SOLUTION BRIEF

Infinera CloudWave T Optics

Doubles the Density, Halves the Power, and Ups the Speed by 50%

Infinera CloudWave T Optics technology features the industry's most compelling pay-as-you-grow approach that enables the lowest initial costs, reduced equipment sparing costs and cost-effective scalability. CloudWave T achieves its leading performance advantage by leveraging the latest innovations in digital signal processing and photonic/electrical integration. This latest generation of optical technology allows the user to increase optical bandwidth to 38.4 Tb/s per fiber pair, using advanced modulation formats and programmable spectrum per wavelength.

CloudWave T technology enables a single optical wavelength to carry as much as 600 Gb/s of capacity. For long distance applications such as transcontinental or submarine networks, CloudWave T offers the opportunity to tailor the system to achieve an optimal balance between reach and performance thus maximizing spectral efficiency. Advanced line side programmability in terms of baud rate, forward error correction (FEC) and modulation depth allow adaption to any boundary condition to an extent that it is even possible to provide 400G wavelengths on a 50 GHz installed base or improve current 200G reach on an 50 GHz installed base by 40 percent.

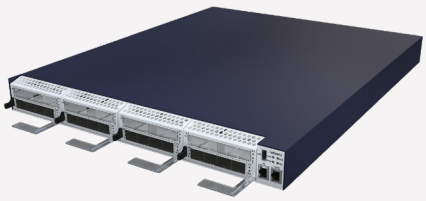
FEATURING MODULARITY AS A BUSINESS ENABLER

Supported across the portfolio, CloudWave T technology forms one of the cornerstones of Infinera's end-to-end solutions. With the industry evolution to open systems and disaggregation, key network functions, such as optical signal processing, are separated from individual hardware elements, such as line systems or switches, to empower a new level of freedom and choice in functionality through pluggables. The Infinera Groove G30 Network Disaggregation Platform (NDP) supports the open concept with a modular architecture, minimal footprint and field replaceable plug-in units, enabling pay-as-you-grow scalability and instant bandwidth opportunities.

The CloudWave T sleds in the Groove G30 NDP are based on the innovative three-tier modular architecture, which offers many competitive advantages for data center interconnect (DCI) and telecom network planners and architects. Four service slots in the Groove G30 1RU chassis support up to four single-slot sleds or two double-slot sleds that are field replaceable, individually configurable and hot swappable. Each CloudWave T sled provides two integrated 600G line side interfaces and can be equipped with up to 12x100G or 3x400G client interfaces (QSFP28/QSFP28-DD). The one-slot CHM1T module provides up to 3x400G client interfaces based on QSFP28-DD pluggables. The sleds/modules and the pluggable interfaces can be purchased and deployed one at a time as required.

HIGHLIGHTS OF INFINERA CLOUDWAVE T OPTICS

- **Supports** tunable bit rate, modulation and forward error correction with line rates of up to 600 Gb/s per single wavelength
- **Improves** reach, performance and capacity in all network scenarios, from data center interconnect to ultra-long-haul, using the latest DSP technologies
- **Offers** leading energy efficiency due to ultra-low power consumption of 16W per 100G and integrated state-of-the-art dual-carrier 1.2 Tb/s coherent DSP, employing recent advancements in photonic integration and ultra-dense client optics
- **Maximizes** fiber utilization and spectral efficiency, providing a fine granularity trade-off between reach and capacity
- **Leverages** optical reach and spectrum programmability with line side support for unlimited combinations of modulation schemes and baud rates



Infinera CloudWave T is delivered by the Groove G30 Network Disaggregation Platform

KEY ADVANTAGES OF CLOUDWAVE T OPTICS

- Highest density
  - 1.2 Tb/s of optical line interface capacity per muxponder sled
  - 2x improvement over the closest comparable solution
  - Unprecedented OpEx savings as networks scale
- Lowest power consumption
  - 0.16 Watts per gigabit
  - Up to half the power consumption of competing solutions
  - Ultra-power efficient, power-as-you-grow operations
- Advanced programmability
  - Programmable baud rate (30-70G baud); FEC (0-27 percent); fractional QAM and geometrical shaping
  - Optimal spectral efficiency and reach with lowest latency
  - Encryption at line speed
- Unmatched speed and reach
  - 600 Gb/s transmission over a single wavelength (up to 38.4 Tb/s of capacity per fiber)
  - Support for 400G transmission at distances of up to 1000 kilometers and up to 4000 kilometers for 200G
  - Support for 400G wavelengths over a deployed 50 GHz grid

LEVERAGING PROGRAMMABLE MODULATION FORMATS AND BAUD RATES

CloudWave T supports programmable DWDM line interface bandwidth and performance to optimize high-capacity transmission from 100G to 600G per wavelength in metro, regional or long-haul applications. The technology features an almost infinite number of different user-programmable line rates and modulation formats to further cost-optimize each network design for optimal transparent reach and fiber spectral utilization. Each CloudWave T line side port can be independently configured, with modulation formats ranging from QPSK to 64QAM, including space partitioning (e.g., SP-16QAM) or hybrid modulation formats. Advancements in FEC algorithms provide industry-leading signal robustness. The size of the FEC overhead can be programmed up to 27 percent of the payload signal used. The resulting bandwidth of each individual wavelength is measured by its signal rate, which can range from 30 to 70 GBaud, with the corresponding spectrum used per channel between 31 and 75 GHz (or higher, if desired). Existing networks with a fixed channel grid can be easily reused when adapting the used baud rates to the spectral width of the existing filters.

MODULATION SHAPING IN THREE DIMENSIONS

Fractional QAM: Shape probability of constellation points to adapt capacity to reach

Geometrical Shaping: Shape location of constellation points to optimize sensitivity

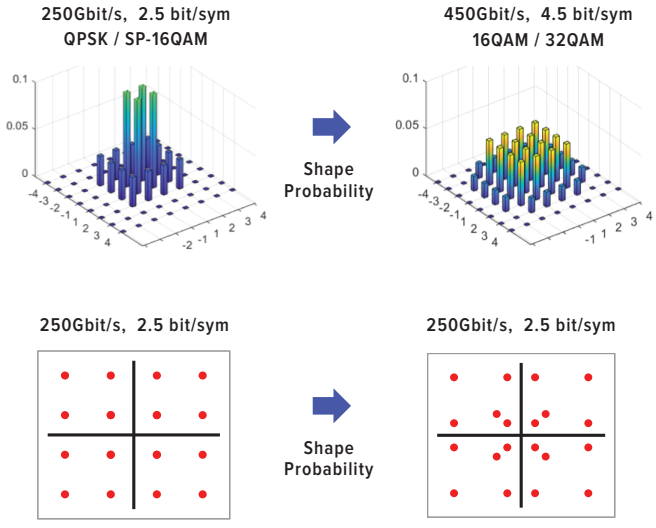
Adaptive Baud Rate: Shape spectrum to available passband

ENHANCED SD-FEC

Configurable overhead and FEC iterations
15% overhead and 27% overhead

LOW POWER CONSUMPTION

Constellations, FEC bandwidth, and baud tuned to desired reach/capacity



Maximum capacity for any network, any distance, any passband

Figure 1: Modulation Shaping with Infinera CloudWave T Optics

SUPPORTING OPEN, FLEXIBLE BANDWIDTH

Each CloudWave T line side wavelength can be independently tuned over the entire C-band supporting full flexibility per channel. This means that any fixed channel plans such as 96 or 128 are no longer needed and each service will only use the spectrum necessary for its error-free transmission. CloudWave T supports seamless interworking with all Infinera and third-party flexi-grid capable line systems. This includes the Groove G30 NDP OLS configuration, Infinera FlexILS and Infinera hiT 7300 Multi-Haul Transport Platform for multi-haul interconnectivity applications, as well as any third-party line system that supports either fixed grid or flexible spectrum provisioning. Comprehensive management and control are available through Infinera Transcend Software Suite, including the Infinera Transcend Chorus for Transport network management system, Infinera Transcend Symphony multi-vendor SDN controller and Infinera Transcend Maestro multi-domain orchestrator.

SIMPLIFYING INTEGRATION AND OPERATION IN CLOUD AND DATA CENTER ENVIRONMENTS

In addition to the DSP technology deployed with CloudWave T, Infinera provides standards-based interfaces that simplify integration and operation within cloud and data center environments, including support for open Northbound Interfaces (NBIs) and APIs. The supported interfaces include CLI, Web GUI, SNMP fault and performance management, Syslog, Zero Touch Commissioning (ZTC), NETCONF, RESTCONF, and gRPC machine-to-machine APIs. The Groove G30 NDP provides a set of native YANG models that can map into any industry standard defined or proprietary YANG model. These interfaces enable rapid integration of the Groove G30 NDP into traditional telecommunications environments and data center software defined networking (SDN) environments. The Groove G30 NDP including CloudWave T is fully integrated with Infinera's network planning, management and control solutions, including Transcend Chorus and the Transcend Software Suite.

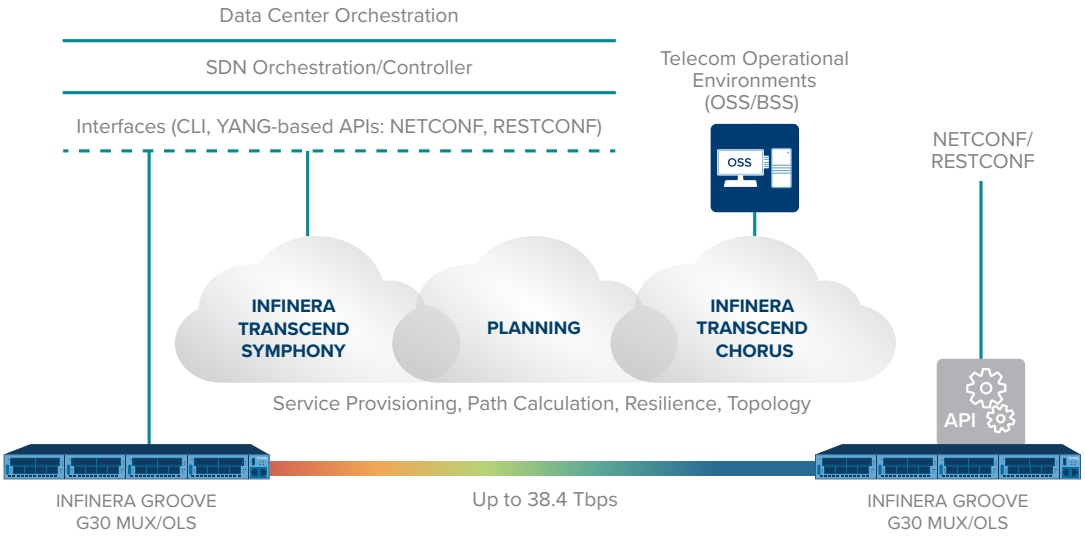


Figure 2: Groove G30 MUX Management and Control

TECHNICAL SPECIFICATIONS*

System Configuration and Modularity in the Groove G30

- Maximum capacity per fiber: 38.4 Tb/s
- Maximum capacity per rack: ~400 Tb/s
- Four individually configurable and hot-swappable single slot FRUs (1.2T sleds CHM1T)
- Two individually configurable and hot-swappable dual slot FRUs (1.2T sleds CHM2T)
- Single slot FRUs and dual slot FRUs can be mixed within the same system
- Up to 24 x QSFP28 pluggable (100G) in 1RU
- Up to 12 x QSFP28-DD pluggable (400G)

Electrical Power

- 16W per 100G

Client Side Interface 400G

- QSFP28-DD LR4, FR4

Client Side Interfaces 100G/OTU4

- QSFP28 SR4 (100 m) 100 GbE
- QSFP28 LR4 (10 km) 100 GbE
- QSFP28 CWDM4 (2 km) 100 GbE
- QSFP28 PSM4 (500 m) 100 GbE
- QSFP28 Active Optical Cable (3 m and 10 m) 100 GbE

Line Side Interfaces

- Integrated Tunable Optical Transceiver
- Line Rate 100 Gb/s to 600 Gb/s
- Tunable Signal Rate 30 Gbaud to 70 GBaud
- Modulation Formats: CP-QPSK, SP-16QAM, 16QAM, 32QAM, 64QAM, hybrid

Data Encryption

- Integrated wire-speed ODU4 AES-256 payload encryption
- Diffie-Hellman (D-H) dynamic key exchange
- Secure key transmission via local OTUk GCC0 communications channel

TECHNICAL SPECIFICATIONS CONTINUED*

Regulatory and Compliance

- RoHS-6 compliant and lead-free per Directive 2002/95/EC
- GR-3160-Core Generic Requirements for Telecommunications Data Center Equipment and Spaces
- Emissions: FCC Part 15 Class A, EN55022/CISPR Class A Compliant, CE Laser Safety: ANSI Class 1M, IEC Class 1M, EN 60825-1/2, 21 CFR 1040 US FDA CDR, Class 1
- Electrical Safety: UL 60950, CSA22.2 60950 and IEC 60950

Environmental

- Operating Temperature: 0°C to 40°C / 32°F to 104°F
- Transport and Storage: -40°C to +70°C / -40°F to 158°F / 40°C + 93% RH
- Humidity: 5% to 90% non-condensing

Groove G30 NDP Performance Monitoring

- Ethernet PMs: 24 hour, 15 min, 1 week, 1 month
- OTN PMs: Tx/Rx, FEC

Groove G30 NDP Management Options

- Management and control platforms:
  - Infinera Transcend Chorus for Transport network management system
  - Infinera Transcend Symphony multi-vendor SDN controller
- NETCONF and RESTCONF YANG model based machine-to-machine APIs
- Command Line Interface (CLI)
- Zero Touch Commissioning (ZTC)
- SNMP fault management
- GUI based craft terminal

** Product features and specifications are subject to change.*

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