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Coriant Metro Transport Solutions

Grow Your Metro Network Cost Effectively While Minimizing Operational Costs

TACKLING NEW VIDEO, CLOUD, IoT, AND DCI CHALLENGES IN THE METRO

Metro network operators are faced with a number of challenges. Bandwidth is growing strongly, with many network operators seeing traffic growth of 30% per year or more in the metro, driven primarily by internet video and Data Center Interconnect (DCI). Enterprise traffic is also escalating significantly as enterprises migrate their IT to public data centers and cloud services, driving the demand for cloud connect services and increasing Ethernet service bandwidth by close to 30% per year. In addition, tomorrow's metro networks will have to cope with significant growth of latency-sensitive applications, including augmented reality, the tactile internet, and autonomous driving, and with huge increases in IoT scale, driven primarily by the adoption of 5G.

These trends are driving demand for a more scalable and flexible metro that can adapt to changing traffic patterns, minimize latency, and grow cost effectively. Furthermore, agility, including faster service development, installation, and service provisioning, is becoming a key enabler of competitiveness. At the same time, network operators are focused on reducing their operational costs including both easier to quantify costs related to space and power as well as harder to quantify costs related to planning, installation, provisioning, maintenance, and troubleshooting.

To meet these demands, metro networks are currently undergoing a number of significant transitions including the evolution from 10G wavelengths to 100G wavelengths and to 100G+ flexi-rate wavelengths, SONET/SDH to packet transport and OTN switching, and closed, proprietary architectures to programmable, disaggregated architectures leveraging open APIs and SDN.

ADDRESSING A WIDE RANGE OF METRO APPLICATIONS

Coriant metro solutions can address numerous applications including any or all of the following on a single multi-purpose metro:

- **Business and Wholesale Ethernet Services:** MEF-defined EPL, EVPL, EPLAN, EVPLAN, E-Tree, E-Access, and E-Transit services with speeds ranging from Mbps delivered on a 10 Mbps access circuit to 100 Gbps based on 100 GbE or LAG-aggregated 10 GbEs can be delivered cost effectively on Coriant MEF 2.0 certified end-to-end packet optical solutions.
- **Mobile Backhaul:** With options for both transparent OTN-based backhaul and MPLS-TP packet transport, Coriant metro solutions can cost effectively deliver mobile backhaul with bandwidth ranging from 10s of Mbps per cell site for 3G to 10 Gbps or more per cell site for 5G.

BENEFITS OF CORIANT METRO TRANSPORT SOLUTIONS

- **Grow** your metro cost effectively with ROADM-based optical express and fabricless switching
- **Adapt** to changing traffic patterns with integrated packet switching, OTN switching, and ROADM-on-a-blade
- **Prepare** for the future with the Coriant® Pluggable Optical Layer, universal switching, and SDN
- **Save** space and power with compact packet switching and high-density 10G and 100G+ transponders
- **Reduce** operational costs with consistent end-to-end provisioning across technology layers enabled by the Coriant Transcend™ Software Suite
- **Migrate** SONET/SDH to next-generation packet optical technologies including MPLS-TP with TDM circuit emulation, Carrier Ethernet, OTN, and multi-terabit STS-1/VC-4 switching
- **Maximize** network and service availability with a wide range of protection and restoration mechanisms including Y-cable, 1+1 OCh, OMS and OTS protection, Carrier Ethernet and MPLS-TP protection mechanisms, ASON/GMPLS, and vASON

- **Fixed Broadband Backhaul:** The Coriant® Pluggable Optical Layer and ROADM-on-a-blade together with high-density transponders and integrated packet switching can provide ideal solutions for scaling fixed broadband backhaul to meet the needs of high speed broadband access technologies including G.fast DSL, NG-PON/NG-PON2, and DOCSIS 3.1/DOCSIS 3.1 Full Duplex.
- **SONET/SDH Migration:** Coriant metro solutions provide a number of options for migrating legacy SONET/SDH to next-generation packet optical technology. These options include MPLS-TP based packet transport with TDM circuit emulation, OTN switching, SONET/SDH ADM-on-a-blade technology, and 1.68 Tbps of STS-1/VC-4 switching with packet/OTN interworking leveraging the agnostic fabrics and universal switching of the Coriant® mTera® Universal Transport Platform (UTP).
- **Router Interconnect:** Coriant high-density 10G and 100G+ interfaces provide an ideal solution for interconnecting routers across the metro, with packet and hybrid packet/OTN switching able to groom traffic onto a smaller number of high speed router interfaces.
- **Data Center Interconnect and Cloud Connect:** With support for high-density 10G and 100G+, Coriant metro solutions address a wide range of data center interconnect and cloud connect applications including the cost-effective extension of the ROADM core via the Pluggable Optical Layer and packet optical cloud connect services. Coriant metro DCI solutions include the industry-leading Coriant Groove™ G30 Network Disaggregation Platform (NDP).
- **SAN Services:** SAN protocols including 1G/2G/4G/8G/10G/16G/32G Fibre Channel, Infiniband, ESCON/FICON, and ISC are supported. SAN certifications include EMC and Brocade.
- **Native Video Services:** Native video support includes SDI, HD-SDI, and 3G-SDI and can provide an ideal solution for broadcast, film, and TV production industries and for applications such as telemedicine and distance learning.

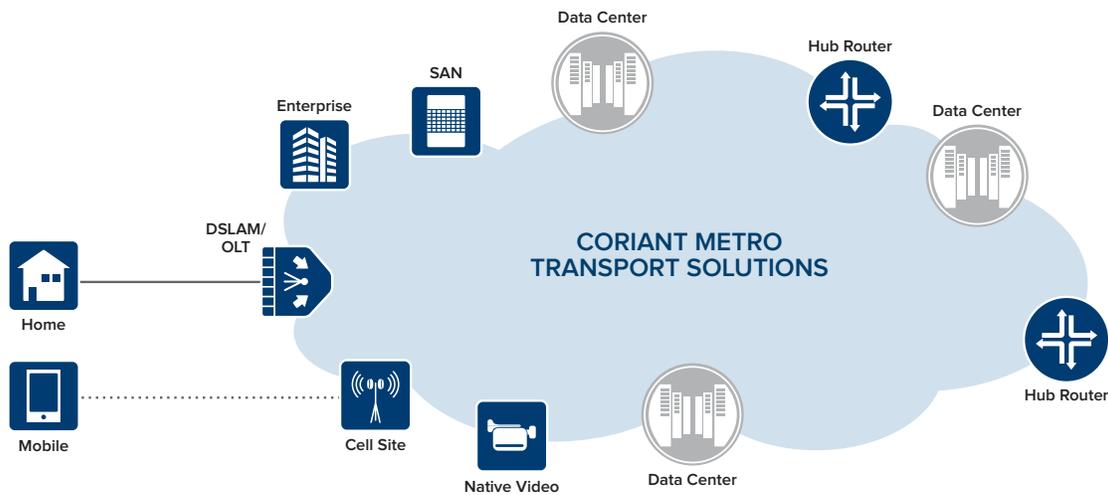


Figure 1: Key Coriant Metro Solution Applications

CHOOSING FROM A FLEXIBLE SELECTION OF METRO TECHNOLOGIES

Coriant metro solutions enable network operators to select from a wide array of technologies to build a network that can optimally support their given mix of network applications with the best trade-off between CapEx and functionality. These technologies include:

- **Pluggable Optical Layer:** By shrinking optical layer functions including EDFA-based amplifiers, EVOAs, Optical Per Channel Power Monitoring (OCM), Optical Protection Switch (OPS), OSC, OTDR, and WSS to compact pluggables, network planners can mix and match optical layer functions to optimally meet the requirements of their networks in the short term, with the ability to add functionality over time as needs evolve, and can support a wide range of applications including CWDM, passive DWDM, amplified DWDM, and ROADM.
- **Broadcast and Select ROADM-on-a-blade:** Integrating amplifiers, WSS, OSC, and OCM into a single module with support for 88 channels and 4 or 8 degrees provides a highly compact and cost-effective solution for metro ROADM.
- **Route and Select ROADM-on-a-blade:** With support for 88 or 96 fixed grid channels or 128 channels with flexi-grid, and available with 9 or 20 ports, these solutions leverage the superior scalability and performance of route and select WSS technology to provide a high-end yet compact ROADM option.
- **CD, CDC, and Flexi-grid Add/Drop:** In addition to 50 GHz fixed grid colored/directional and directionless add/drop, Coriant metro solutions can deliver CD and CDC add/drop with both 50 GHz fixed grid and flexi-grid, leveraging technologies including WSS, splitter/combiner, and optical multicast switch.

- **High-density, Transparent 10G and 100G+:** The Coriant® 7100 Nano™ Packet Optical Transport Platform and Coriant® 7100 Pico™ Packet Optical Transport Platform include a single slot 8x10G (16xSFP+) transponder and single slot 100G transponders and ADM/muxponders. The Groove G30 NDP supports up to 4.8 Tbps of line capacity in 1RU leveraging Coriant CloudWave™ T Optics technology.
- **Coriant CloudWave™ Optics and Coriant CloudWave™ T Optics:** Coriant CloudWave™ Optics enables flexi-rate modulation (100G/QPSK, 150G/8QAM, 200G/16QAM) and delivers up to 25.6 Tbps per fiber pair. Coriant CloudWave™ T Optics evolves CloudWave with a programmable baud rate from 28 GBaud to 69 GBaud and advanced modulation including 64QAM, enabling 600G wavelengths, up to 38.4 Tbps per fiber pair, and power consumption of 0.16 W per Gbps.
- **Wire-speed Encryption:** Coriant solutions can provide ODU encryption, FIPS 140-2 Level 2 compliant.
- **OTN ADM:** The 7100 Nano/Pico support both a single slot 40G ADM with two 10G line interfaces and 8 low speed client interfaces (can also be paired for redundancy) and a 400G ADM with two 100G line interfaces and twenty 10G client ports comprising two paired one slot modules.
- **OTN Switching:** OTN switching of up to 7 Tbps in a single shelf or 12 Tbps in two paired shelves is supported in the mTera UTP, while the 7100 Nano provides a 120 Gbps OTN switch with support for low speed interfaces or 1.2 Tbps of OTN switching with three paired 100G ADMs (400 Gbps per pair).
- **Packet Transport:** Coriant delivers MEF 2.0 certified end-to-end packet transport with Coriant® 7090 Packet Transport Solutions including compact GbE and 10 GbE NIDs and packet/aggregation switches, 7100 Nano/Pico packet optical in the metro edge, and mTera UTP multi-terabit packet optical in the metro core. Carrier-class OAM and protection is provided with protocol options including MPLS-TP, Ethernet Bridging, or VLAN cross-connect.
- **Universal Switching:** Each interface and virtual interface can be configured for OTN, Ethernet Bridging, VLAN cross-connect, or MPLS-TP including VPLS/H-VPLS in software. Universal switching also supports the interworking of SONET/SDH switching with OTN and packet switching.
- **SONET/SDH Switching:** Leverage up to 1.68 Tbps of STS-1/VC-4 switching with packet/OTN interworking through mTera UTP universal switching.
- **ASON/GMPLS:** Key features of the common ASON/GMPLS control plane include dynamic restoration at the optical and electrical layers and the ability to combine protection and restoration for cost-effective, fast multi-failure service recovery.
- **SDN:** SDN enables centralized multi-layer control and network programmability via open interfaces enabling automation and new approaches to service and application development such as DevOps. The Coriant Transcend™ Software Suite includes the Coriant Transcend™ Symphony for Transport SDN controller, which supports the full Coriant packet optical portfolio, and the Coriant Transcend™ Maestro multi-domain orchestrator enabling multi-layer, multi-vendor end-to-end service provisioning.
- **vASON:** vASON provides a centralized SDN-based alternative to traditional ASON/GMPLS that can be more quickly and easily added to existing networks and supports a wide range of transmission technologies. Additional benefits include multi-vendor support, IP-optical integration, and programmable restoration behavior.
- **Coriant Aware™ Technology:** This technology provides the real-time residual margin of each channel and generates the valid parameter options for each channel enabling the best options to be automatically selected by the management/control plane. Aware also speeds the activation of new wavelengths by enabling accurate, real-time wavelength planning in the Coriant Transcend™ Software Suite with reach/capacity that matches, or even exceeds, that of best-in-class offline planning tools.

LEVERAGING A BROAD METRO PORTFOLIO

With a broad product portfolio extending from metro access to the metro core, Coriant can tailor solutions for a wide range of metro networks and applications, from simple point-to-point applications to the largest meshed metros. Key products within this portfolio include:

- **Coriant® mTera 14-slot Shelf:** The 19RU mTera 14-slot shelf provides up to 7 Tbps of universal switching with support for sub-10G, 10G, 100G, and Coriant CloudWave™ Optics enabled flexi-rate (100G, 150G, 200G) interfaces. 12 Tbps can be supported with paired shelves. An optional optical layer based on a route and select ROADM-on-a-blade architecture can be deployed as part of a converged platform or as a disaggregated next-generation DWDM layer.
- **Coriant® mTera 8-slot Shelf:** The 10RU/12RU mTera 8-slot shelf provides up to 4 Tbps of universal switching leveraging the same fabrics and switching modules as the mTera 14-slot shelf. It also supports an optional optical layer based on the same route and select ROADM-on-a-blade architecture as the 14-slot mTera.

- **Coriant® 7100 Nano™ Packet Optical Transport Platform:** The 5RU 7100 Nano provides six full size slots per shelf and scales to ten shelves per system. It supports the Pluggable Optical Layer, broadcast and select ROADM-on-a-blade, high-density 10G and 100G, fabricless switching for OTN, and packet, and a SONET/SDH ADM-on-a-blade. Up to 1.2 Tbps of packet switching interfaces are supported per shelf including support for 100 GbE ports (grey or coherent DWDM).
- **Coriant® 7100 Pico™ Packet Optical Transport Platform:** The 2RU 7100 Pico provides two full size slots and an auxiliary slot for additional Pluggable Optical Layer pluggables. It can support a wide range of 7100 modules including high-density 10G, 100G, OTN ADM, packet switching, and Pluggable Optical Layer carrier cards. The 7100 Pico also supports fabricless switching enabling a paired 100G ADM with 400 Gbps OTN capacity or a 400 Gbps packet switch.
- **Coriant® 7100 PSX-3S:** Leveraging the same packet switching software as the 7100 Series and mTera UTP, the 7100 PSX-3S delivers 376 Gbps in 1RU with support for flexible combinations of GbE, 10GE, OTU2, and 100GE interfaces.
- **Coriant® 7090 Packet Transport Solutions:** The 7090 Series includes compact GbE and 10G CPE/NIDs with a full suite of Carrier Ethernet features and a range of MPLS-TP switches with support for TDM CES and capacities from 5 Gbps to 960 Gbps.
- **Coriant Groove™ G30 Network Disaggregation Platform:** An innovative 1RU modular open transport solution for cloud and data center networks, the Groove G30 can be equipped as a muxponder terminal solution leveraging Coriant CloudWave™ Optics and Coriant CloudWave™ T Optics technologies and as an Open Line System (OLS) optical layer solution, leveraging the Pluggable Optical Layer.
- **Coriant Transcend™ Software Suite:** The software suite includes Coriant Transcend™ Chorus for network management and operations, Coriant Transcend™ Symphony SDN controller, Coriant Transcend™ MANO for NFV, and Coriant Transcend™ Maestro multi-domain orchestrator.
- **Coriant® 7196 Optical Planning Tool (OPT):** The 7196 OPT provides a powerful and user-friendly tool for multi-layer, multi-period planning including optical, packet, OTN, and SONET/SDH layers with support for a variety of protection and restoration mechanisms.

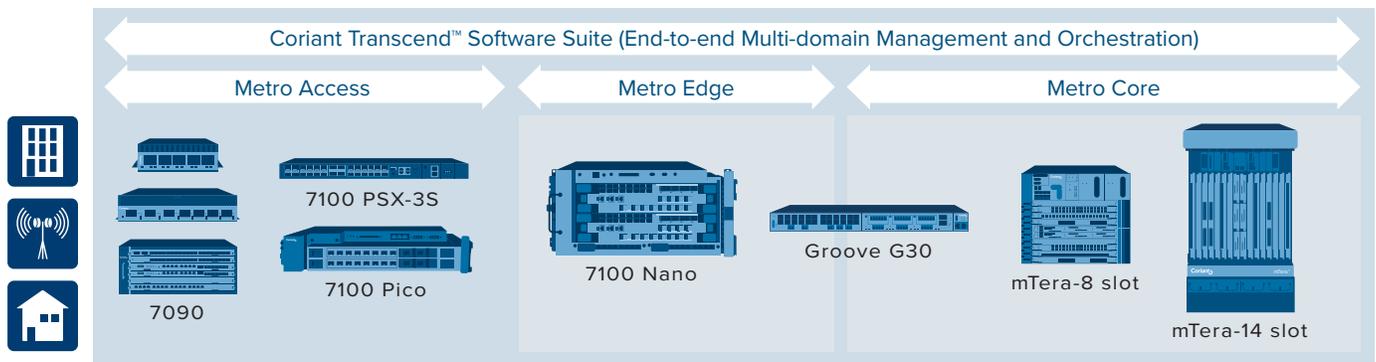


Figure 2: Coriant Metro Solutions Product Portfolio

Growing Your Network Cost Effectively

Coriant enables cost-effective network growth with highly flexible and future-proof metro transport solutions. Fabricless switching in the 7100 Nano and Pico enables switching to be added incrementally without the need for an upfront investment in fabrics. Universal switching in the mTera UTP offers cost savings by mixing OTN, SONET/SDH, and packet traffic on the same 100G+ interface while also providing investment protection against changing traffic patterns and client types with the ability to define interface and sub-interface protocols in software. With the Pluggable Optical Layer, new functionality can be easily and cost effectively added with new pluggables, while preserving investment in those pluggables that do not need to change. The Pluggable Optical Layer delivers CapEx savings of up to 30% relative to traditional solutions based on individual module per function or system-on-a-blade architectures. Converging packet and optical layers in the same shelf can also deliver CapEx savings of up to 25%, relative to separate platforms for packet and optical.

Leveraging the optical express capabilities of ROADM-on-a-blade enables wavelengths to be quickly and cost effectively added to the network. However while not every network needs ROADM on day one, the Pluggable Optical Layer offers FOADM to ROADM upgrades with the cost-effective addition of WSS pluggables. In terms of network management and orchestration, the Coriant Transcend™ Software Suite improves network efficiency and enables cost-effective growth through network discovery of nodes and services in real time to ensure that its database is always synchronized with the network while also delivering end-to-end multi-layer service provisioning. Transcend also provides a future-proof solution with the ability to seamlessly transition from traditional network management to SDN and to migrate from one packet protocol to another, for example from VLAN cross-connect to MPLS-TP.

Minimizing Operational Costs

Coriant metro transport solutions ensure minimal operational costs in a number of ways. First by offering highly compact and integrated solutions, both footprint and power consumption can be minimized. Examples of this include the highly integrated ROADM-on-blade modules, high-density transponder and switching modules, the 7100 PSX-3S, and the Groove G30 with 0.16 W per Gbps and 4.8 Tbps of line interface capacity in 1RU. The Pluggable Optical Layer can deliver footprint savings of up to 70% and power consumption savings of up to 50% relative to traditional solutions based on individual module per function or system-on-a-blade architectures. Converging packet and optical layer technologies can reduce footprint by over 30% and power consumption by up to 40% relative to separate systems for the packet transport and optical layers.

Second, Coriant metro solutions lower the costs of network operation in terms of planning, installation, provisioning, maintenance, and troubleshooting while simultaneously minimizing downtime. Examples of simplified installation include ROADM-on-a-blade, which reduces the amount of cabling, and Zero Touch Provisioning (ZTP), which works to simplify the installer's job by downloading the software and configuration automatically from a central server based on the location of the node in the network. Simplified provisioning is enabled by end-to-end service provisioning with consistency in workflows across technologies and a WDM layer that is able to auto-balance the amplifiers and channels, together with integrated test and loopback facilities for remotely testing wavelengths and RFC 2544/Y.1564 for Ethernet service activation.

Troubleshooting tools include per channel power monitoring, integrated OTDR, OTN Tandem Connection Monitoring (TCM), packet OAM including Y.1731 and 802.1 CFM OAM, and per channel residual margin values provided by Coriant Aware™ Technology. Spares are reduced with universal switching, programmable and tunable interfaces, and ROADM-on-a-blade/amplifiers that support a wide range of span losses.

Offering a Comprehensive Services Portfolio

Coriant also offers a broad range of services to help network operators plan, deploy, maintain, and optimize their metro networks and to migrate to more resilient, flexible, and scalable metro networks. The Coriant® Global Services team can facilitate a variety of metro network migrations including 10G to 100G+, SONET/SDH to packet optical, and traditional management to SDN.

Delivering Proven and Innovative Metro Solutions

With metro networks deployed by over 100 customers, Coriant metro transport solutions have been proven in the most demanding environments. At the same time, Coriant metro solutions are able to draw on numerous Coriant innovations including ROADM-on-a-blade, the Pluggable Optical Layer, Coriant CloudWave™ Optics and Coriant CloudWave™ T Optics, Coriant Aware™ Technology, vASON, and mTera UTP universal switching.

Leveraging a broad product portfolio and wide range of technology options together with a comprehensive services portfolio, Coriant delivers solutions for metro networks of any size that enable cost-effective growth while simultaneously minimizing operational costs.

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