Product Overview

Horizon Compact+

DragonWave

www.dragonwaveinc.com

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CORPORATE OVERVIEW

DragonWave® is a leading provider of high-capacity packet microwave solutions that drive next-generation IP networks. DragonWave's carrier-grade point-to-point packet microwave systems transmit broadband voice, video and data, enabling service providers, government agencies, enterprises and other organizations to meet their increasing bandwidth requirements rapidly and affordably. The principal application of DragonWave's products is wireless network backhaul. Additional solutions include leased line replacement, last mile fiber extension and enterprise networks. DragonWave's award winning Horizon® solutions are known in the industry for their leading capacity, reliability, and spectral efficiency.

DragonWave has a network of distributor and reseller partners globally. Customers include service providers, utilities, hospitals, schools, enterprises and other organizations. All are assured the highest level of excellence in product design, product quality, and overall customer service and support. DragonWave's corporate headquarters is located Ottawa, Canada, with sales locations across the globe. DragonWave has been widely deployed since 2001, with thousands of customers in over fifty countries.

HORIZON COMPACT+ SUMMARY

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.

SOLUTION HIGHLIGHTS

- Zero footprint, fully integrated all-outdoor unit
- 1 to 2 Gbps capacity with DragonWave's Bandwidth Accelerator
- Service aware Hitless Automatic Adaptive Modulation (HAAM)
- Synchronous Ethernet (SyncE) support
- 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 DragonView NMS
- Lowest total cost of ownership solution
- 6 to 60 GHz frequency support

SOLUTION FEATURES

Reliability

DragonWave products are designed to operate in the harshest environments, from extreme cold to extreme heat. The Horizon Compact+ has an operational temperature of -40° to 60°degrees C (with sun shield) and is currently deployed in a wide variety of climates. The actual mean time between failure (MTBF) routinely exceeds calculated values by a factor of 3 to 5.

Availability

The link availability of the Horizon Compact+ is characterized by DragonWave's link planning software. A web-based link planning application allows operators to predictably engineer a link to provide 99.999% path availability, if required.

DragonWave's solutions have a native IP design, enabling ultra-low latency over the link. This provides the base required for time-sensitive mission-critical applications such as Voice-over-IP and Video-over-IP, including streaming associated with distance learning applications.

The DragonWave Ethernet-based solution keeps time-sensitive traffic on the native Ethernet transport layer. This dramatically reduces the risk of incurring delays associated with segmentation and re-assembly (SARing in ATM transport) or frame adaptation (in SONET transport).

Service availability is delivered through a rich set of redundancy options, from conventional 1+1 hot standby, to patented Rapid Link Shutdown which delivers ring and/or mesh failover in under 50 ms using standard Ethernet switching, to reduce the mean time to repair for outdoor components.

Rapid Deployment and Ease of Operation

The Horizon Compact+ can be installed using alignment/performance software that runs on a Windows-based device, greatly simplifying the installation and support function at the tower site. Horizon offers the flexibility to choose the location of the electronics of the wireless unit either outdoors with the antenna, eliminating the need for indoor space, or indoors at the bottom of the tower, in the equipment hut.

Horizon Compact+ integrates the modem and radio functions together into a single, rugged outdoor unit (ODU). The elimination of multiple units per end, coupled with Ethernet and the introduction of RF loopback, dramatically simplifies installation and troubleshooting. The elimination of the indoor unit removes cabling congestion and the air conditioning burden on the base station cabinet, further simplifying the installation.

Flexible management is another important advantage; Horizon systems can be managed with DragonWave's DragonView element management system or any other standards-based management system. Not only does this decrease the cost of the solution, but it also simplifies the network operation by minimizing the number of different management platforms that need to be maintained. Through the use of the radio's internal embedded HTTPS server, customers are able to manage any unit from any terminal that has secure access to the management network. DragonWave uses

industry standard SNMP MIBs, supporting SNMP v1, v2c, v3, and RADIUS to monitor radio and network parameters, and is designed to easily integrate into any existing SNMP based management system. Management traffic may be carried in-band directly, over a private 802.1q VLAN, or through an out of band solution.

Bandwidth Accelerator

DragonWave's Bandwidth Accelerator feature combines white space suppression, lossless bulk compression, and header optimization technology to significantly enhance the efficiency of microwave transmission. Unlike lossy compression technology, which decides which data to send based on what it considers to be useful, Bandwidth Accelerator uses lossless compression, looking for patterns in both the header and the payload information string in order to substitute these with shorter representative "codes". This is done without losing any of the original data.

The bulk compression function of the Bandwidth Accelerator achieves gains similar to those found in software compression tools used to reduce file sizes; yet it is able to do this in real-time at high speeds thanks to DragonWave's innovative technology. The header optimization and white space suppression also provide additional throughput gains.

The Bandwidth Accelerator feature delivers more than twice the throughput improvement compared to simple header compression techniques. Additionally, the operator is able to specify whether to turn Bandwidth Accelerator on or off for individual queues and can select which block size to use in order to achieve optimized throughput and latency for each traffic type carried in the network.

Enabling the Bandwidth Accelerator feature on the Horizon Compact+ introduces minimal latency while compressing and decompressing data, while storing data until a compression block is filled - and as the data stream is buffered at the far end of the link. Also, latency increases linearly with block size – a parameter which is set by the end user.

Packet delay variation can occur when non-compressed time-sensitive queues collide with large output blocks – the result of low compression gain. This situation is similar to instances where time-sensitive queues are mixed with all jumbo frames. Selecting smaller block sizes minimizes the number of collisions and reduces the packet delay variation of the system.

FLEX

FLEX was developed specifically for customers with rapid scalability requirements, delivering a bandwidth scalable solution from 10 Mbps up to 800 Mbps per link. These capacity levels can be doubled in a dual-polarization configuration. FLEX allows the operator to address a wide spectrum of customer requirements using just one product platform. FLEX also lowers the operator's risk and initial investment when connecting customers with a low capacity requirement today without committing to a future upgrade. The operator is then able to deploy a fully scalable transmission system at a substantially reduced entry price, resulting in an attractive business case.

Keyless Capacity Upgrades

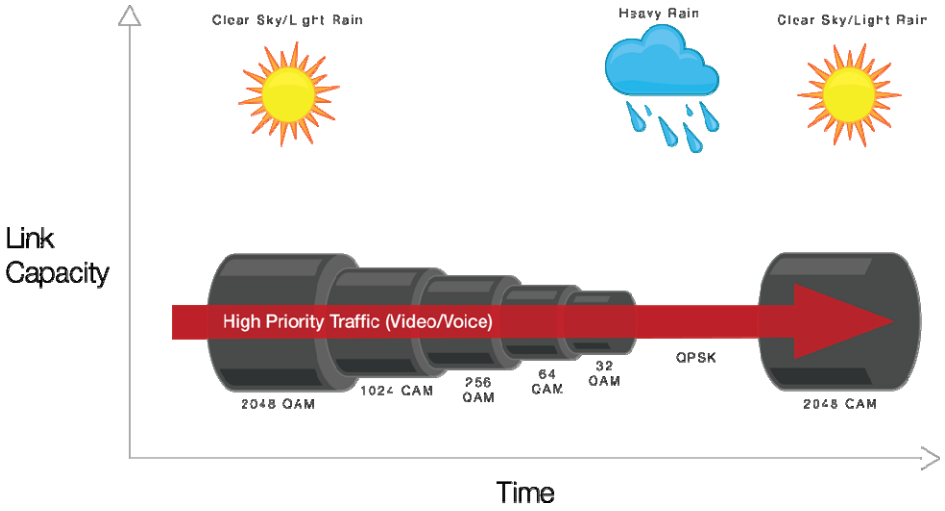
DragonWave's unique keyless capacity upgrade is a simple and automatic remote scalability option where the purchase price is based on current capacity requirements. Daily radio logs track rolling average capacity usage, triggering a capacity upgrade based on pre-negotiated parameters. This greatly simplifies network operations by eliminating the need for network capacity forecasting and license key administration. Additionally, this system provides accurate information on the actual network utilization. An added benefit of the keyless features is free restoration bandwidth for ring/mesh by allowing the network to burst to higher data rates, during an outage, without incurring the cost of a capacity upgrade - as long as MTTR is shorter than the trigger period.

Hitless Automatic Adaptive Modulation (HAAM)

AAM is a software-enabled feature which allows the modulation scheme to fluctuate from its defined operating mode, shifting to a lower modulation when weather conditions cause signal levels to deteriorate below acceptable levels. This allows the radio link to remain intact, at a lower modulation rate and lower throughput level. The modulation is then returned to the original scheme, and the throughput is returned to normal, once the link operates above an acceptable level. This system supports intermediate modulation schemes ranging from QPSK to 2048 QAM, which are software selectable at any time.

This feature is combined with adaptive coding and adaptive power (where permitted) to provide the most efficient operation. This switch operation is hitless.

On average, fade events requiring a modulation shift only take place a couple times per month, lasting just a few minutes per occurrence.



Automatic Transmit Power Control (ATPC)

ATPC is a software-enabled feature that allows the transmit power of the radio ends to power down by up to 20dB in un-faded conditions where link availability would not be affected.

Advanced Security

DragonWave's Horizon systems are highly resistant to data intercept and decoding and offer a number of imbedded security characteristics, including:

- Integrated 256-bit AES encryption

- Narrow beamwidth, directional point-to-point communications
- A bit-level data stream with Horizon synchronization and framing
- Multi-level authentication
- TACACS+ support
- Leading network management security

In addition, Horizon systems are inherently secure from common intrusion schemes for signal intercept and decoding. Any intruder even attempting to extract the wireless signal would have to execute a very elaborate plan involving all of the following:

- Direct access to the LAN/WAN data stream via network equipment at the customer premises
- Access to appropriate user names and passwords
- Physical access to the Horizon units
- Direct inline access to the narrow-beam signal using a DragonWave Horizon system as the receiver. If Horizon authentication is enabled, even a 3rd Horizon system would not be able to communicate with the secure link. Any other non-DragonWave receivers would not be able to decode the Horizon synchronization and framing information.

If data security over the physical LAN connection by way of tapping into Ethernet cable or a LAN device is a concern, DragonWave recommends the use of a Virtual Private Network (VPN) between Horizon endpoints.

Network Synchronization

Because synchronization is the building block of traditional networks, the Horizon Compact+ is designed to seamlessly transport TDM services and support Synchronous Ethernet (SyncE), and can transparently pass 1588v2. Support of these synchronization standards ensures that all existing and future services can be converged of in a single packet infrastructure.

Broad Frequency Support

The Horizon Compact+ is designed for use over a variety of internationally licensed frequency allocations. Frequencies that are currently supported include:

- 6, 7, 7/8, 8, 10.5, 11, 13, 15, 18, 23, 24 DEMS, 26, 28, 31, 32, 38, 60 GHz

Advanced Ethernet Feature Support

DragonWave's Horizon Compact+ offers several integrated bandwidth management features, including 4 different levels of prioritization and advanced flow control via 802.3X, expedite queuing, VLAN queuing, Weighted Fair Queuing, strict queuing, and expedite queuing. Prioritization is based on 802.1p/q, MPLS, or DSCP. Additionally, the Horizon systems support jumbo frames for increased network performance and efficiency.

DragonWave's patented Rapid Link Shutdown (RLS) detects error conditions and triggers 50-100 ms

switching, with industry standard RSTP, PBT, and MPLS switches, activated when a predetermined threshold is met.

Differentiated Services Code Point (DSCP) is supported for DragonWave's Quality of Service (QoS) policy enforcement.

Multiple Protection Options

Ring/Mesh

DragonWave's ring/mesh configuration enables carrier grade performance, while achieving the lowest network cost. DragonWave's ring/mesh provides 99.999% availability by providing redundant link diversity from each location. The Ring/Mesh N+1 architecture requires only one more link than there are nodes, thus minimizing network costs. This is a significantly lower factor than on a 1+1 architecture, where at least two or more links are needed per node, depending on the diversity required.

Other benefits of the DragonWave ring/mesh configuration include:

- Shortened Radio Links – requiring reduced antenna size and repeater requirements;
- Angle Diversity – providing 5 to10x per link availability improvements;
- Option for 3rd diverse links from any node; and
- Option for 2nd hub node to provide nodal redundancy.

Ring/Mesh is deployed by using DragonWave links, in tandem with an approved Ethernet switch, and a DragonWave multi-beam antenna assembly. The Ethernet switch provides protection switching in less than 50 ms.

1+0 and 1+1 Space and Frequency Diverse Protection

A single Horizon link carries all the traffic requirements between two locations enabling the lowest link cost, while providing 99.999% network availability, and delivering high-speed native Ethernet services. The 1:0 configuration is an extremely cost-effective solution which is ideal for 99.99% availability services.

Horizon solutions can be deployed in a fully redundant, 1+1 mode, using two complete links. Link1 is the "live/hot" link and link2 runs as the "standby" link. In a strictly redundant focus, all traffic runs on the hot link. When a hardware failure is detected, traffic is immediately switched to the standby link using Rapid Spanning Tree Protocol (RSTP) or Link Aggregation Control Protocol (LACP). For further link optimization, this configuration can support prioritized load sharing. The 1+1 configuration delivers <50ms protection Ethernet switching, creating a hardened redundant configuration.

Rapid Link Shutdown (RLS)

It is often desirable to signal or detect network link issues in the quickest manner possible. This is especially true when running Layer 2 redundancy protocols, such as Spanning Tree and Metro Ring

protocols. Signaling to the network is done by shutting down the Ethernet data port(s) connecting the Horizon Compact+ to the network. The Rapid Link Shutdown (RLS) feature provides this functionality.

Some situations that would result in Rapid Link Shutdown include:

- Link outage - should a power failure or a complete loss of link occur, the Ethernet ports at both ends of the link can be shut down.
- Far-end Ethernet connection problems – if the remote unit data Ethernet port is disconnected or disabled, the near-end unit Ethernet port will also be shutdown.
- Link quality problems – if the link quality (error rate) reaches user programmable thresholds, the Horizon Compact+ Ethernet ports can be shut down.
- Horizon Compact+ configuration or hardware failure – if hard faults, such as a hardware failure, interrupt the link, both Horizon Compact+ Ethernet ports can be shut down.

NETWORK MANAGEMENT

Element Management System Support

DragonWave platforms are designed with flexible, carrier-grade management requirements in mind. Using industry standard and customized MIBs to monitor radio and network parameters, Horizon systems can be managed by DragonWave's DragonView element management system or integrated directly into any SNMP management environment. Management traffic may be carried in-band or out-of-band directly and configurable for transport over a private 802.1q VLAN.

Horizon Compact+ can be managed locally, through the RS232 serial port or Ethernet management port. Local node management can be achieved using:

- A Windows-based PC, running a terminal emulation program such as HyperTerminal;
- DragonWave's web-based graphical user interface (GUI) which runs on any Windows PC;
- A smart phone or other devices running Windows or Windows CE

The system can also be managed remotely. Remote link management can be achieved using:

- Telnet
- DragonView
- A third party network management tool such as HP OpenView or Castle Rock SNMPc
- HTTP (Web-based management) with SSL/SSH

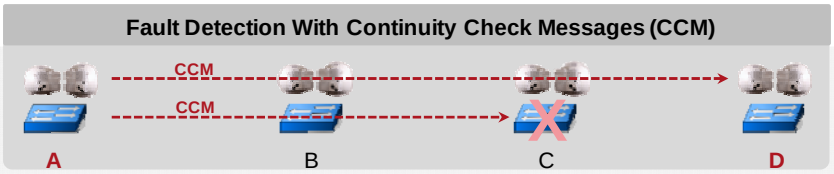
Remote management is available through the local Ethernet management port connected to the customer data communication network, or "in-band," meaning that special cables and network configurations, such as dial-up modems, are not required. With "in-band" management, all management traffic is within the same channel that carries the user's Ethernet traffic. Through the use of traffic prioritization, management traffic can be provisioned as either higher or lower priority than the actual load. This architecture is consistent with other managed Ethernet network devices, such as routers and switches.

Horizon systems detect and terminate all management traffic over both the ingress network connection and RF connections. Management traffic destined for a particular node is not passed outside of the node.

Management of the nodes can be performed anywhere in the network. The “Near End” Horizon node, being the node closest to the Network Management System NMS, is accessed in the same manner as the “Far End” node. The only difference is that the “Far End” management packets travel over the air link prior to delivery to the management software in Horizon systems. NMS workstations may be on both sides of the node, making “Near” and “Far” Ends semantically interchangeable based on the physical locations of the NMS.

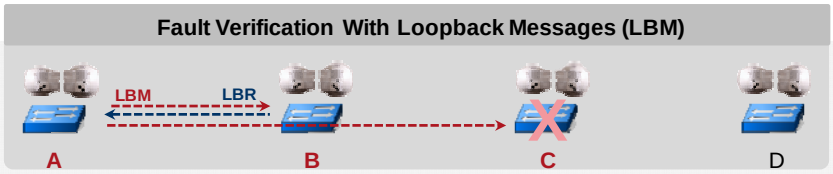
Ethernet OAM Feature Overview:

Fault Detection



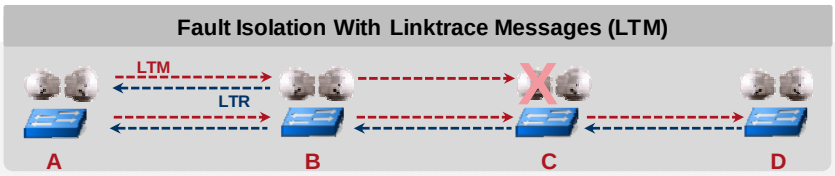
- 802.1ag and Y.1731 support fault detection through Continuity Check Messages (CCM).
- CCMs are sent from the source to destination node periodically. If either does not receive a CCM within a specified time a fault is detected against the service
- In this example A sends a CCM to D, which is not received.

Fault Verification



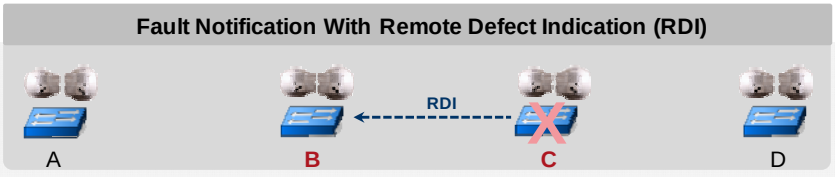
- 802.1ag and Y.1731 support fault verification through Loopback Messages (LBM) and Loopback Reply (LBR)
- These can be used during initial setup or when a fault has been detected in order to verify that the fault has occurred between two end points.
- In the example, after a loopback message is sent from A to B, then from B to C, identifying the location of the fault after a fault was detected somewhere between A and D by a CCM.

Fault Isolation



- 802.1ag and Y.1731 support fault isolation through Linktrace Messages (LTM) and Linktrace Reply (LTR)
- When a node received the LTM they respond with a LTR and pass on the LTM to the next node
- Under normal conditions this allows the operator to identify the path taken by the service
- Under a fault condition, this allows the operator to isolate the fault location

Fault Notification



- Horizon systems support fault isolation through Remote Defect Indication (RDI) specified in 802.1ag and Y.1731.
- When a downstream node detects a defect condition, it will send an RDI in the opposite upstream direction to its peer nodes, informing the upstream nodes that there has been a downstream failure.

System Testing

Designed to be globally compliant, DragonWave's complete product line has been certified for use in North America, Europe, and several Asian markets. The product has also been exhaustively tested by carrier customers prior to wide-scale deployment. Horizon products meet NEBs level3 requirements, and support CLEI codes.

APPLICATIONS

Engineered to meet the requirements of future networks, the Horizon Compact+ solutions address the technical and business challenges faced by next generation mobile operators by providing:

- Packet based architecture
- High-capacity and scalability
- Low latency
- Operational simplicity
- Legacy service support for network evolution
- Advanced queuing and Quality of Service (QoS) support
- Lowest total cost of ownership

LTE-Optimized Backhaul

LTE networks demand much greater backhaul capacity than most existing deployments can provide. Operators also want a fully packet-based architecture, Synchronous Ethernet and ultra-low latency. Engineered for the requirements of future networks, DragonWave's Horizon solutions respond to the needs of LTE service providers with sub 0.1 ms latency, native Ethernet, wire speeds from 2 to 4 Gbps and convergence of existing TDM traffic. The Horizon product line offers intelligent networking with integrated switching, hitless AAM, and integrated prioritization.

Leased Line Replacement

For many businesses, the only option for last mile access is an aging copper infrastructure with long MTTR. Horizon can replace leased services and eliminate expensive, recurring telecom costs. At the same time, businesses can improve availability and scale their capacity for new services over an IP network.

Last Mile Fiber Extension

Horizon delivers a superior method of rapidly extending high-speed IP services from locations already in the service provider's network. DragonWave products are ideal for network hardening and disaster recovery, as well as applications that require both legacy TDM services and carrier-grade, high-capacity native Ethernet.

Private and Enterprise Networks

Municipalities, healthcare facilities, schools, government institutions, and other organizations can build carrier-grade private networks, achieving payback within the first year. DragonWave's Horizon software-scalable GigE wireless mesh connectivity means no capacity constraints, and because it is licensed, there is no interference.

Network Evolution

Enable your existing network to carry emerging IP applications and services. DragonWave's converged IP backbone offers a simple solution for evolving to an IP-optimized network while seamlessly carrying legacy TDM services.

FREQUENTLY ASKED QUESTIONS

What are key differentiators for the Horizon Compact+?

The Horizon Compact was the industry's first all-outdoor packet microwave solution. The Compact+ builds on this success to deliver the most innovative all-outdoor solution available today. Differentiated, market leading features include:

- All-outdoor, zero-footprint solution for
  - Reduced site leasing costs
  - Low installation cabling costs
  - Reduced power consumption
  - Flexible deployment options
  - Operational simplicity
- Bandwidth Accelerator feature
- Highest spectral efficiency
- Keyless upgrades and remote, pay-as-you-grow bandwidth scaling
- RF loop back for improved fault isolation
- Support for Ethernet OA&M: Y.1731, 802.1ag, 802.3ah
- 2048QAM operation
- Higher modulation support in small channel sizes
- Lowest power consumption per bit
- Synchronization (1588v2, SyncE)

What is meant by all-outdoor zero-footprint?

Zero-footprint means that all hardware is located outside of a collocation facility. The Horizon Compact+ unit is clip mounted to the appropriately sized Dual Pole High Performance antenna. Two weatherproof, RJ45 Ethernet connectors provide data and management connections to the unit over CAT5E cabling. The Horizon Compact+ is protected from cable transients and power surges caused by lightning, or other sources, by means of internal surge arrestor components and external housing

grounding points. Protection of the connected network is provided by a PonE power integrator/surge suppressor unit, into which the Ethernet cables are plugged. The power integrator/surge suppressor is located close to the network termination point.

How does Horizon Compact+ measure up for spectral efficiency?

Compact+ has industry leading spectral efficiency across all channel widths, delivering:

- From 1 to 2 Gbps in 56 MHz
- From 500 Mbps to 1 Gbps in 28 MHz
- From 250 to 500 Mbps in 14 MHz
- From 100 to 200 Mbps in 7 MHz

*Assumes 2048QAM operation and varies by traffic mix.

What equipment is required to deploy an unprotected Horizon Compact+ link?

A customer would purchase the following equipment from DragonWave: a Radio Link, Installation Kit & Cables.

Radio Link – DragonWave provides: 2 x High Performance antenna's (including mounting bracket), 2 x Horizon Compact+ ODU units (TxH and TxL).

Installation Kit – DragonWave provides: 2 x PonE units (which contain surge arrestors); 2 x AC or DC power; 0, 2 or 4 weather proof cable glands; 0, 4 or 8 connectors.

Cables - Cabling from the Horizon unit to the PonE transtector consists of outdoor rated, shielded, Cat5E cables equivalent to Belden 7919A. Cable can be sourced locally or purchased through DragonWave. DragonWave cable is shipped with weather proof cable glands and connectors.

What modulation modes are supported by Horizon Compact+?

Horizon Compact+ supports QPSK, 16 QAM, 32 QAM, 64 QAM, 128 QAM, 256 QAM, 512 QAM, 1024 QAM, 2048 QAM modulation, which is software scalable at any time.

What is the wind loading and temperature range of the Horizon Compact+?

Horizon Compact+ is operational in winds up to 112 km/hr or 70 mph. Survival status is activated when in winds up to 200 km/hr or 125 mph. This ruggedized all-outdoor hardened solution can tolerate extreme operating temperatures. There are no active cooling components required for this device.

How does the Horizon Compact+ deliver up to 2 Gbps of capacity?

A Dual Pole Radio Mount (DPRM) or OMT coupler can be used to double the throughput of a link by having the two Horizon Compact+ systems transmitting and receiving simultaneously using the same

antenna. One radio is horizontally polarized and the other is vertically polarized. Using a DPRM coupler, this can increase the link capacity up to 2 Gbps Mbps across a single link.

Does Horizon Compact+ offer remote software scalability?

Yes, Horizon Compact+ offers FLEX, which provides a software configurable throughput speed from 10 Mbps up to 1000 Mbps in 10 Mbps increments across a single RF carrier. Depending on the customer's requirements, the Horizon Compact+ link can be engineered and licensed at the maximum throughput speeds, but deployed at current demanded throughput levels. This can allow a customer to license for a target bandwidth and set the system to that target modulation, but start at a lower initial capacity. DragonWave believes that this capability to FLEX the bandwidth of the network and map capital outlays to growth requirements to revenues is crucial for our customers to have a backhaul network that is affordable from the start while gracefully expanding to meet incremental bandwidth requirements, when and if they occur.

How does traffic mix affect the throughput of the Bandwidth Accelerator?

DragonWave's Bandwidth Accelerator leverages white space suppression, lossless bulk compression, and header optimization technology to greatly increase throughput. The performance of the Bandwidth Accelerator varies depending on the traffic type, as show in the following table:

Channel Bandwidth	Traffic Type					
	Compressed VoIP	HTML	FTP	Partially Filled TDM	Uncompressed VoIP	Typical Traffic Mix
56 MHz	482	554	587	1203	1757	539
50 MHz	455	524	555	1138	1661	510
40 MHz	347	398	423	866	1264	388
28 MHz	238	273	290	594	867	266
14 MHz	119	137	145	297	434	133
7 MHz	49	56	60	122	178	55

Assumptions: 256QAM, RFC2544 average frame size

Compression occurs after queuing but before the rate limiter. For this reason, the rate limiter sees compressed flows, allowing queues to exceed their actual CIR. Additionally, when queues with compression gain are under subscribed, QOS can share this bandwidth with other queues as needed.

How does the Bandwidth Accelerator affect latency?

Enabling the Bandwidth Accelerator feature on the Horizon Compact+ introduces minimal latency while compressing and decompressing data, while storing data until a compression block is filled, as the data stream is buffered at the far end of the link. Latency increases linearly with block size – a parameter which is set by the end user.

Packet delay variation can occur when non-compressed time-sensitive queues collide with large output blocks – the result of low compression gain. This situation is similar to instances where time

sensitive queues are mixed with all jumbo frames. Selecting smaller block sizes minimizes the number of collisions and reduces the packet delay variation of the system.

How do FLEX upgrades work?

A FLEX upgrade code can be ordered from DragonWave and requires the serial number of each modem. Once the code is received (typically within 24 hours) and entered into the system, the capacity is upgraded. If a large number of upgrades are done, the customer can request a FLEX web account, and automatically download keys against an account using the DragonWave FLEX License Website. Alternatively, the customer may opt for keyless upgrades.

How does keyless capacity upgrading work?

Keyless capacity upgrade is a simple and automatic remote scalability option where the purchase price is based on current capacity requirements and daily radio logs that track rolling average capacity usage, triggering a capacity upgrade based on pre-negotiated parameters. This greatly simplifies network operations by eliminating the need for network capacity forecasting and license key administration. In addition, this system provides accurate information on the actual network utilization. An added benefit of the keyless features is free restoration bandwidth for ring/mesh by allowing the network to burst to higher data rates during an outage without incurring the cost of a capacity upgrade as long as MTTR is shorter than the trigger period.

How does ATPC work on Horizon Compact+?

Adaptive Transmit Power Control (ATPC) allows a Horizon Compact+ system to adjust its transmit power to compensate for far end signal loss caused by changes in atmospheric conditions (e.g. heavy rain). ATPC also helps in reducing the noise floor during non-faded conditions. ATPC maintains a constant RSL and adjusts the transmit power as necessary in order to maintain desired RSL during fade conditions. RSL threshold levels that trigger power changes, the maximum power change allowed, and a hysteresis factor, are preset at values which optimize the operation of the Horizon Compact+ system. A fade factor of 5dB/second can be handled. The Horizon Compact+ system is able to discriminate between RSL levels that are reduced as a result of interference and those as a result of genuine path loss, so that ATPC is not invoked unnecessarily.

Does Horizon Compact+ support ring/mesh configurations?

Yes, Horizon Compact+ supports ring and mesh switching using any Ethernet switch which supports standard protocols, such as RSTP (Rapid Spanning Tree Protocol), PBT, or MTLS.
The Horizon Compact+ ring protection relies on the Rapid Link Shutdown (RLS) feature to determine when a redundancy switch needs to take place. Protection switching is triggered as a result of data loss caused by link outage, power failure, or hardware failure. Modem-to-modem communications occur constantly, whether or not Ethernet data is being sent over the Horizon link. This continuous data stream is used as the trigger for Protection Switching activation. Therefore, it is able to detect both hardware failures as well as link failures. Switching times are in the order of 50 msec.

The system can distinguish between hardware failure and a link failure in order to perform an intelligent handover of traffic from one radio to another.

The RLS feature is not enabled by default and must be activated in the field in order to support 50 ms protection switching.

What are other enhanced protection options?

Redundancy can be achieved using redundant equipment:

Two radio ODUs are mounted to the same antenna via a Power Split Radio Mount (PSRM). In this configuration, only one radio can operate at a time. The second radio is for redundancy back-up purposes. This mount allows two radios to be mounted face to face, directing radio frequency energy from the transmitting radio to the antenna via the integral coupler. The insertion losses for the PSRM are 1.9dB for the primary port and 6.5dB for the secondary port. The port with the least loss should be used for the normally-operating radio and the other for the stand-by radio. Both radios are oriented for the same polarization. The antenna used is a standard antenna.

Can the system classify packets based on IEEE.802.1p/q?
If yes, how many queues are supported for various QoS classes?

Yes, Horizon Compact+ supports the 8 Class of Service (CoS) levels (0-7) defined within 802.1P. There are 5 CoS queues within Compact+, numbered 1 to 5. Each of the 8 CoS levels can be assigned to any of the five Compact+ CoS queues. Each queue can be allocated a percentage (queue width) of the total memory space available for CoS queues. Two of the queues can be assigned as the Expedite Queue. Each queue can also be assigned a committed information rate (CIR) as a percentage of the maximum rate available (depends on Compact+ type and radio band employed).

If 802.1P filtering is disabled in the Compact+ system, all incoming packets are treated equally and are forwarded on a first-come, first-served basis.

What are the maximum frames sizes supported?

Jumbo frames are supported, enabling 9600 byte frames.

What is the maximum cable length supported?

Cabling from the Horizon unit to the Ethernet switch consists of outdoor-rated, shielded, Cat5E cables equivalent to Belden 7919A and Commscope 2003B. The CAT5E cable length is restricted to a maximum distance of 100 meters. Optionally, fiber can be selected for a maximum cable length of up to 10Km.

What are the measured throughput values of a Horizon Compact+ link at varying packet sizes?

28 MHz Modes	28MHz, QPSK	28MHz, 16QAM	28MHz, 32QAM	28MHz, 128QAM	28MHz, 256QAM

Ethernet Frame Size	Ethernet Throughput (Mbps)	Ethernet Throughput (Mbps)	Ethernet Throughput (Mbps)	Ethernet Throughput (Mbps)	Ethernet Throughput (Mbps)
64	56.8	84.5	127.8	169.9	227.3
128	50.8	75.6	114.3	151.9	203.3
256	47.7	71	107.4	142.8	191
512	46.2	68.7	103.9	138.1	184.8
1024	45.4	67.5	102.1	135.8	181.7
1518	45.2	67.2	101.6	135	180.7
average	48	71	108	144	193

*Performance without Bandwidth Accelerator

DragonWave radios can deliver high spectral efficiency in all channel sizes, even the narrow 7 MHz and 14 MHz channels. These same efficiencies are available in all frequencies, from 11 GHz through to 38 GHz in channel spacing from 7 to 56 MHz. Additionally, with the use of adaptive modulation, the user can achieve the maximum throughput during no fade conditions, while still having high availability at lower throughputs, further improving the efficiency compared to conventional solutions.

What other advanced Ethernet features does Horizon Compact+ support?

- 802.3x Flow Control
- Expedite Queues
- RSTP via Rapid Link Shutdown (RSL)
- Link Aggregation Control Protocol (LACP)

What are the latency and packet delay variations for streaming Video and VoIP?

Overall Ethernet packet delay across a Horizon Compact+-based PtP radio link is < 140 µs (all/any packet size of packet size distribution) in a 256QAM mode. Typical delay distribution is:

	QPSK	**256QAM**
64 byte packets:	540.3	104.8
256 byte packets:	564.8	109.4
1024 byte packets:	664.9	127.5
1518 byte packets:	727.3	138.8

The delay variation of packets (i.e. jitter) of various sizes flowing across a Horizon Compact+ PtP link is +/- 15 us.

Antenna Support

Frequency Band	Direct Mount Antenna Sizes Supported						
	0.15 M	0.3 M	0.6 M	0.75 M	0.9 M	1.2 M	1.8 M
	0.5 ft	1ft	2 ft	2.5 ft	3 ft	4 ft	6 ft
L6						•	•
U6			•		•	•	•
L7			•	•	•	•	•
U7			•	•	•	•	•
L8			•	•	•	•	•
U8			•	•	•	•	•
10.5		•	•	•	•	•	•
11			•	•	•	•	•
13		•	•	•	•	•	•
15		•	•	•	•	•	•
18		•	•	•	•	•	•
23		•	•	•	•	•	•
24 DEMS	•	•	•	•	•	•	
26		•	•	•	•	•	
28	•	•	•				
31	•	•	•				
32		•	•				
38		•	•				

Exceptions for FCC & IC:

- 6 GHz: minimum antenna size is 6’
- 11 GHz: minimum antenna size is typically 2.5’
- 15 GHz: minimum antenna size is 2’
- 18 GHz: minimum antenna size of 2’

Exceptions for ETSI:

- 28 GHz: minimum antenna size is 1’