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Coriant CloudWave™ Optics

Increased Reach and Spectral Efficiency with Reduced Power, Footprint, and Cost

The demand for bandwidth is growing significantly driven by internet video, cloud, and data center interconnect. This increase is likely to accelerate as mobile networks move to 5G. In addition to finding cost-effective solutions for managing this traffic growth, network operators also need to reduce operational costs including power consumption and footprint, maximize unregenerated wavelength distances in long haul networks, extend the life of fiber assets and existing optical layer investments, and maximize network availability. Deployed across the Coriant optical transport portfolio, Coriant CloudWave™ Optics uses advanced optics technologies to address these challenges.

COMBINING ADVANCED SIGNAL PROCESSING, PHOTONIC INTEGRATION, AND EMBEDDED SOFTWARE

Coriant CloudWave™ Optics combines advanced digital signal processing, photonic integration, and embedded software to enable flexi-rate coherent interface support including QPSK (100G), 8QAM (150G), and 16QAM (200G) across the Coriant packet optical transport portfolio including the Coriant® hiT 7300 Multi-Haul Transport Platform, Coriant® mTera® Universal Transport Platform, and Coriant Groove™ G30 DCI Platform. Signal processing includes best-in-class DSP and framer technology. Photonic integration is provided on the module boards with integrated interfaces or through CFP2-ACOs for modules with pluggable optics including Coriant designed pluggables leveraging silicon photonics. The embedded software performs tasks such as measuring and correcting impairments as well as optimizing signal power levels.

BENEFITS OF CORIAINT CLOUDWAVE™ OPTICS

- **Minimize** OEO regenerations with reach of over 5,000 km in terrestrial networks and over 12,000 km in submarine networks
- **Extend** the life of your fiber assets through increased spectral efficiency including 8QAM/16QAM modulation and super-channel support enabling over 25 Tbps per fiber pair
- **Reduce** footprint and power consumption as demonstrated by the Coriant Groove™ G30 with <0.45W per Gbps and 3.2 Tbps in 1RU
- **Upgrade** existing networks cost effectively with optimized performance for mixed 10G/100G networks, and compatibility with 50GHz/100GHz fixed grid networks for all modulation formats including 8QAM
- **Maximize** network availability with 50 ms protection and robust performance in even the most challenging conditions

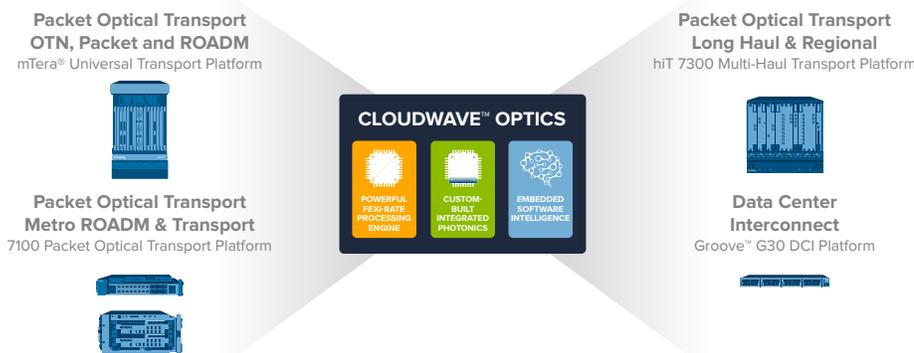


Figure 1: Application spectrum of Coriant CloudWave™ Optics across the Coriant portfolio



CloudWave-enabled Flexi-rate Interface Modules

EXTENDED REACH: >5,000 KM TERRESTRIAL, >12,000 KM SUBMARINE

When combined with Coriant Advanced Optical Link Control and optimized EDFA/Raman amplification technology, Coriant CloudWave™ Optics offers extended reach of over 5,000 km in terrestrial networks and over 12,000 km in submarine networks. The features enabling this extended reach include 25% Forward Error Correction (FEC) with an 11.8dB net coding gain, non-differential encoding, spectral shaping including WSS filtering mitigation for extended ROADMs cascades, and high tolerance to chromatic dispersion (>300 ns/nm, >14,000 km) and polarization mode dispersion (PMD) (up to 50 ps mean DGD).

INCREASED SPECTRAL EFFICIENCY: >25 TBPS PER FIBER PAIR

Coriant CloudWave™ Optics enables spectral efficiency of up to 5.3 bits/s/Hz and over 25 Tbps per fiber pair. Modulation formats include 8QAM for 150G wavelengths and 16QAM for 200G wavelengths. In addition to 25% FEC for extended reach, 7% and 15% FEC are supported for spectral efficiency and interoperability. Super-channels are enabled with center wavelength tuning of +/-2.5GHz or better and spectral shaping. Examples of supported super-channel options include 2x100G in 100GHz and 4x200G in 150GHz.

REDUCED FOOTPRINT AND POWER CONSUMPTION

Leveraging a dual lambda DSP along with photonic integration including silicon photonics enabled CFP2-ACO pluggables, Coriant CloudWave™ Optics delivers industry-leading density and low power consumption. The Groove G30 demonstrates the low power consumption and footprint of Coriant CloudWave™ Optics by delivering less than 0.45W per Gbps and 3.2 Tbps in 1RU.

ROBUST PERFORMANCE UNDER CHALLENGING CONDITIONS

Challenging conditions can include high attenuation, bad splices and reflections, sub-optimal dispersion, non-G.652 fiber (G.653, G.655), mixed spans with different fiber types, long spans, aerial fiber, and extreme environmental conditions including temperature, pressure, vibrations, and lightning strikes. In combination with Coriant Advanced Optical Link Control and EDFA/Raman amplification technology, Coriant CloudWave™ Optics provides robust performance maximizing reach and tolerating degradations under even the most challenging conditions. In addition to high tolerance to chromatic dispersion (>300 ns/nm, >14,000 km) and PMD (up to 50 ps mean DGD), Coriant CloudWave™ Optics delivers extreme tolerance to lightning strikes that are a key challenge with aerial fibers (OPGW), with industry-leading SOP rotation tolerance of >3 Mrad/s.

FAST PROTECTION AND RESTORATION

Fast protection for coherent channels requires the DSP to quickly adjust for different parameters, including PMD and chromatic dispersion, of the protection path relative to the working path. In addition when using coherent colorless add/drop, loss of signal can no longer be used for fast failure detection. Coriant CloudWave™ Optics addresses these challenges delivering 50 ms for 1+1 OCh protection and 1+1 OMS protection, including coherent colorless add/drop. Furthermore, Coriant CloudWave™ Optics supports sub-second modulation switching and channel retuning, enabling fast restoration, though actual restoration times will typically be constrained by other factors including WSS switching times and amplifier adjustment times.

COMPREHENSIVE PERFORMANCE MONITORING

Coriant CloudWave™ Optics supports comprehensive performance monitoring including chromatic dispersion, PMD/DGD, Polarization Dependent Loss (PDL), pre-FEC Bit Error Rate (BER), Q-factor, and OTU-level performance monitoring. Accurate and real-time OSNR and Residual Margin measurements are enabled by the Margin Processing Engine (MPE) component of the Coriant Aware™ Technology toolkit. PRBS test and loopback is also supported, reducing the operational cost of testing new wavelengths during the commissioning process. Additional capabilities include delay measurement and Tandem Connection Monitoring (TCM).

COMPATIBILITY WITH EXISTING (10G AND FIXED GRID) NETWORKS

10G wavelengths and Dispersion Compensation Modules (DCMs) create challenges for coherent 100G+ performance due to non-linear effects such as Cross Phase Modulation (XPM) and the lack of chromatic dispersion to prevent the buildup of XPM and Self Phase Modulation (SPM). In addition to the ability of Coriant Advanced Optical Link Control to set optimal power levels to minimize XPM in mixed 10G/100G networks, Coriant CloudWave™ Optics spectral shaping also helps to maximize reach in mixed 10G/100G networks. Together these features can deliver unregenerated reach of up to 2,000 km in mixed 10G/100G networks with EDFA-only amplification and even longer with Raman amplification. Furthermore, as Coriant CloudWave™ Optics uses 32Gbaud for all modulations (QPSK, 8QAM, and 16QAM), this ensures compatibility with 50GHz/100GHz fixed grid networks. In particular, Coriant CloudWave™ Optics 150G 8QAM is compatible with the 50GHz grid where it can deliver a reach of more than 2,500 km – the sweet spot for many long haul applications.

KEY CORIANT CLOUDWAVE™ OPTICS FEATURES

Dual lambda DSP with two flexi-rate interfaces

- 100G QPSK/lambda
- 150G 8QAM/lambda
- 200G 16QAM/lambda
- Each lambda can be a different rate

Programmable FEC

- 25% FEC with 11.8dB net coding gain
- 7% and 15% FEC for interworking and spectral efficiency

Non-differential encoding

Spectral shaping including WSS filtering mitigation

Chromatic Dispersion tolerance of >14,000 km (>300 ns/nm)

PMD: Up to 50 ps mean DGD

Extreme fault tolerance to lightning strikes in aerial fibers

- SOP rotation tolerance: >3 Mrad/s

Performance Monitoring

- CD, PMD, PDL, Q-factor, pre-FEC BER
 - OTU-Level PM, Delay Measurement, and TCM
 - OSNR and Residual Margin with Coriant Aware™ Technology
 - PRBS test and loopback
- 50 ms line protection including coherent colorless add/drop**

AES256 ODU payload encryption

Low Latency: 5~10us for 100G, ~30us for 10G

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