

Coriant Metro Transport Solutions

Grow Your Metro Network Cost Effectively While Minimizing Operational Costs

TACKLING NEW VIDEO, CLOUD, 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. 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. Another key trend driving the metro is Data Center Interconnect (DCI), with the number and scale of data centers in key metros continuing to grow strongly, together with a push to distribute data centers closer to users in order to reduce latency and enable new cloud-based services.

These trends in video, cloud, and DCI are driving demand for a more scalable and flexible metro that can adapt to changing traffic patterns 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 10G wavelengths to 100G wavelengths and to 100G+ flexi-rate wavelengths, SONET/SDH to packet transport and OTN switching, static/closed architectures to programmable and open architectures leveraging more flexible hardware, and software architectures such as 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 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 Coriant Transcend™ SDN
- **Save** space and power with compact and highly integrated solutions including high-density 10G and 100G+
- **Reduce** operational costs with consistent end-to-end provisioning across technology layers
- **Migrate** SONET/SDH to next-generation packet optical technologies including MPLS-TP, 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 protection, Carrier Ethernet and MPLS-TP protection mechanisms, and ASON/GMPLS restoration

- **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 3.0/3.1.
- **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.
- **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:** With support for high-density 10G and 100G+, Coriant metro solutions address a wide range of data center interconnect applications including the cost-effective extension of the ROADM core via the Pluggable Optical Layer. Coriant metro DCI solutions include the industry-leading Coriant Groove™ G30 DCI Platform with 3.2 Tbps in 1RU.
- **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.

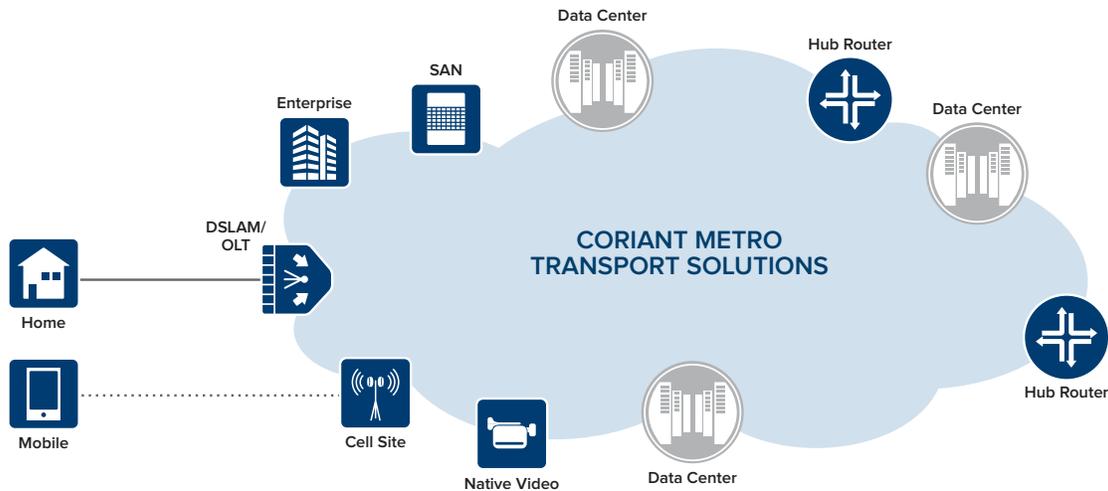


Figure 1: Key Coriant Metro Solution Applications

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), 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, Fixed 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 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, including support for Colorless/Directionless/Contentionless (CDC) add/drop.
- **Colorless, Directionless, and/or Contentionless:** In addition to fixed directional add/drop, Coriant metro solutions can deliver colorless and directionless as well as colorless, directionless, and CDC add/drop, leveraging a variety of technologies including WSS, splitter/combiner, star-coupler, and optical multicast switch.

- **High-density, Transparent 10G and 100G:** Coriant innovation includes a single slot 8x10G (16xSFP+) transponder and single slot 100G transponders and muxponders for the Coriant® 7100 Nano™ Packet Optical Transport Platform and Coriant® 7100 Pico™ Packet Optical Transport Platform. Furthermore, Coriant metro transponders and muxponders support extensive OTN OAM and protection capabilities enabling interoperability with switching nodes.
- **Coriant CloudWave™ Optics:** Leveraging advanced digital signal processing, embedded software, and photonic integration, Coriant CloudWave™ Optics supports flexi-rate modulation (100G/QPSK, 150G/8QAM, 200G/16QAM), offers increased spectral efficiency with up to 25.6 Tbps per fiber pair, and delivers industry-leading power consumption and density.
- **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/VPLS in software. Universal switching also supports the interworking of SONET/SDH switching with OTN and packet switching.
- **SONET/SDH Switching:** Leverage up to 120G STS-1/VC-4 switching in the 7100 Nano and 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™ SDN Transport Controller offers full support for the Coriant packet optical portfolio.

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. Route and select ROADM-on-a-blades provide the option of a converged switching and optical solution.
- **Coriant® mTera 8-slot Shelf:** The 10RU/12RU mTera 8-slot shelf provides up to 3.2 Tbps/4 Tbps of universal switching leveraging the same fabrics and switching modules as the mTera 14-slot shelf. It also supports the option of route and select ROADM-on-a-blade for a converged switching and optical solution.
- **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, and fabricless switching for SONET/SDH, OTN, and packet. 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® 7090 Packet Transport Solutions:** 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 320 Gbps.

- **Coriant Groove™ G30 DCI Platform:** The 1RU Groove G30 is a stackable transport solution for cloud and data center networks with support for up to eight Coriant CloudWave™ Optics-enabled flexi-rate interfaces (100G, 150G, 200G) and up to sixteen 100G clients providing 3.2 Tbps in 1RU with an industry-leading 0.45W per Gbps. Additional clients supported include 40 GbE, 10 GbE, and Fibre Channel.
- **Coriant® Transport Network Management System (TNMS):** TNMS is an end-to-end management platform (FCAPS) that enables operators to easily and cost effectively manage multi-layer, multi-domain, and multi-vendor networks. TNMS integrates into existing OSS environments and empowers a holistic approach to network and service management.
- **Coriant Transcend™ SDN Solution:** With full support for Coriant end-to-end packet optical transport solutions, the Coriant Transcend™ SDN Transport Controller provides an open and multi-layer solution enabling new applications including Bandwidth-on-Demand, Network as a Service, and SLA-aware Service Assurance.
- **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.

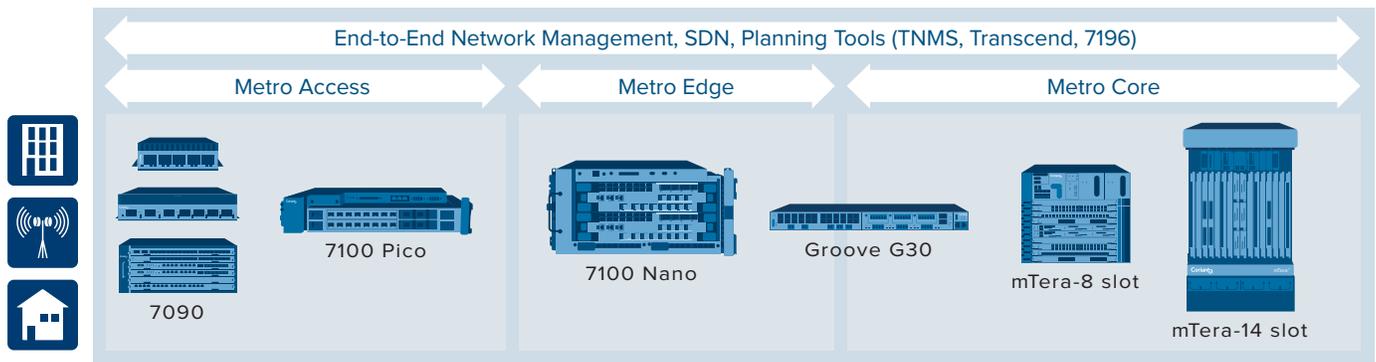


Figure 2: Coriant Metro Solutions Product Portfolio

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 or replaced by swapping 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 upgrade with the cost-effective addition of WSS pluggables. In terms of network management, TNMS 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. TNMS also provides a future-proof solution with the ability to seamlessly transition 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 a highly compact and integrated solution, both footprint and power consumption can be minimized. Examples of this include the highly integrated ROADM-on-blade, high-density transponder modules and the Groove G30 with 0.45W per Gbps and 3.2 Tbps 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 Commissioning, 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.

Troubleshooting tools include per channel power monitoring, integrated OTDR, OTN Tandem Connection Monitoring (TCM), and packet OAM including Y.1731 and 802.1ag CFM. 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 over 12,000 nodes deployed in 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 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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