Product Overview

Horizon Quantum

DragonWave

DragonWave

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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 QUANTUM SUMMARY

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.

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 DragonView NMS
- Lowest total cost of ownership solution
- solution Features

Quantum ODU

The extremely compact Outdoor Unit (ODU) is designed for simple installation with BNC connectors for RSL readings, coming with an orientation sensor, increased cable length support and a clip-mount.

The Quantum ODU offers both standard power (SP) and high power (HP) capability within a single unit, eliminating the need for multiple radio variants. Advanced radio features and OA&M support, are described in detail in the solutions features section.

Quantum IDU

The Horizon Quantum Indoor Unit (IDU) occupies only one half rack-unit of space yet delivers the highest performance and most advanced features of any system available.

6 GbE and 2 SFP ports and nodal intelligence provide aggregation and restoration. Power connectors are screw mounted, and the system's active fans are field replaceable. The IDU features a serial connector on the rear of the unit. Also, the Quantum IDU offers transparent mux capability.

Availability

The link availability of the Horizon Quantum is characterized by our own link planning software. Additionally, our 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 (voice and/or video over-IP, for example) 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 Quantum split-mount system 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.

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 SMP 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 Quantum 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. 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 4 Gbps. These capacity levels can be doubled in a dual-polarization configuration. FLEX allows the operator to address a wide spectrum of customer

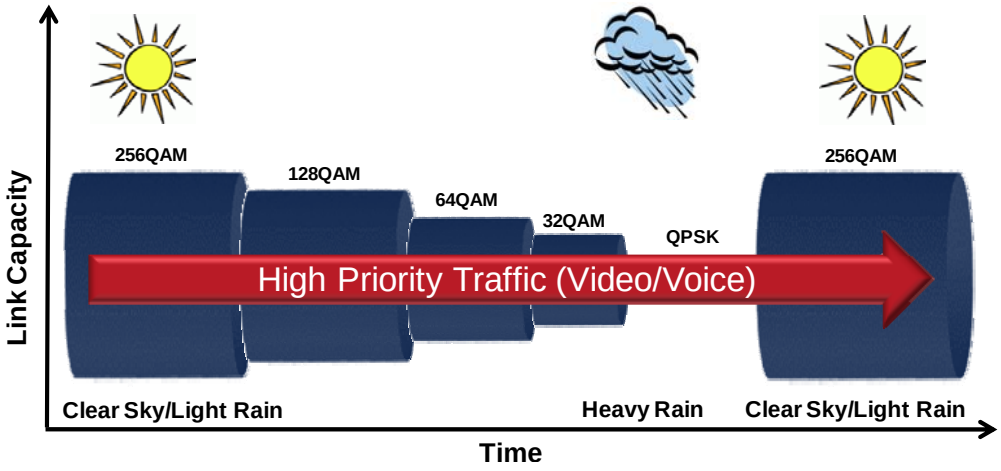
requirements using just one product platform. *FLEX* also lowers the operator's risk and initial investment when connecting customers with a low capacity requirement today without committing to a future upgrade. The operator is then able to deploy a fully scalable transmission system at a substantially 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 256 QAM, which are software selectable at any time.



DragonWave's AAM feature is completely hitless with, ensuring that no priority traffic is ever dropped while the system is shifting between modulation schemes. This feature is combined with adaptive coding and adaptive power (where permitted) to provide the most efficient operation.

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:

- Narrow beamwidth, directional point-to-point communications
- A bit-level data stream, with Horizon synchronization and framing
- Horizon authentication
- Proven interoperability with 3rd party 256-bit AES encryption
- 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 Quantum is designed to seamlessly transport TDM services and support Synchronous Ethernet (SynchE), and can transparently pass 1588v2. Support of these synchronization standards ensures that all existing and future services can be converged in a single packet infrastructure.

Licensed Frequency Support

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

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

Intelligent Nodal Switching

The Horizon Quantum's integrated switch enables aggregation and restoration in a single unit – greatly simplifying operations for service providers. Multi-service support is provided with aggregation of up to 8 ports, which is ideal for aggregating multiple Horizon Compact links into a high capacity Quantum system.

The integrated ring and mesh switching allows operators to use active and protection capacity or up to 8 Gbps per ring. The Horizon Quantum also provides a transparent mux capability for additional deployment flexibility.

Advanced Ethernet Feature Support

DragonWave's Horizon 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 queues. 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.

Cross Polarization Interference Canceller (XPIC)

The Horizon Quantum can be deployed with an XPIC, which eliminates the cross-polarization interference in signals having orthogonal (vertical & horizontal) polarizations. This allows two separate data streams to be transmitted over the same channel, doubling capacity with only a limited impact to link budget (1dB).

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.

Mesh/Ring is driven by the Horizon Quantum – which delivers integrated nodal switching – deployed in conjunction with a DragonWave multi-beam antenna assembly. This solution delivers 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. Signalling to the network is done by shutting down the Ethernet data port(s) connecting the Horizon Quantum 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 then 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 Quantum Ethernet ports can be shut down
- Horizon Quantum configuration or hardware failure - if hard faults, such as a hardware failure, interrupt the link, both Horizon Quantum Ethernet ports can be shut down.

Flexible Deployment

The Horizon Quantum is available in all-indoor and split-mount configurations. It can be deployed with either single or dual pole radio mount configurations – as shown here:

Field Maintenance Friendly

Operators are able to perform maintenance on the IF cable without powering down the IDU modem. A serial connector on the rear of the Horizon Quantum IDU allows for simple on-site management and configuration.

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 Quantum 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 Computing 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. It should be pointed out that 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:

Ethernet OAM features will be supported in a future release of the Horizon Quantum.

Fault Detection

Fault Detection With Continuity Check Messages (CCM)

- 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

Fault Verification With Loopback Messages (LBM)

- 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

Fault Isolation With Linktrace Messages (LTM)

- 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

Fault Notification With Remote Defect Indication (RDI)

- 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 Quantum solutions address the technical and business challenges faced by next generation mobile operators, with:

- A packet based architecture
- High-capacity and scalability
- Low latency
- Operational simplicity
- Legacy service support for network evolution
- High spectral efficiency
- Advanced queuing and Quality of Service (QoS) support
- Intelligent ring/mesh switching for carrier-grade availability
- Lowest total cost of ownership

WiMAX Backhaul

DragonWave offers a high-capacity, carrier-grade, integrated packet solution perfectly suited to WiMAX Ethernet services. DragonWave Horizon products enable rapid network expansion using licensed or unlicensed spectrum, and deliver remote scalability from 10 Mbps up to 4 Gbps per link. Horizon is ideally suited for greenfield deployments, offering zero footprint options and minimized antenna size through hitless Automatic Adaptive Modulation (AAM).

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 Quantum?

The primary differentiators for the Horizon Quantum are: unparalleled capacity and spectral efficiency – delivering performance levels that are currently unavailable from any other vendor. Additional differentiators include:

- Bandwidth Accelerator feature
- Dual channel operation drives for 2 to 4 Gbps total capacity per link
- Highest spectral efficiency
- Integrated switching
- 256QAM in small channel sizes
- Smallest footprint – IDU occupies only 1/2 of a rack unit
- Lowest power consumption per bit
- Keyless upgrades and remote, pay-as-you-grow bandwidth scaling
- Increased IF cable loss budget (longer runs with smaller cables)
- RF loop back for improved fault isolation
- Support for Ethernet OA&M: Y.1731, 802.1ag, 802.3ah (future release)
- Synchronization (1588v2, SyncE)

How does Horizon Quantum measure up for spectral efficiency?

Quantum 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 256QAM operation and varies by traffic mix.

What's new in the Horizon Quantum, relative to Duo?

The Horizon Quantum is DragonWave's next-generation split mount microwave solution. Quantum builds on the Duo platform, adding several significant features including:

- Improved channel band coverage
- A single ODU covers both Standard Power and High Power radio variants
- Bandwidth Accelerator feature for greater capacity and spectral efficiency
- XPIC support
- Integrated nodal switching
- Reduced footprint, occupying only one half rack unit
- Hitless automatic adaptive modulation

Can I upgrade my AirPair or Horizon Duo to Quantum? What's involved?

Yes, the Horizon Quantum offers a seamless upgrade path for AirPair and Duo deployments.

What equipment is required to deploy a single Horizon Quantum link?

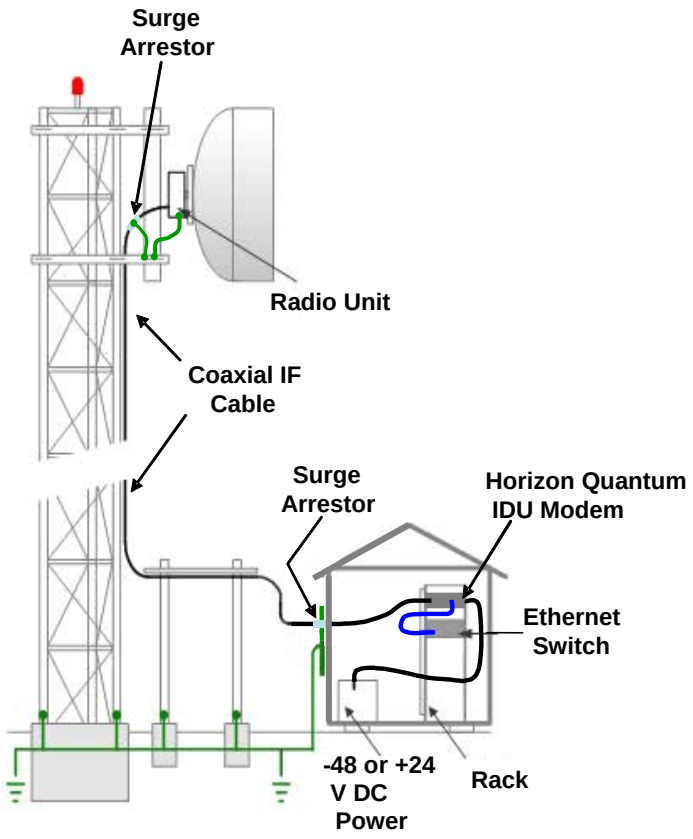
The Horizon Quantum links consist of the following equipment:

- Outdoor radio unit (ODU), with single- or dual-radio assembly options
- Indoor unit (IDU), with single or dual-channel options
- Antenna, including mounting hardware
- Cable, connectors, lightning arrestors, power supplies, grounding kit (optionally supplied by DragonWave)
- Mounting rack and brackets to mount an IDU (optionally supplied by DragonWave)

Horizon Quantum with DPRM configuration

To deploy a single Horizon Quantum link, a customer would purchase the following from DragonWave: **Radio Link, Installation Kit, Cables,** and an **Indoor Unit (IDU)**.

Single IDU Setup



Radio Link – DragonWave provides: 2 x High Performance antennas (including mounting bracket), 2 x Horizon outdoor radio (ODU) units (TxH and TxL). For customers who wish to mount the radio remote from the antenna, there are special mounting kits available. DragonWave provides 2 x Horizon Duo IDUs. Horizon Duo supports: 7, 10, 13.75, 14, 27.5, 28, 30, 40, 50, 55 & 56 MHz channel spacing; Horizon Duo supports: QPSK; 16, 32, 64, 128 & 256 QAM modes. Single + dual channel options and single + dual radio options.

Installation Kit – DragonWave provides: 4 x Lightning Arrestors; 2 x Grounding Kits; 2x 6m Jumper Cable; 2 x 2M Jumper Cable; Optional – 2 x AC power supplies. Note that if the customer possesses multiple radios, the customer will need to have multiple installation kits.

What are the maximum cable lengths available?

The following cables are available:

LMR-400: 120M (400 ft)
LMR-600: 185M (615 ft)
LMR-900: 275M (900 ft)
RG-8U: 104M (340 ft)

Cable Type	*Single Channel/ Single Radio*		*Single Channel with Combiner*		*Dual Channel/ Single Radio*		*Dual Channel/ Dual Radio*	
	ft	*M*	*ft*	*M*	*ft*	*M*	*ft*	*M*
LMR 400	427	130	359	109	308	94	376	115
LMR 600	660	201	555	169	475	145	581	177
LMR 900	976	298	820	250	703	214	859	262
LDF5-50	1389	423	1167	356	1000	305	1222	373

What antenna sizes are supported for Horizon Quantum?

Direct Mount	Non-Direct Mount
15 cm/6" (only for 24 DEMS and 28 LMDS) 30 cm/1' 60 cm/2' 90 cm/3' 120 cm/4' 180 cm/6'	240 cm/8' 300 cm/10' 360 cm/12'

What design configurations are available for the Horizon Quantum IDU?

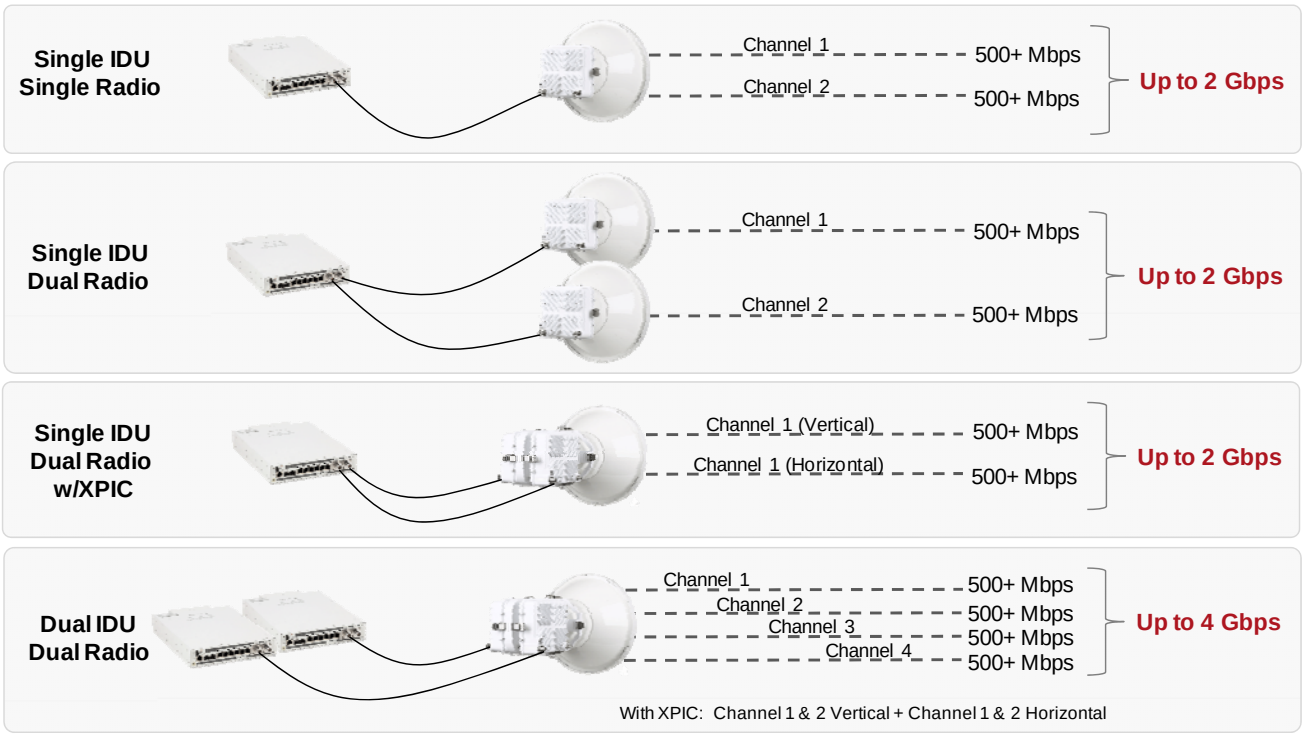
The Horizon Quantum is available with a single channel or dual channel IDU. Additionally, the dual channel IDU is available with one or two IF feeds to support either single or dual radios. The design configurations of the Horizon Quantum are as follows:

1. Single IDU, Single Radio:
   - With single channel IDU, this configuration provides a throughput of 500 to 1000 Mbps.
   - With dual channel IDU, the throughput range doubles to 1 Gbps to 2 Gbps.
   - Note that operating a dual channel system requires appropriate licensing approvals.

2. Single IDU, Dual Radio:
   - This configuration, with a dual channel IDU, provides a range of 500 Mbps to 1 Gbps per radio.

3. Single IDU, Dual Radio with XPIC:
   - This configuration achieves from 1 Gbps to 2 Gbps within a single licensed channel.

4. Dual IDU, Dual Radio:
   - Incorporates two IDU and an external combiner, with each IDU and radio supporting two channels for a total of 4 channels and a throughput range of 2 Gbps to 4 Gbps per link.
   - This configuration can be delivered with XPIC, achieving 2 Gbps to 4 Gbps within two licensed radio channels.



What is the wind loading and temperature range of the Horizon Quantum ODU?

Like the DragonWave AirPair and Compact, Horizon Quantum ODU's are 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. The Horizon Quantum ODU is a ruggedized all-outdoor hardened solution which can tolerate extreme operating temperatures. There are no active cooling components required for this device.

Radio Operating Temperatures:

High Power + Standard Power	-40°C to + 45°C (-40°F to +113° F)
Standard Power + Solar Shield	-40°C to + 60°C (-40°F to +140° F)
IDU Operating Temperature	0°C to + 50°C (0°F to +122° F)
ODU Humidity	100 % Condensing
IDU Humidity	95% Non-Condensing
Altitude	4500 m (14,760 ft)
NEB-3 Compliant	Yes

What is the total capacity of the Horizon Quantum system?

Depending on the IDU option, total system capacity ranges from 500 Mbps to 4 Gbps. The system capacities of the various design combinations are shown below:

IDU	IF Outputs	Capacity (Mbps) per Radio
Single Channel	1	500–1000 Mbps
Dual Channel	2	500–1000 Mbps **+** 500–1000 Mbps
Dual Channel	1	1000–2000 Mbps

If a Dual Polarization Radio Mount (DPRM) is used, then the dual-channel configuration can provide from 2 to 4 Gbps. Total system capacity of Horizon Quantum is up to 4 Gbps – a level of throughput that is unparalleled in the industry.

What kind of lightning protection is available?

The Horizon Quantum modem and radio system is protected from cable transients and power surges caused by lightning or other sources by means of surge arrestor components and external housing grounding points.

It is highly recommended that the IF cable be grounded at both ends, and that it be provided with in-line surge arrestors at either end.

What is the power consumption of the Horizon Quantum?

The Horizon Quantum comes as a -48 V DC powered version or a +24 V DC or AC powered version. The Horizon Quantum supports dual power feeds if power redundancy is a requirement.

The Horizon Quantum ODU unit typically consumes the following power at each end of each Point-to-Point link:

Power Consumption:

Single channel, single radio: <105 Watts
Dual channel, single radio: <126 Watts
Dual channel, dual radio: <172 Watts

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

Overall Ethernet packet delay across a Horizon Quantm-based PtP radio link is < 800 µs (all/any packet size of packet size distribution). 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 Quantum PtP link is +/- 150 us.

When turned on, the Bandwidth Accelerator feature introduces minimal delay, depending on the traffic mix and the compression block sizes designated by the operator.

What are the VLAN and maximum packet size supported?

The DragonWave Horizon Quantum employs a transparent bridging technique and it is therefore transparent to any VLAN or Q in Q protocols allowing the delivery of VPN based networking architectures.

Maximum packet size is 9600 bytes - supporting all propriety protocols.

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 shown in the following table:

Channel Bandwidth	Traffic Type					
	Compressed VoIP	HTML	FTP	Partially Filled TDM	Uncompressed VoIP	Typical Traffic Mix
56 MHz	963	1107	1174	2406	3513	1078
50 MHz	910	1047	1110	2275	3322	1019
40 MHz	693	796	845	1731	2528	776
28 MHz	475	546	580	1188	1734	532
14 MHz	238	273	290	594	867	266
7 MHz	98	112	119	244	356	109

Assumptions: 256QAM, dual channel operation, 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. In addition, 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 Quantum introduces minimal latency while compressing and decompressing data, 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 Quantum?

Adaptive Transmit Power Control (ATPC) allows a Horizon Quantum system to adjust the transmit power to compensate for far end signal loss caused by changes in atmospheric conditions (e.g. heavy rain). ATPC maintains a constant RSL and adjusts the transmit power as necessary in order to maintain desired RSL during fade conditions. For optimal operation, the Horizon Quantum has preset values for the RSL threshold levels (that trigger power changes), the maximum power change allowed, and a hysteresis factor. A fade factor of 5dB/second can be handled.

The Horizon Quantum 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 Quantum support ring/mesh configurations?

Yes, Horizon Quantum 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 Quantum 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.

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. There is approximately a 6-dB difference between the RSL (Receive Signal Level) of the radio on one PSRM port compared with that of the radio on the other PSRM 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.

A dual output IDU is used to connect to the two ODUs. The selection of the active and standby ODU is done automatically by the IDU based on path failure criteria. Switching times are on the order of 800 ms with improvements to 50 ms.

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

The Horizon Quantum does not tag packets with 802.1p priorities; however it can enforce quality of service based on these tags. Horizon Quantum supports the 8 Class of Service (CoS) levels (0-7). The 8 levels can be extracted from 802.1P inter and outer headers, MPLS or DSCP priority bits.

There are 4 CoS queues within Quantum, numbered 1 to 4. Each of the 8 CoS levels can be assigned to any of the four Quantum CoS queues; each queue can be allocated a percentage (queue width) of the total memory space available for CoS queues. One of the queues (Queue 4) 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.

There are two queuing types DragonWave supports: Weighted and Strict. Weighted fair queuing ensures each priority level gets their guaranteed bandwidth before allowing any queues to exceed their guaranteed bandwidth. The second type, Strict Queuing, always serves the highest priority queues first. The following is a more detailed WFQ description:

- 4 user queues are supported
- User sets the weight for each queue
- The wireless bandwidth is distributed amongst the queues proportional to their weights
  - Ex: total bandwidth of the queue is ‘b’, and user assigns weights to queues as ‘w1’, ‘w2’, ‘w3’, and ‘w4’ to queues 1 to 4 respectively where w1 to w4 are integers. The bandwidth share of queues 1 to 4 shall be b*w1/(w1+w2+w3+w4), b*w2/(w1+w2+w3+w4), b*w3/(w1+w2+w3+w4), and b*w4/(w1+w2+w3+w4) respectively.
- The granularity of the bandwidth is 1Mbps
- The queues are serviced in round-robin fashion with the number of packets taken out equivalent to the assigned weight
- In future releases, the system will also support packet cut-through for reduced latency

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

Are licensing changes required if a Horizon Duo IDU is being replaced with a Quantum IDU?

No licensing changes are required as the Quantum has the same emission designators and system performance parameter as the Horizon Duo.

What is expected in the future releases of Horizon Quantum?

Future releases include the following new features and feature activation:

- Cut-through prioritization
- 2 Modem 1+1 Support
- SynchE Activation
- ADM/Regen Support
- RSTP Support
- 802.3ah Support
- Hitless Space/Frequency Diversity
- 4 channel XPIC Support
- Ethernet Header Compression