RU platform. With the A20, service providers gain the versatility to expand their service offerings and smoothly migrate to a single converged Carrier Ethernet network, while preserving revenue streams from profitable legacy services.

A Modular Design for Flexibility and Investment Protection

Completely modular, the A20 delivers a level of functionality more commonly found in higher-end aggregation and core devices. This design allows operators to configure the device based on location-specific needs, and make simple adjustments as requirements evolve. The A20 is the only product of its kind to provide significant investment protection by accommodating new software features and a wide variety of cards as market requirements change and new services, protocols, or interfaces are developed.

A Versatile, Cost-Effective Solution for Every Operator

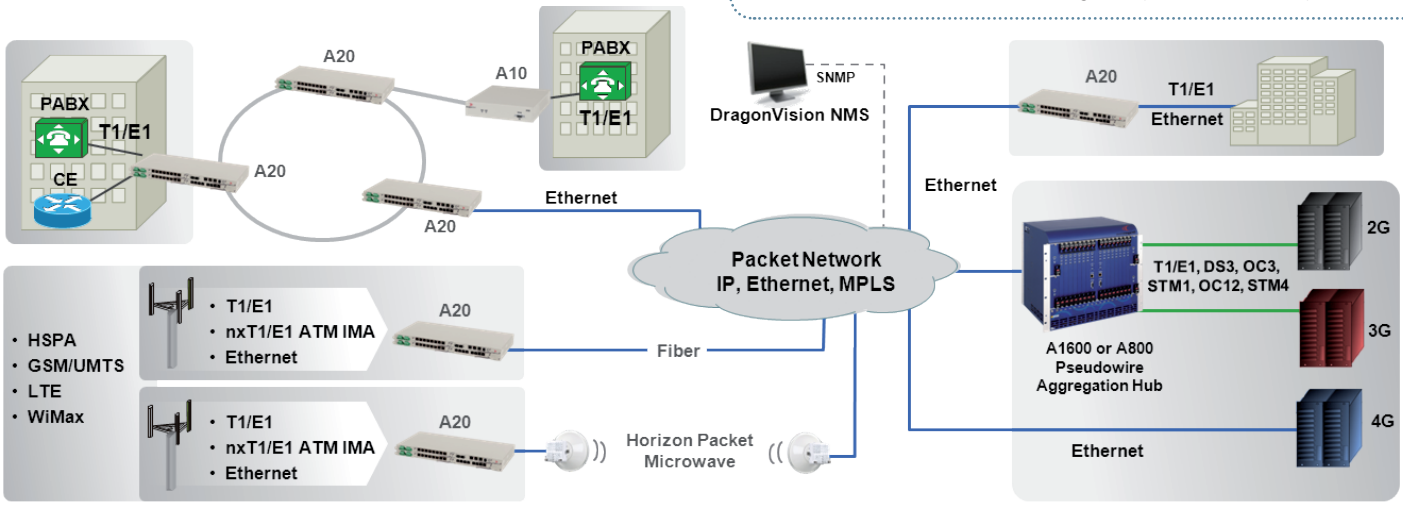
The A20 provides mobile operators, cable MSOs, incumbent carriers and other operators with a competitive advantage by offering a dramatic reduction in OPEX and improved ROI – particularly in mobile backhaul and business services delivery. Only DragonWave provides operators with a solution that has the versatility to address legacy-only, Ethernet access-only and hybrid applications.

SOLUTION HIGHLIGHTS

- Flexible “pay-as-you-grow” platform
- 3 field-replaceable line card slots
- Up to 26 Ethernet ports, 24 T1/E1 ports or a combination of each
- Multi-service pseudowire capabilities – Circuit Emulation Service (CES), ATM, FR, and HDLC
- Various network topologies, including G.8032 Ethernet ring
- Extensive Ethernet functionality – Ethernet services (MEF-9) with advanced traffic management (MEF-14)
- Comprehensive QoS and Ethernet OAM & PM – 802.3ah, 802.1ag, Y.1731, for guaranteed SLAs
- High Precision Clock Recovery (HPCR®) – the industry’s most robust adaptive clock recovery technology
- Extended temperature range
- Positioned for the future – supports multiple topologies and modular cards

KEY APPLICATIONS

- Mobile Backhaul
  - 2G / 3G / 4G packet network access
  - 2G / 3G / 4G mobile backhaul services delivery
  - Microwave and fiber access network switching and aggregation
- Business Services Delivery
  - T1/E1 service delivery and line replacement
  - E-LINE and E-LAN Ethernet services delivery and demarcation
  - Internet access, IP convergence (voice, video, data)



FUSION A20

PRODUCT SPECIFICATIONS

CHASSIS

- Full front access, 1RU tall, 17.5" wide, with 3 line card slots, 1 processing and fabric switch slot and redundant DC or AC power supplies
- Line Card Types Supported
  - 8x T1/E1
  - 8x 10/100/1000BaseTx Ethernet
  - 8x 100/1000BaseX Ethernet (SFP)
- Main Card Types Supported
  - 2x 1000 BaseX Ethernet (SFP)

PHYSICAL INTERFACES E1

- Bit Rate: 2.048 Mbps ± 50 ppm
- Standards Compliancy
  - ITU G.703, G.704, G.706, G.732
- Framing
  - Unframed, FAS, FAS with CRC4, MFAS with CAS, MFAS with CAS and CRC4
- Line Code: AMI
- Zero Suppression: HDB3
- Jitter and Wander Performance
  - ITU-T G.823, G.8261
- Connectors
  - Balanced RJ-45, 120 Ω
  - Unbalanced BNC 75 Ω connectors via an optional adapter cable

T1

- Bit Rate: 1.544 Mbps ± 32 ppm
- Standards Compliancy
  - ANSI T1.403, Telcordia TR-62411
- Framing: Unframed, D4, ESF
- Line Code: AMI
- Zero Suppression: B8ZS
- Jitter and Wander Performance
  - Telcordia TR-62411, ITU G.824, G.8261
- Connectors: Balanced RJ-45, 100 Ω

ETHERNET

- Connectors
  - 10/100/1000BaseTx – RJ-45
  - 100BaseFx/1000BaseX – LC duplex (SFP)
- Standards Compliancy
  - IEEE 802.3u Fast Ethernet
  - IEEE 802.3z Gigabit Ethernet
  - IEEE 802.3 (Fixed settings, auto-negotiation)

EXTERNAL CLOCK

- In and Out
- Supports G.703.5 (1.544Mbps), G.703.9 (2Mbps) and G.703.13 (2MHz) - Configurable
- Connector: RJ-45

MANAGEMENT

- RS-232 (using RJ-11 to RS-232 cable)
- Ethernet: 10/100BaseTx (RJ-45)

ETHERNET SWITCHING

- 10G L2 bridging capacity
- Support 802.1D, 802.1Q and 802.1AD switching (no vlan, single vlan, double vlan)
- 16KMAC addresses
- Learning control (enable/disable) per port, EVC, EVCxport – reduces dramatically MAC table utilization.
- VLAN (and PCP) ingress and egress manipulation
- Jumbo frame (up to 10240 bytes)

ETHERNET SERVICES SUPPORT

- E-Line: EPL and EVPL
- E-LAN: EP-LAN, EVP-LAN
- L2 control protocol (L2CP) filtering/tunneling
- MEF-9 and MEF-14 certified

TRAFFIC / QOS MANAGEMENT

- Flow classification: Customer traffic mapped to flows based on port, VLAN tag, VLAN priority, DSCP
- Marking – VLAN 802.1Q/P
- Hierarchical Policing
  - Port rate limiting
  - Per flow/service traffic class
  - Broadcast/Mutlicast/Unknown Unicast policing
- WRED – Color aware queue management
- Hierarchical Queuing
- Scheduling: Strict priority and WFQ
- Shaping per port

ETHERNET OAM & PM

- Link OAM: IEEE 802.3ah local and remote loopback with internal 1Gbps traffic generator, OAM statistics
- Service OAM: IEEE 802.1ag / ITU-T Y.1731
  - Down MEP and UP MEP with CCMs rate of 3.3msec and up to 10seconds, Loopback, Link-Trace
- Ethernet PM: ITU-T Y.1731
  - Loss-Measurement, Delay-Measurements, jitter
  - 96x15 minutes intervals: min&max jitter, min&max delay, frame loss ratio , unavailable seconds
- Alarms: RDI, LOS, XCON (configuration mismatch)
- Loopback: Facility loopback with MAC swap
- MEF 10.1 Ethernet Service Attributes
- Support MEF Service OAM IA

PSEUDOWIRE SERVICES

TDM

- Framed (CESoPSN; RFC 5086)
  - n x DS0 (1=< n =< 31)
- Unframed (SAToP; RFC 4553)
- CES over Ethernet: MEF3/8/18
- Jitter buffer: configurable 1ms – 256 ms

ATM

- Complying with RFC 4717
- Cell-based (AAL0)
  - VPC, VCC
- Frame-based (AAL5)
- ATM cell concatenation: single or multiple cells encapsulated per Pseudowire frame
- ATM VP/VC cross connect
- ATM IMA UNI

HDLC/PPP

- Complying with RFC 4618
- Port mode

FRAME RELAY

- Complying with RFC 4619
- One-to-One mode
- Port mode

ETHERNET

- Complying with RFC

PSEUDOWIRE OAM & PM

DIAGNOSTICS

- VCCV-BFD
- Tunnel Connectivity Check (TCC)

PERFORMANCE MONITORING

- CES-PM (G.826)

TDM OAM & PM

DIAGNOSTICS

- Tunnel Connectivity Check (TCC)
- Terminal (Local) loopback
- Facility (Remote) loopback
- In-band loopback

TDM OAM & PM

PERFORMANCE MONITORING

- CES-PM (G.826)
- T1 / E1 (G.826)
  - 5 X 24 hour interval
  - 96 X 15 minute interval
  - ES, SES, UAS

ALARMS

T1

- Alarm Indications Signal (AIS)
- Remote Alarm Indication (RAI)
- Loss of Signal (LOS)
- Loss of Framing (LOF)

E1

- Alarm Indications Signal (AIS)
- Remote Alarm Indication (RAI)
- Loss of Signal (LOS)
- Loss of Framing (LOF)
- Loss of Multi-framing (LOM)
- Remote Loss of Frame Indication (RAIM)

TIMING

- IEEE 1588-2008 (Precision Time Protocol) complying with: Telcordia TR-62411, ITU-T G.823, G.824, G.8261
- High Precision Clock Recovery (HPCR®) complying with: Telcordia TR-62411, ITU-T G.823, G.824, G.8261
- Quasi-Precision Adaptive Clock Recovery (ACR)
- Per T1/E1 clock recovery
- External clock (BITS)
- Loopback timing
- Internal -- 25 ppm (non-HPCR)

PROTECTION

- Ethernet link aggregation (IEEE 802.3ad)
- G.8032 Ring Protection
- Clock & Timing source protection
- Optional power supply redundancy

POWER FEEDING

- Single or redundant (1+1) field-replaceable and hot-swappable power supplies
- DC: +24 VDC (+18 to +30 VDC)
- DC: -48 VDC (–40 to –60 VDC)
- AC: 100 - 240 VAC (90 to 264 VAC), 50/60Hz

MAXIMUM POWER CONSUMPTION

- 120 Watts

FAN UNIT

- Hot-swappable fan module with multiple independent cooling fans

ENVIRONMENTAL SPECIFICATIONS

- Operating temp: -40ºC – 65ºC
- Humidity: Up to 95% non-condensing

REGULATORY SPECIFICATIONS

- Safety: UL 60950-1, CE EN 60950-1
- EMC: GR-1089, FCC part 15-class B (USA) ETSI 300-386-2 Class B, VCCI Class B
- Environmental: EN 300-019, GR-63
- RoHS-6

DIMENSIONS & WEIGHT

- ETSI or 19" or 23" rack-mountable
- CM: 4.4 x 44.0 x 22.0 (H x W x D)
- Inches: 1.75 x 17.5 x 8.75 (H x W x D)
- Fully populated: 10 lbs; 4.5 kg

CARRIER ETHERNET MEF Certified Compliant

DragonWave

www.dragonwaveinc.com

82-000059-01-02 Version 3

FUSION A1600/A800

PSEUDOWIRE AGGREGATION HUBS

INNOVATIVE SOLUTIONS FOR MOBILE WIRELESS RAN BACKHAUL OVER CARRIER ETHERNET AND IP ACCESS NETWORKS

DRAGONWAVE'S FUSION A1600 AND A800 PSEUDOWIRE AGGREGATION HUBS ARE FLEXIBLE, MODULAR, CARRIER-CLASS PLATFORMS THAT ENABLE SERVICE PROVIDERS AND OTHER OPERATORS TO SUPPORT LEGACY TDM AND LAYER-2 SERVICES AND PROTOCOLS OVER ANY NEXT GENERATION PACKET NETWORK (ETHERNET, IP, MPLS).

The Fusion A1600/800 platforms are extremely scalable, fully redundant systems that have been specifically designed for mobile wireless backhaul and business service delivery central office applications.

Enables New Converged Multiservice Edge

The A1600 and A800 are typically deployed as hub points between packet-based access networks and legacy networks, such as a mobile wireless core network (GSM, UMTS and CDMA) carrying TDM, ATM, HDLC or Frame Relay protocols. When deployed at the edge of a packet-based access network, the A1600/A800 operate as companion systems together with core network infrastructure switches and routers and are used to terminate large concentrations of pseudowire-based legacy services such as T1/E1 TDM or ATM virtual circuits. The A1600/800 supports multiple physical interface types including T1/E1, DS3, OC3/STM1 and OC12/STM4 for traffic hand-off to legacy voice or mobile switching platforms, SONET ADMs, Digital Cross Connects or ATM platforms.

SOLUTION HIGHLIGHTS

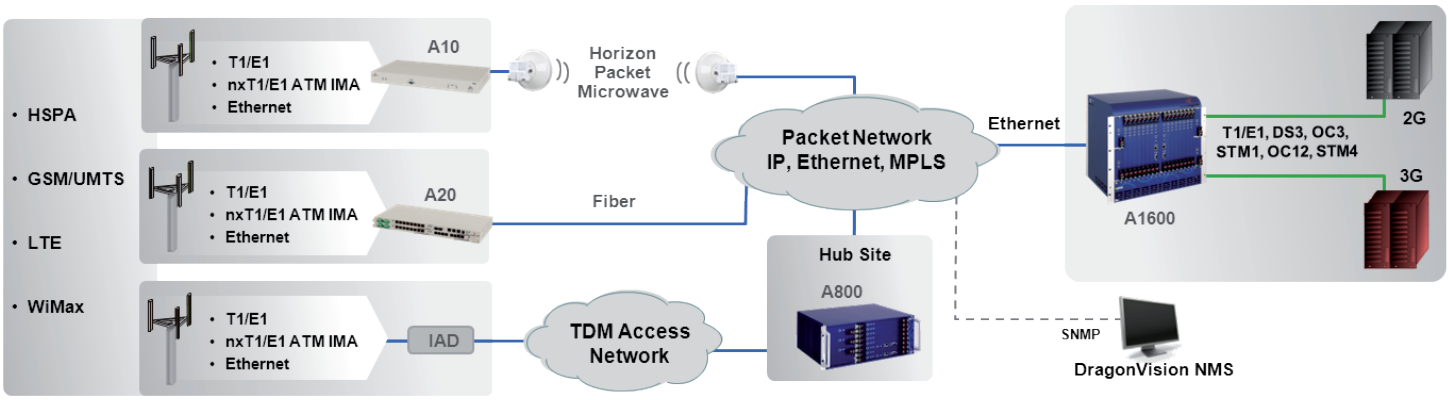
- High Capacity System, supports termination of over 1,100 T1/850 E1 emulated circuits
- The industry's most comprehensive set of IETF PWE3-compliant pseudowire capabilities including T1/E1 CESoPSN/ SAToP, ATM, HDLC, and Frame Relay
- Broad range of channelized (DS0) and unchannelized narrowband and broadband physical interfaces
- "Telco-grade" carrier-class availability through a complete set of redundancy capabilities
- Advanced QoS mechanisms, including multiple prioritized queuing, DiffServ, and 802.1Q/P CoS on a per-service flow basis
- Advanced management capabilities through DragonWave's CLI and DragonVision NMS

KEY APPLICATIONS

- GSM/UMTS and CDMA/CDMA2000 RAN backhaul
- Business Service Delivery

Industry-Leading Pseudowire Platforms

The A1600 and A800, when used in concert with other DragonWave Fusion products, provides a robust end-to-end legacy services delivery solution that meets any carrier application, site or capacity requirement. Whether the requirement is for 2G/3G mobile backhaul, legacy business services delivery, or legacy protocol packet network transport, the A1600/800 platforms provide a comprehensive central site solution for the aggregation, switching and termination of legacy traffic streams.



Product Sheet

PHYSICAL INTERFACES

IOM LINE CARDS (IOM)

- 16-port channelized T1/E1
- 3-port channelized (DS0) T3
- 1-port channelized (DS0) OC-3/STM-1
- 3-port OC-3c/STM-1 ATM
- 2-ports channelized (DS0) OC-12/STM-4 or
  - 8-ports channelized (DS0) OC-3/STM-1

NETWORK UPLINK (INI)

- 2-ports Gigabit Ethernet 1000BaseX

MANAGEMENT CARD (ICP)

- RS-232, RJ-45

POWER OPTIONS

- DC Power: -36 to - 72 VDC
  - Nominal: -48, -60 VDC
- AC Power: 90 to 264 VAC
  - Nominal: 100 – 240 VAC

RESILIENCY

- OC-n/STM-n: L-MSP/LAPS, equipment and link protection
- INI: 1:1 Redundancy, LAG (IEEE 802.3ad), equipment and link protection
- Power Supply 1:4 Redundancy (1600)
- Power Supply: 1:3 Redundancy (800)
- ICP: 1:1 Redundancy
- All modules are hot swappable

PSEUDOWIRE SERVICES

TDM-CES

- Framed (CESoPSN)
  - n x DS0 (1=< n =< 31)
- Unframed (SAToP)

ATM

- Cell based (AAL0): VCC/VPC/Port, VCC bundle
- Frame based (AAL5): VCC

HDLC/PPP

- Port mode

FRAME RELAY

- One-to-One mode
- Port mode

IP SERVICE INTERWORKING

- FR, HDLC, PPP, ATM-AAL5

ETHERNET SERVICES

- Bridging/Forwarding between Ethernet interfaces
- Port-based VLAN tagging
- VLAN stacking per customer VLAN
- Rate limiting (per port)
  - Up to 1 Mbps – 512 kbps steps
  - 1 Mbps up to 100 Mbps – 1 Mbps steps
  - 100 Mbps up to 1 Gbps – 10 Mbps steps

OAM

DIAGNOSTICS

- Terminal (Local) loopback
- Facility (Remote) loopback
- FDL
- In band loopback
- BERT

PERFORMANCE MONITORING

- According to ITU-T G.826

ALARMS

- According to ITU-T G.706, G.751, G.775, G.783, T1.107

Physical Specifications	A1600N	A1600E	A800
Dimensions (H x D x W) Inches Centimeters	 9 RU x 13.7 x 19” 40 x 35 x 43.6	 14 RU x 10 x 19” 65 x 25 x 43.2	 4 RU x 14.4” x 19” 17.8 x 36.5 x 43.6
Weight	9.6Kg	11Kg	8.32Kg
Number of Slots	16	16	8
Architecture	Mid-Plane carrier class 2 x INI (redundant) 2 x ICP (redundant) 12 x IOM	Mid-Plane carrier class 2 x INI (redundant) 2 x ICP (redundant) 12 x IOM	Mid-Plane carrier class 2 x INI (redundant) 2 x ICP (redundant) 4 x IOM
Mounting	19” Telco Rack	19” ETSI (300 mm depth)	19” Telco Rack

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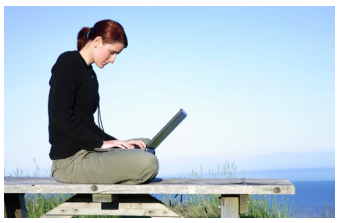
BUILDING BETTER BACKHAUL EVERYWHERE



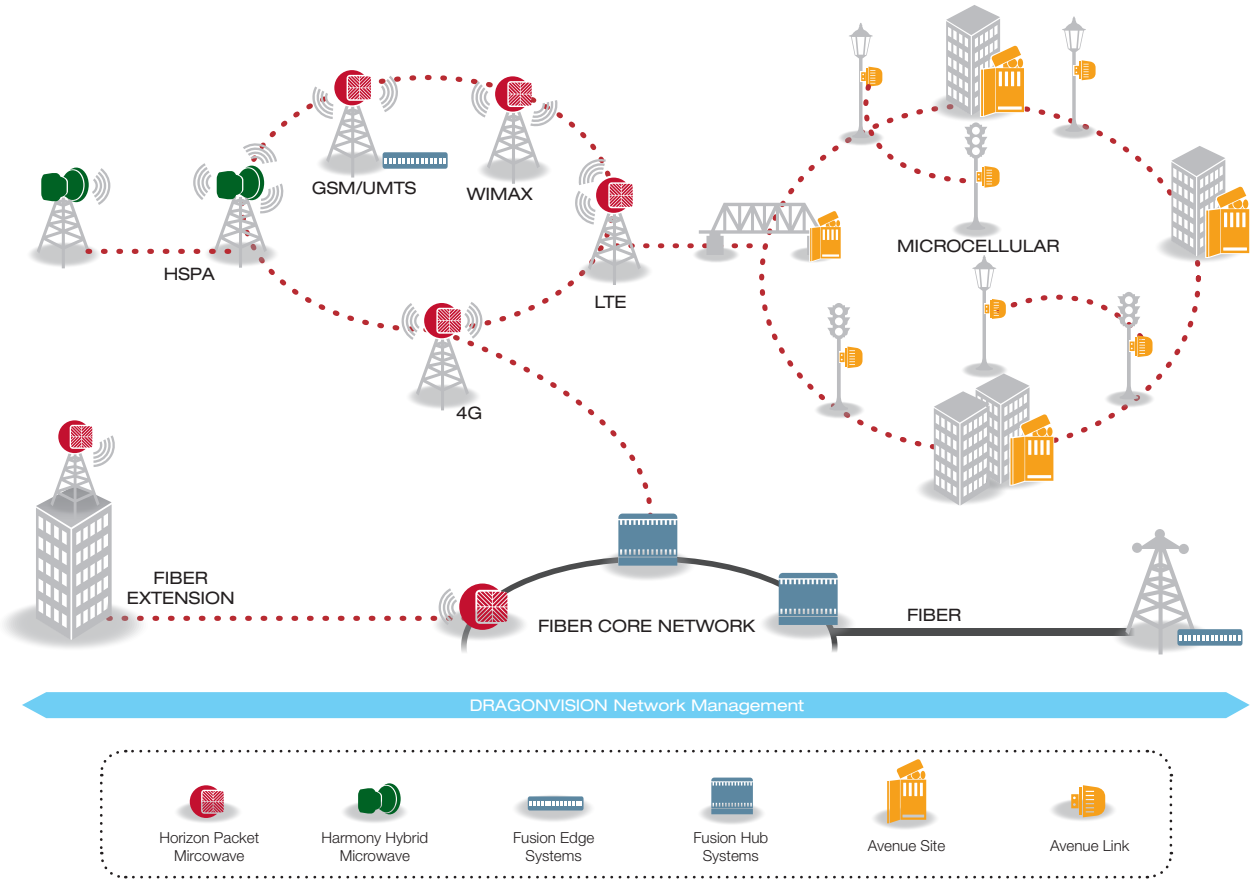


DRAGONWAVE PRODUCT GUIDE

BUILDING BETTER BACKHAUL EVERYWHERE

As service providers and enterprises scale their wireless access networks to enable powerful new applications and services, many existing backhaul solutions are rapidly becoming a major bottleneck. DragonWave is building better backhaul everywhere with packet and hybrid microwave backhaul solutions that unleash the potential of true broadband mobility. Designed to meet the varied requirements of mobile networks, microcellular deployments and trunking applications, our highly flexible backhaul solutions deliver unmatched capacity, reliability and cost efficiency, while supporting a smooth evolution to advanced packet networks.

DRAGONWAVE SOLUTIONS



DRAGONWAVE APPLICATIONS

4G-Optimized Backhaul

Engineered for the requirements of tomorrow's networks, DragonWave's solutions respond to the needs of WiMAX and LTE service providers, delivering native packet transport, sub 0.1 ms latency, multi-Gigabit capacity and convergence of existing TDM traffic.

Multi-Generation Mobile Backhaul

DragonWave's backhaul solutions offer a smooth transition from 2G to next generation 3G or 4G networks by offering TDM and packet interfaces and a single end-to-end management framework.

Leased Line Replacement

Replace TDM leased line services and eliminate expensive recurring telecom costs while improving capacity and availability with an Ethernet packet network.

Last Mile Fiber Extension

Extend high-speed IP services beyond your existing network. DragonWave products are ideal for network hardening and disaster recovery, as well as for applications that require both legacy TDM services and carrier-grade, high-capacity native Ethernet.

Network Evolution

DragonWave offers the industry's only software-configurable microwave solution that can easily switch from hybrid to full-packet transmission, providing a simple and intelligent future-proof network evolution.

New Service Enablement

Cable MSOs, fiber providers and other packet network operators gain immediate new revenue opportunities by offering profitable traditional services such as T1/E1 private line and PBX voice backhaul, as well as advanced Carrier Ethernet services.

Private and Enterprise Networks

Municipalities, healthcare facilities, financial institutions, schools, government institutions and other organizations can build carrier-grade private networks, achieving payback within the first year.

Public Safety

DragonWave provides essential inter-site connectivity and backhaul solutions for first responders, city facilities, wireless mesh networks, surveillance systems, city fleets and sensor networks.

Microcellular Networks

DragonWave's fully integrated, zoning-friendly microcellular platforms allow mobile operators to expand their mobile presence, improve in-building coverage and increase network capacity in high user-density areas.






HORIZON COMPACT+ | HORIZON QUANTUM | HORIZON S-SERIES | HORIZON E-SERIES | AVENUE LINK | AVENUE SITE

HORIZON

PACKET MICROWAVE

DragonWave's Horizon packet microwave solutions deliver new levels of capacity, spectral efficiency and reliability—all at the lowest total cost of ownership. To provide maximum flexibility, DragonWave Horizon products operate in licensed or unlicensed frequencies from 2.3 GHz to 80 GHz. For all-outdoor requirements, the Horizon Compact+ delivers big performance in a small package by integrating the radio and modem into a single highly compact unit. The Horizon Quantum split-mount system delivers unparalleled capacity, while supporting multi-carrier operation, advanced synchronization and nodal intelligence, making it the most powerful packet microwave solution available today. DragonWave's S-Series radios deliver non-line-of-sight performance in sub-6 GHz frequencies, while our E-Series millimeter-wave solutions provide high capacity point-to-point links in 70/80 GHz spectrum.

With unmatched radio performance, simple installation and operation, as well as sophisticated remote management capability, Horizon solutions deliver significant life-cycle cost savings for service providers, government agencies and enterprises.

- Licensed and license-exempt point-to-point wireless from 2.3 GHz to 80 GHz
- Up to 2 Gbps per 56 MHz channel with DragonWave's Bandwidth Accelerator and XPIC
- Network synchronization with SyncE and 1588v2
- TDM/Ethernet interface options for network evolution
- Service-aware radio to support differentiated QoS with up to 8 hardware queues
- Hitless Automatic Adaptive Modulation (HAAM)
- All-outdoor, split-mount and all-indoor deployment options
- Pay-as-you-grow with automatic remote scalability
- Advanced security with integrated 256-bit AES encryption
- Comprehensive Ethernet OAM support (802.3ah, 802.1ag, Y.1731)
- Ethernet ring protection

AVENUE

MICROCELLULAR SOLUTIONS

DragonWave's Avenue portfolio comprises several microcellular solutions ranging from a single microcell backhaul link (Avenue Link), to a fully-integrated microcellular unit (Avenue Site) containing up to three high capacity packet microwave backhaul radios and antennas, Ethernet switching, power supply, battery backup and a slot for a 3G/4G micro base station.

All Avenue solutions are integrated within an environmentally hardened enclosure that is optimized for street-level deployment in urban environments. Engineered to provide the greatest flexibility for mobile operators, Avenue products can be deployed on any number of structures including street lamps, traffic light poles, or building sides. Avenue systems are designed to meet size, weight and aesthetic requirements set by city zoning officials, allowing the units to blend into urban environments.

Avenue systems operate in 24, 28, 31, 38 and 60 GHz bands and are completely interoperable with other DragonWave solutions.

- Avenue Site offers a fully integrated microcellular platform:
  - Up to 3 independently aligned packet microwave radios
  - Battery backup
  - Power supply
  - Ethernet switching
  - 3G/4G RAN slot
  - Flat-mini antenna(s)
- Avenue Link includes integrated backhaul radio and flat-mini antenna
- Zoning-friendly, environmentally hardened enclosure
- Backhaul powered by Horizon for unparalleled packet microwave performance

HARMONY RADIO | HARMONY FIRST MILE & HUB | HARMONY TRUNK | FUSION A1/A10/A20 | FUSION A800 | FUSION A1600

HARMONY

PACKET HYBRID MICROWAVE

As the industry's only software-selectable evolution from hybrid to all-IP packet networks, Harmony is the intelligent solution for operators looking to future-proof their network investment. This unique solution can operate in hybrid or full-packet traffic modes, enabling a simple migration path from TDM to all-IP backhaul with true "zero-touch" on the existing hardware. This results in simplified operations, reduced capital cost and significant savings in total cost of ownership, while meeting the most stringent network requirements for highly time-sensitive applications.

With the ability to operate either standalone or with the Harmony First Mile or Hub indoor units, the Harmony Multi-Radio can be optimized for each site, saving on capital and operations by reducing the number of elements in the network.

For high capacity, long-haul applications, the Harmony Trunk offers high power transmission and a simple software-enabled migration from full-TDM to Hybrid TDM/IP to full-IP.

- Software-selectable hybrid and/or full packet air interface
- 3.5 to 42 GHz frequency coverage
- Pay-as-you-grow scalability up to 1 Gbps per 56 MHz channel
- XPIC for double capacity in the same channel bandwidth
- Network synchronization with SyncE and 1588v2
- Service-aware radio to support differentiated QoS with up to 8 hardware queues
- Hitless Automatic Adaptive Modulation (HAAM)
- All-outdoor, split-mount and all-indoor deployment options
- Pay-as-you-grow with automatic remote scalability
- Space and frequency diversity with multiple protection options
- 802.1ad provider bridging and 802.1Q bridging
- E-LINE and E-LAN services
- Comprehensive Ethernet OAM support (802.3ah, 802.1ag, Y.1731)
- Ethernet ring protection

FUSION

PACKET CONVERGENCE

DragonWave Fusion packet convergence solutions enable a smooth migration to a flat packet network, driving greater efficiency, lower cost, simplified operations and new revenue opportunities from mobile backhaul and business services. Fusion products come in a variety of both fixed and modular configurations with port and packet processing capacities to meet a wide range of edge or central office site requirements and network topologies.

Mobile service providers can cost effectively transition from TDM-based backhaul to hybrid and all packet-based backhaul while replacing costly leased line access and avoiding the complexity of running multiple overlay networks. Wireline service providers are able to preserve customer revenue from traditional services while migrating to next generation networks. Carrier Ethernet service providers gain immediate new revenue opportunities by offering profitable traditional services such as T1/E1 private line and PBX voice backhaul, as well as advanced MEF certified ELINE and ELAN Ethernet services.

DragonWave Fusion solutions can be deployed in standalone applications or as a companion to Horizon radio systems.

- A single packet-based network to operate and manage
- Converged packet transport for less cabling, fewer network elements, and simple configuration of services
- Multiservice pseudowire capabilities
- ELINE and ELAN support
- Ethernet switching, aggregation, LAG and 8032 ring redundancy support
- High Precision Clock Recovery (HPCR®) — the industry's most robust adaptive clock recovery technology
- Comprehensive QoS and Ethernet OAM support
- Field-replaceable line cards and power supplies
- Carrier-grade redundancy
- Multiple interfaces (T1/E1, OC-3/STM-1, OC-12/STM-4, 10/100/1000 Ethernet)
- MEF certified

ONE SIMPLE MANAGEMENT SOLUTION

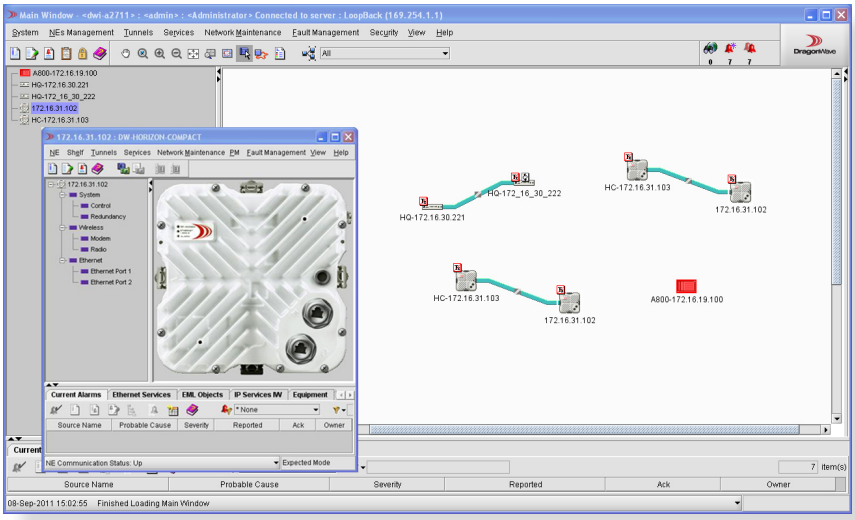
DRAGONVISION

NETWORK AND ELEMENT MANAGEMENT SYSTEM

DragonVision is a comprehensive carrier-class management solution for both the network and element system levels (NMS/EMS). DragonVision offers network operators a broad set of tools that simplify the operation, administration, maintenance and provisioning of DragonWave's end-to-end portfolio of Horizon, Avenue, Harmony and Fusion products. This solution also provides extensive fault management, performance monitoring, and security management capabilities.

This standards-based solution uses a highly scalable application server and delivers a real-time representation of network topology, connectivity, and operational status. DragonVision enables operators to respond quickly to changing requirements, thereby reducing time to-service, and delivering significant operational cost savings.

- Simple and intuitive point-and-click Graphical User Interface (GUI)
- End-to-end service provisioning
- Network-wide device discovery
- Real-time dashboard with performance monitoring, statistics and charting
- Bandwidth utilization indicators
- Advanced fault isolation and management
- Real-time configuration and security management
- Simple integration with external OSS
- Innovative and scalable application server architecture



DRAGONWAVE FEATURES AND BENEFITS

Unparalleled Capacity

- DragonWave's Bandwidth Accelerator drives 1 to 2 Gbps per 56 MHz channel
- Highest capacity XPIC
- Maximum throughput at the lowest cost per bit

Broad Frequency Support

- Licensed and license exempt frequencies from 2.3 to 80 GHz

Flexible Deployment

- Available in all-indoor, all-outdoor or split-mount implementations
- Modular, pay-as-you-grow platforms

Hybrid Solutions

- Software-configurable evolution from Hybrid TDM/packet to full-packet
- "Zero-touch" on the existing hardware

Microcellular Architectures

- Fully integrated microcellular platforms
- Single link or nodal applications
- Designed to meet city zoning requirements

Spectral Efficiency

- Bandwidth Accelerator drives more capacity within existing spectrum allocations
- 7 to 56 MHz channel size options
- Up to 2048QAM
- XPIC enables channel reuse

Extended Reach

- Hitless Automatic Adaptive Modulation (HAAM) for longer link spans, smaller antennas and fewer sites
- Provides up to 111 dB system gain, enabling link lengths beyond 50 km (30 mi)

Eco-Friendly

- Zero footprint
- No trenching or traffic disruption required
- Lowest power consumption per bit
- Zoning friendly

Advanced Security

- Advanced security with integrated 256-bit AES encryption
- Narrow beamwidth, directional point-to-point communications
- Bit-level data stream with Horizon synchronization and framing
- Horizon authentication
- Leading network management security

Network Intelligence and Protection

- Intelligent nodal switching for simplified operation
- Advanced ring and mesh configurations with 50 ms switching for carrier class services
- Active use of both working and protection channels eliminates wasted capacity
- Offers 1+0, 1+1, space diverse, and frequency diverse options
- Integrated bandwidth management features include advanced prioritization and flow control
- RSTP/MSTP, G.8031, G.8032 network protection

Seamless Multiservice Convergence

- Converged packet solutions for microwave and fiber networks
- T1/E1, nxE1 ATM IMA, Ethernet convergence
- Integrated bandwidth management
- Simplified operations and management
- Comprehensive services, including TDM, ATM, HDLC/PPP, Frame Relay, Ethernet
- True packet network convergence—no need to manage TDM connections at intermediate network points

Timing and Clock Recovery

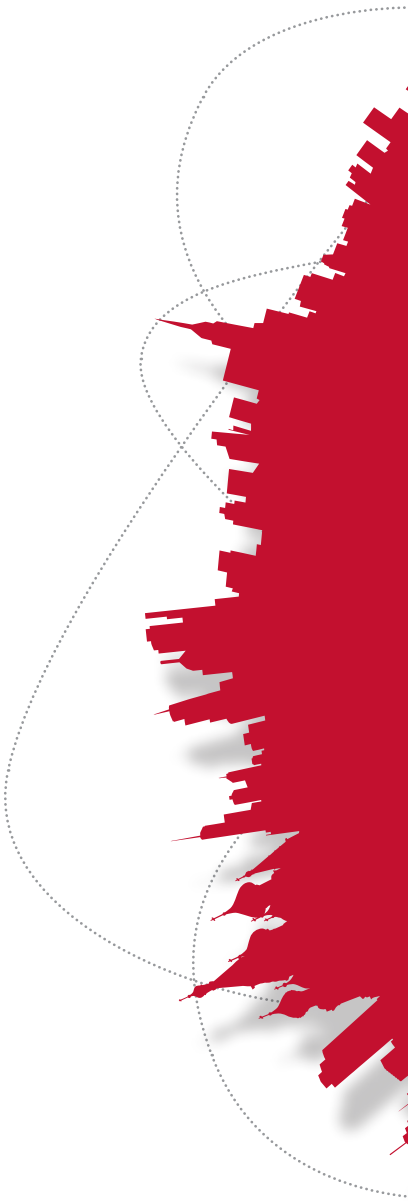
- HPCR® – the industry's most robust adaptive clock recovery technology
- IEEE 1588-2008 (Precision Time Protocol)
- External clock (BITS)
- Clock protection
- Loopback timing
- Synchronous Ethernet (SyncE) support
- Optimized transport of 1588v2

Comprehensive Management

- End-to-end management and provisioning with DragonVision NMS
- Advanced Ethernet OAM & PM support (802.3ah, 802.1ag, Y.1731)
- TDM and Layer-2 OAM & PM

Advanced QoS

- Advanced traffic management
- 8 levels of prioritized queuing
- Service-aware HAAM



DragonWave

Connect with us today!

www.dragonwaveinc.com

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