DATA SHEET

5168

Ciena's 5168 Router is purpose-built for 5G networks that converge 4G/5G fronthaul, midhaul, and backhaul (xHaul) networks onto a common, simpler infrastructure. With dense 1/10/25GbE to 100/200GbE aggregation and support for both hard network slicing (FlexEthernet) and soft network slicing (Segment Routing), the 5168 is the ideal platform to simplify and de-risk the unique 4G to 5G journeys of mobile and wholesale operators.

The industry drives toward converged xHaul transport networks

Continued annual growth in 4G and 5G Radio Access Network (RAN) bandwidth demand is driving a change in the mix of connections and services, from 1GbE aggregation to 10GbE, and 10/25GbE aggregation to 100/200GbE. This ongoing growth will continue as network operators, mobile, and wholesalers embark on their unique 4G to 5G journeys—resulting in substantial upgrades to their xHaul networks—with traditional Mobile Network Operators (MNOs) modernizing their transport networks to support the vastly improved end-to-end network performance that is the promise of 5G.

Besides the substantial improvements in capacity and latency, one key aspect of 5G networks is the decoupling of the Remote Radio Unit (RRU), also referred to as Remote Radio Head (RRH), from the Baseband Unit (BBU) in a mobile macro cell.

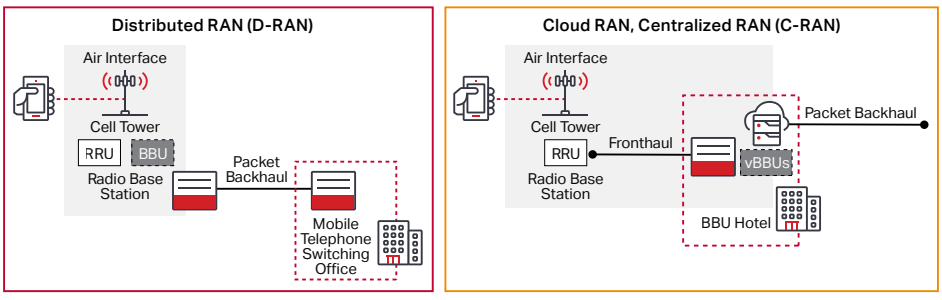

Figure 1. D-RAN and C-RAN

Features and Benefits

- Temperature-hardened (-40°C to +65°C) small form factor 1RU (11.81"/300mm)
- 18 CPRI (modes 3, 5, 7, 8) or 1/10/25GbE and 14 x 1/10/25GbE (32 ports total)
- L1/L2/L3 low latency switching
- Service isolation using FlexEthernet (FlexE)
- Carrier Ethernet, IP routing, SR-MPLS, and SRv6
- CPRI to O-RAN fronthaul including L1 offload processing
- IEEE 1914.3 Radio Encapsulation over Ethernet (RoE)
- 3GPP F1 functional split and open (Fronthaul-HLS) interfaces
- Hardware-assisted packet OAM scaled to deliver 25GbE services with guaranteed SLA differentiation
- Secure Zero-Touch Provisioning (SZTP) for rapid, secure, and error-free turn-up of services
- Advanced synchronization including built-in GNSS receiver
- Built-in RFC 2544 and ITU-T Y.1564 SAT with 100 Gb/s traffic generation and analysis
- Ciena's MCP multi-layer support for end-to-end network management control and planning
- Redundant AC or DC power

This results in a fronthaul transport network between the RRU and the centralized BBUs that will then be virtualized, using Commercial Off-The-Shelf (COTS) servers. This new architecture is referred to as Centralized/Cloud (C-RAN). The BBU itself will be further disaggregated into a Centralized Unit (CU) and Distributed Unit (DU), which results in a midhaul transport network between them. By converging 4G/5G fronthaul, 5G midhaul, and 4G/5G backhaul, network infrastructure cost and complexity are optimized.

C-RAN enables significant reductions in power consumption, footprint, and complexity deployed at 4G/5G cell sites. The Common Public Radio Interface (CPRI) for 4G LTE C-RAN is highly inefficient and won't scale cost effectively from a fronthaul bandwidth perspective. For 5G NR RAN, available capacity will be significantly higher than 4G LTE, particularly with High Order Multiple-Input Multiple-Output (MIMO) antenna deployments. Several sub-layers of the 5G NR RAN functions will be decomposed and virtualized over x86 COTS servers, which will have a major impact on the required xHaul network performance to deliver upon the full promise of 5G.

Dense, compact form-factor platform

Efficient use of real estate assets is a growing concern for MNOs, who either host their own network equipment or lease power, space, and connectivity from wholesale providers. As services multiply, MNOs must choose between stacking 10G xHaul-capable equipment and new 5G NR RAN equipment, which will incur additional collocation costs. The 5168's sleek, shallow depth and front access enable and facilitate cabinet and controlled environmental vault deployment. Extended temperature range support allows for installations in uncontrolled environments for outdoor aggregation of 1/10/25GbE and CPRI, enabling high capacity at the outdoor edge for both 4G and 5G connectivity.

Space is increasingly limited and expensive, and network operators face substantial capital expenditures to activate new locations or must retire active equipment to free space for new service delivery. Addressing bandwidth demand growth by deploying more and larger equipment is simply not a sustainable business model—economically or environmentally. Ciena's 5168 cost-effectively offers dense Ethernet, eCPRI, and

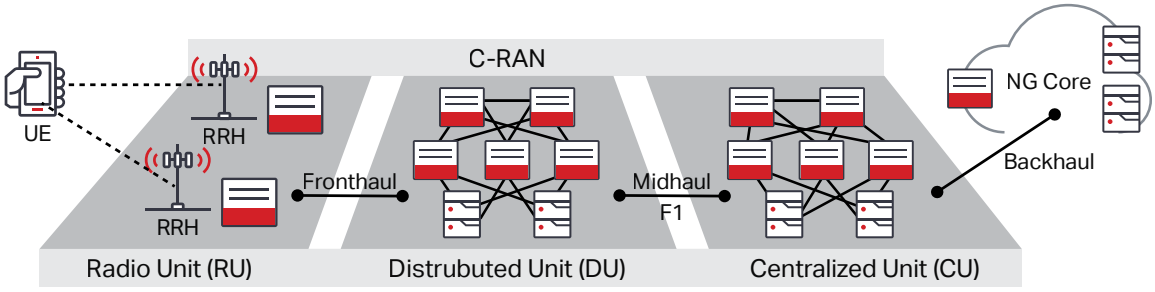

Figure 2. 5G NR RAN architecture

5G NR RAN

As MNOs upgrade to a 5G NR RAN network, shown in Figure 2, changes in the User Equipment (UE, more commonly referred to as a mobile smartphone or handset), RAN and mobile core are required. 5G brings the need to deliver higher capacity over the mobile network, driving the change in mix of wireline technology, performance, and services required in the access network. Driving wireline connections from 1GbE to 10GbE, and increasingly from 10GbE to 25GbE, all require aggregation up to 100GbE and 200GbE. Additionally, the need to reduce latency for new applications like Augmented Reality (AR), Virtual Reality (VR), mobile gaming, and the growing IoT space will require ultra-reliable Low-Latency Communications (urLLC) and network slicing capabilities. Ciena's 5168 supports all of these new technology and associated performance requirements, as well as existing 4G RAN networks.

CPRI service delivery in a 1RU, 300mm deep, fixed form-factor with dual power supplies, and a variety of pluggable optics to minimize network downtime.

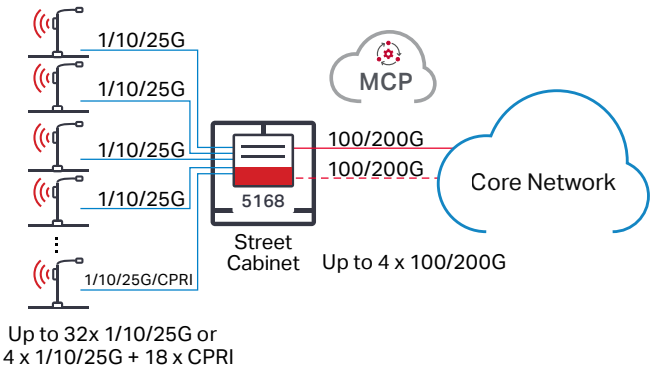

Figure 3. Ciena's 5168 outside service and aggregation

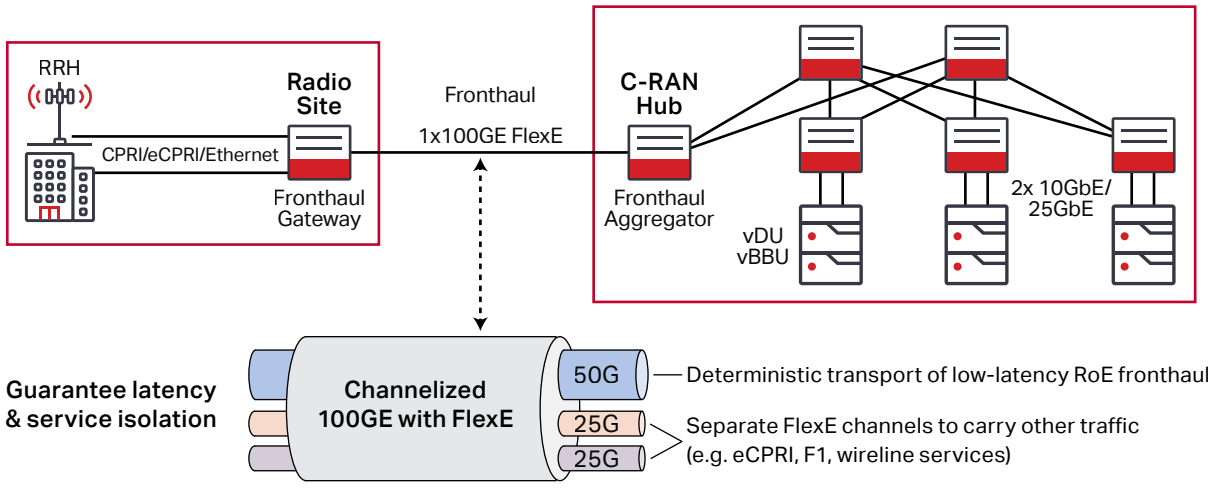

Figure 4. 5168 Channelized FlexE

Programmable fronthaul gateway

As MNOs look for the ability to derive new revenue streams, the 5168 CPRI/eCPRI/Ethernet-capable interfaces can be used to provide guaranteed Service Level Agreement-based (SLA-based) 5G services—made possible by network slicing and the underlying programmable wireline infrastructure that supports it—for new use cases and revenues, which is different from existing best-effort 4G LTE-centric mobile network services. There are two technologies in the fronthaul that can be applied to mitigate latency impacts on CPRI/RoE when combined with other traffic. One such mechanism is Flex Ethernet (FlexE), standardized in the OIF, which supports channelization as one of its use cases. Figure 4 shows how multiple traffic types (CPRI, eCPRI, F1, wireline services) can be carried using FlexE channels over a 100Gb/s FlexE link. Ciena's 5168 optimizes bandwidth, opens the fronthaul with O-RAN mapping, and provides deterministic low-latency transport with FlexE. For example, CPRI mode 7 links (9.83Gb/s), can be optimized by mapping into one 50Gb/s FlexE channels. By mapping CPRI/RoE into one of these channels with dedicated TDM-like scheduling, its latency and jitter will not be impacted by traffic in the other channel and bounded low-latency delivery can be ensured. Structure-aware mapping reduces required fronthaul to some degree by discarding non-utilized and idle portions of CPRI traffic. More significant gains can be achieved with CPRI Layer 1 offload by implementing Intra-PHY functional split, as defined in eCPRI and xRAN/ORAN fronthaul specifications.

The other technology is ITU-T G.mtn (Metro Transport Networking), in its ability to provide Time-Aware Scheduling (IEEE 802.1Qbv) with Frame Pre-emption (IEEE 802.1Qbu). IEEE 802.1Qbv enables all eight Ethernet queues closing time for frame transmission in nano seconds. When combined with IEEE 802.1Qbu, non-fronthaul traffic can be preempted to immediately service CPRI/RoE frames without incurring further delay.

Fine-grained SLA monitoring and enforcement

The 5168 includes performance benchmark testing based on ITU-T Y.1564 and RFC 2544, enabling up to 100Gb/s line-rate traffic measurements across virtual circuits. This approach improves end-customer satisfaction by enabling operations personnel to proactively respond to network events via increased performance visibility for differentiated SLA reporting.

Advanced multi-layer protocol support

The 5168 supports a flexible selection of service offerings, including L2 and L3 services over a carrier-class, connection-oriented infrastructure using MPLS and Segment Routing.

The platform supports a rich suite of L2/L3 features with Ethernet, MPLS, MPLS LDP, Seamless MPLS, OAM, QoS, Sync, LAG, FRR, TI-LFA, FlexEthernet, Network Slicing, IGP (IS-IS, OSFP), BGP/MP-BGP, Segment Routing functionality. Security functions and North Bound (NB) interfaces like ACL, TACACS+, Radius, streaming telemetry, NETCONF and YANG are also supported.

The 5168 operates as a full-featured IP router supporting NETCONF/YANG to easily integrate into an open SDN environment, with full visibility via streaming telemetry and automated provisioning using open APIs.

Synchronization and timing

To realize the full benefit of 5G, highly accurate time/phase synchronization, frequency synchronization, and even more stringent timing precision will be required. In the more latency-sensitive fronthaul network, care must be taken to deliver the required performance, especially in situations where traffic from 4G and 5G RRH is mixed. As eCPRI was defined to utilize a native packet transport, it is somewhat more tolerant to jitter than CPRI, which is natively a time domain-oriented constant bitstream. Therefore, when CPRI is packetized via technologies such as IEEE 1914.3 RoE Structure-Agnostic mapping and combined with eCPRI or FI over the same fiber, special provisions are required to guarantee its low-latency and low-jitter delivery to the BBU. New technologies, such as FlexE with ITU-T G.mtn enhancements as well as Time Sensitive Networking (TSN), have emerged as tools to provide these latency and jitter guarantees.

The 5168's rich timing and synchronization options enable new capabilities, such as Sync-as-a-Service with SLA for wholesale providers, hard and soft network slicing, as well as additional applications like massive Machine-Time Communication (mMTC), urLLC, and native Ethernet services in the wireless domain via 5G NRs.

The cost-effectiveness and versatility of the 5168 xHaul network slicing router provides synchronization and timing for C-RAN architectures with support for CPRI/eCPRI/RoE/ORAN, Adaptive IP™, and high density 1/10/25GbE to 100/200GbE aggregation.

Differentiation through accelerated service velocity

Service velocity has become a critical competitive advantage for network operators, mobile, and wholesalers. In many cases, service velocity is the determining factor in winning new service opportunities. The 5168 implements Ciena's unique SZTP capabilities, allowing operators to deploy new packet-based services rapidly and securely in a fully automated manner. By reducing or eliminating costly and time-consuming manual intervention, provisioning errors are eliminated via SZTP. Most importantly, SZTP improves service deployment velocity and significant competitive advantage.

Rich packet Operations, Administration, and Maintenance (OAM) suite of capabilities

As network operators and their customers increasingly rely on new packet-based networks, providers must maintain guaranteed service levels. Packet networks must support a broad array of packet OAM capabilities to ensure operators can proactively and reactively maintain and report on the ongoing health of their networks and delivered services. The 5168 also supports a comprehensive set of hardware-assisted packet OAM capabilities, and is architected to provide SLA metrics and OAM at a high scale. This enables operators to take full advantage of the port density and 800 Gb/s fabric for delivering the maximum number of services at the lowest cost. Additionally, the 5168 has an embedded line-rate Service Activation Test (SAT) engine (RFC 2544, ITU-T Y.1564), with traffic generation to a full 100 Gb/s to guarantee strict, market-differentiating SLAs, without relying on costly external test equipment and the highly trained personnel that requires.

Simplified multi-layer management and control

Ciena's Manage, Control and Plan (MCP) domain controller software offers a unique and comprehensive solution for the administration of mission-critical networks that span access, metro, and core domains, and provides unprecedented multi-layer visibility from the photonic to the packet layers. With this innovative management approach, MCP supports a programmable and automatable solution that provides a fully open approach to installing, manipulating, and monitoring service behaviors in an SDN environment.

Technical Information

Interfaces

Ethernet/CPRI Ports
- 14 x 1GbE/10GbE/25GbE SFP28 ports
- 18 x CPRI (modes 3/5/7/8) including L1 offload or 18 x 1GbE/10GbE/25GbE SFP28 ports
- 4 x 100GbE/200GbE QSFP56/QSFP28 ports

Other
- 1 x USB-C Off-switch memory
- 1 x USB-C Console
- 1 x RJ45 Time-of-Day (ToD)
- 1 x SMB Phase input (1pps/10MHz)
- 1 x SMB GNSS antenna
- 1 x RJ45 Management (MGMT)

Ethernet
- IEEE 802.1ad Provider Bridging (Q-in-Q) VLAN full S-VLAN range
- IEEE 802.1D MAC Bridges
- IEEE 802.1p Class of Service (CoS) prioritization
- IEEE 802.1Q VLANs
- IEEE 802.3 Ethernet
- IEEE 802.3ab 1000Base-T via copper SFP
- IEEE 802.3ad Link Aggregation Control Protocol (LACP)
- IEEE 802.3ba-2010 100Gb/s
- IEEE 802.3bs 200Gb/s and 400Gb/s
- IEEE 802.3by-2016 25Gb/s
- IEEE 802.3z Gigabit Ethernet
- Layer 2 Control Frame Tunneling
- Link Aggregation (LAG): Active/Active; Active/ Standby
- Jumbo frames to 9216 bytes
- VLAN tunneling (Q-in-Q) for Transparent LAN Services (TLS)

Fronthaul
- IEEE 1914.3 RoE transport mapper type 0 & 1
- CPRI to O-RAN evolution with L1 offload
- Configurable CPRI rates supporting modes 3,5,7, and 8
- CPRI interworking function*

FlexE
- FlexE bonding up to 400Gbps
- FlexE channelization down to 5Gbps
- ITU-T G.mtn FlexE channel switching

Carrier Ethernet OAM
- EVC Ping (IPv4)
- IEEE 802.1ab Link Layer Discovery Protocol (LLDP)
- IEEE 802.1ag Connectivity Fault Management (CFM)
- IEEE 802.3ah EFM Link-fault OAM
- ITU-T Y.1731 Performance Monitoring

Synchronization
- External Timing Interfaces
  - ITU-T G.703 Frequency in or out (2.048MHz, and 10MHz)
  - ITU-T G.703 1pps and ToD in or out
- Integrated GNSS receiver
- ITU-T G.8262/G.8264 EED option1 and option2
- ITU-T G.8275.1 full timing support T-GM, T-BC and T-TSC
- G.8275.2 clock, Class C*
- Stratum 3E oscillator

Time-Sensitive Networking
- *IEEE P802.1Qcc Stream Reservation Protocol(SRP) Enhancements and Performance Improvements
- *IEEE P802.1Qci Per-Stream Filtering and Policing
- *P802.1Qcr Bridges and Bridge Networks Amendment: Asynchronous Traffic Shaping
- *P802.1Qav Forwarding and Queuing Enhancements for Time-Sensitive Streams

Networking Protocols

- ISO10598 IS-IS intra-domain routing protocol
- OSFP Segment Routing extension
- OSFP TI-LFA Topology Independent Fast Reroute using Segment Routing
- RFC1195 Use of OSI Is-Is for Routing in TCP/IP and Dual Environments
- RFC1997 BGP Community Attribute
- RFC2328 OSPF Version 2
- BGP Prefix Independent Convergence
- EVPN FXC draft-ietf-bess-evpn-vpws-fxc-03.txt
- RFC2698 A Two Rate Three Color Marker
- RFC2865 Remote Authentication Dial in User Service (RADIUS)
- RFC3031 Multiprotocol Label Switching Architecture
- RFC3032 MPLS label stack encoding
- RFC3107 Support BGP carry Label for MPLS
- RFC4271 A Border Gateway Protocol 4 (BGP-4)
- RFC4360 BGP Extended Communities Attribute
- RFC4364 BGP/MPLS IP Virtual Private Networks (VPNs)
- RFC4456 BGP Route Reflection: An Alternative to Full Mesh Internal BGP (IBGP)
- RFC4632 Classless Inter-domain Routing (CIDR): The Internet Address Assignment and Aggregation Plan
- RFC4760 Multiprotocol Extensions for BGP-4
- RFC4762 Virtual Private LAN Service (VPLS) Using Label Distribution Protocol (LDP) Signaling (HVPLS)
- RFC5004 Avoid BGP Best Path Transitions from One External to Another
- RFC5036 LDP Specification
- RFC5037 Experience with the LDP protocol
- RFC5301 Dynamic Hostname Exchange Mechanism for IS-IS
- RFC5302 Domain-Wide Prefix Distribution with Two-Level IS-IS
- RFC5303 Three-Way Handshake for IS-IS Point-to-Point Adjacencies
- RFC5309 Point-to-Point Operation over LAN in Link State Routing Protocols
- RFC5396 Textual Representation of Autonomous System (AS) Numbers
- RFC5398 Autonomous System (AS) Number Reservation for Documentation Use
- RFC5492 Capabilities Advertise with BGP-4
- RFC5561 LDP Capabilities
- RFC5668 4-Octet AS Specific BGP Extended Community
- RFC6241 Network Configuration Protocol (NETCONF)
- RFC6310 Pseudowire (PW) Operations, Administration, and Maintenance (OAM) Message Mapping
- RFC6793 BGP Support for Four-Octet Autonomous System (AS) Number Space
- RFC7432 EVPN VPWS/VPLS
- RFC7737 Label Switched Route (LSP) Ping and Traceroute Reply Mode Simplification
- RFC7911 Advertisement of Multiple Paths in BGP
- RFC8214 Virtual Private Wire Service Support in Ethernet VPN
- SR-MPLS TI-LFA Topology Independent Fast Reroute using Segment Routing draft-ietfrtgwg-segment-routing-ti-lfa-03
- SRv6 Micro Segments draft-filsfils-spring-net-pgm-extension-srv5-usid-04

Network Management

- Alarm Management and Monitoring Configuration
- Event and Alarm Notification/Generation Comprehensive Management
- Via CLI Management
- Via Netconf/YANG Models
- gRPC-based streaming telemetry
- IPv4 and IPv6 Management Support
- IPv4 Management ACL (in-band)
- IPv6 Management ACL (in-band)
- RADIUS, AAA
- RFC 2131 DHCP Client
- RFC 3046 DHCP Relay
- RFC 5905 NTP Client
- Secure File Transfer Protocol (SFTP)
- Secure Shell (SSHv2)
- Secure Zero-Touch Provisioning (SZTP)
- Software upgrade via FTP, SFTP
- Syslog Accounting
- TACACS + AAA
- Web GUI

*Future: 1H21

Technical Information continued

Physical Characteristics

Dimensions
- 17.5"(W) x 11.81"(D) x 1.75"(H)
- 444mm (W) x 300mm (D) x 44mm (H)

Power Requirements
- DC input: -48 Vdc (nominal)
- AC input: 100Vac, 240 Vac (nominal)

Standards Compliance

Emissions
- CISPR 22 Class A
- CISPR 32 Class A
- EN 300 386
- EN 55032
- FCC Part 15 Class A GR-1089 Issue 6
- Industry Canada ICES-003 Class A
- VCCI Class A

Environmental
- RoHS2 Directive (2011/65/EU)
- WEEE 2002/96/EC

Operating Temperature
- -40oF to +149oF (-40oC to +65oC)

Storage Temperature
- -40oF to +158oF (-40oC to +70oC)

Humidity
- Non-condensing 5% to 90%

Immunity (EMC)
- GR-1089 Issue 6
- CISPR 24

Power
- ETSI EN 300 132-2
- ETSI EN 300 132-3

Safety
- ANSI/UL 60950-1 2nd edition 2007
- CAN/CSA C22.2 No. 60950-1-07
- EN 60950-1
- IEC 60825-1 2nd edition (2007)
- IEC 60825-2 3rd edition (2004)

Service Security
- Broadcast Containment Egress Port Restriction
- Hardware-based DOS Attack Prevention Layer 2, 3, 4 Protocol Filtering
- User Access Rights Local user authorization

Visit the Ciena Community
Answer your questions