Cisco Converged Fronthaul Router Portfolio

SP Networking Systems Business Unit
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5G is Real
Network upgrades aligning with market rollouts

- 5G mass market rollouts are underway and picking up steam

Source: Operator Strategies for 5G Transport, Light Reading, 2019
5G is Real
Network upgrades aligning with market rollouts

- RAN transport upgrades are critical to mass market rollout success

Source: Operator Strategies for 5G Transport, Light Reading, 2019
5G RAN Transformation
Architectural shifts impacting the evolution of RAN transport

- **Software Centric**
  Virtualization, Programmable, Flexible, Any-to-Any Connectivity

- **Decomposition**
  Radio Equipment Controller Decomposition, CU/DU Functional Splits

- **New Radio**
  High Bandwidth, High Density, Low Latency, Precise Timing and Synchronization

- **Convergence**
  Blended SLAs Services, Traffic Steering, Dynamic Path Optimization

- **Automation**
  Open, Pervasive Automation, Service Assurance, Network Slicing

**Radio Technology Innovation**
- Higher frequency spectrum
- Larger radio channels
- Increased network density
- Massive MIMO

Radio Technology Innovation
Benefits of Centralized & Cloud RAN Architectures

Functional & economic advantages

**Functional Benefits**
- Enhanced Coordination
- Enhanced RU Management and Policy
- Baseband Pooling, Flexibility of Software
- Enhanced Network Resiliency

**Economic Benefits**
- Reduced Cell Site Management
- Reduced Site Deployment Costs (less physical equipment)
- Service innovation & Commoditization
- Improved Resource Utilization (spatial efficiency)
RAN Transport Performance Expectations

- Higher Speed Interfaces
- Lower Latency
- More Precise Timing & Synchronization
- Any-to-Any Connectivity

<table>
<thead>
<tr>
<th>Interface(s)</th>
<th>Typical distance</th>
<th>1-way latency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fronthaul</td>
<td>&lt;15KM</td>
<td>75us/100 us (LTE) 150us (5G NR uRLLC)</td>
</tr>
<tr>
<td>Midhaul</td>
<td>&gt;10KM</td>
<td>1-5ms</td>
</tr>
<tr>
<td>Backhaul</td>
<td>&gt;10KM</td>
<td>10ms</td>
</tr>
</tbody>
</table>

Network Configurations:
- D-RAN: RRU to BBU to Backhaul
- C-RAN: RRU to BBU to Backhaul to Mobile core
- Cloud RAN (Midhaul): RRU to Midhaul to vCU to Backhaul to Mobile core
- Cloud RAN: RRU to Midhaul to vCU to Backhaul to Mobile core
# RAN Fronthaul Standards

Evolving towards Open RAN

<table>
<thead>
<tr>
<th>Proprietary</th>
<th>Proprietary</th>
<th>Non-proprietary</th>
<th>Non-proprietary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CPRI</strong></td>
<td><strong>eCRPI</strong></td>
<td><strong>RoE</strong></td>
<td><strong>Open RAN</strong></td>
</tr>
</tbody>
</table>
- Time Sensitive Networking  
  TSN Profiles 802.1CM, Frame Preemption 802.1Qbu | - O-RAN Alliance (Open RAN)  
  Open feature development  
  Reduced time-to-market  
  Incubation of ecosystem innovation |

Driving towards open standards for RAN Interfaces
Traditional Fronthaul Deployment Options are Sub-Optimal for 5G

- Very expensive solution
- Difficult to scale
- Fiber may not be available everywhere

- Limited lambda (λ) scale
- Manual deployments that are time consuming and error prone
- No visibility of the service making it difficult to troubleshoot
- No redundancy

- Expensive due to colored optics
- Active tunable optics have challenge with I-TEMP
- No Statistical Mux
- Topology dependent (Requires ROADM for ring architecture)
Packet-Based Fronthaul

**Packet**
- Stat Mux Advantages
- Cost Effective
- Topology Independent
- Service Visibility & Transparency
- Scalable E2E Converged IP

**Optical**
- Optical multiplexing
- Non-scalable, architecturally rigid
- Limited service visibility
- Capex dependent scale
- Point-to-point, topology dependent

Stat-muxing opportunity
Cisco Converged Packet-based Fronthaul
Extending to meet the needs of Fronthaul, Midhaul, & Backhaul

Converged Packet-based Fronthaul

Cell Site

Business CPE

5G NR RRH

4G LTE RRH

Fronthaul Cell Site Router

Fronthaul Aggregation Router

BBU Pool

Backhaul

CRAN Hub

BENEFITS

High-Speed and Ultra-Low Latency Forwarding w/ Stat Mux

Flexible and programmable architecture

Precise timing and synchronization capabilities

End to end IP based network for a simplified architecture

Open and automated management
Radio transport requirements
High speed and Ultra-Low Latency forwarding

High Performance ASIC
2us ASIC latency, <10us platform latency with statistical multiplexing

Optimized Platforms
Low cost, low power, and optimal form factors for remote cell site router, and aggregation roles

Low Latency
802.1Qbu - frame preemption (TSN) support on 10G/25G

Advanced Forwarding
Flexible hierarchical QoS, scalable L3 services

Clocking & Synchronization
Class C, eEEC, PRTC-B, better oscillator

E2E Transport Performance
Simplified E2E network fabric with SR/EVPN, SR PM, L2/L3 VPNs

IP packet-based networks deliver 5G performance and optimal customer experiences
Cisco Fronthaul Router Models  
NCS 540 family

<table>
<thead>
<tr>
<th>Fronthaul Router</th>
<th>Use Case</th>
<th>Port Config</th>
<th>RU</th>
<th>Capacity</th>
<th>Software</th>
</tr>
</thead>
</table>
| N540-FH-CSR-SYS  | Remote Indoor Router [Packet + CPRI + TSN] | • 8xCPRI (Option 3-8)  
• +4x1/10G/CPRI (Option 3-8)  
• 8x1/10G  
• 4x10/25G  
• 2x10/25G (802.1Qbu)  
• 2x100G | 1 RU | 300Gbps | IOS XR |
|                  |          | *Universal Port = Port can be used for CPRI or eCPRI or Ethernet (1/10/25GE) |     |          |          |
| N540-FH-AGG-SYS  | Aggregate Site Router [Packet + CPRI + TSN] | • 24x10G/25G*  
• (802.1Qbu, CPRI 3–8)  
• 4x100G | 1 RU | 900Gbps | IOS XR |
|                  |          | *Universal Port = Port can be used for CPRI or eCPRI or Ethernet (1/10/25GE) |     |          |          |
Flexible & Fully Programmable Architecture
To support evolving standards

Field Programmable Gate Array (FPGA) for evolving RAN
- Flexible platform to address both short term and long-term requirement for CPRI, eCPRI and RoE
- Optimized for RoE type 0 and type 1
- Future proofed to allow operators to add new RAN functions and interworking scenarios

IOS XR
IOS-XR Based - Open APIs
- Common operating system software across the physical and virtual platforms
- Delayered IOS XR software stack with APIs exposed for management, service and hardware layers
- Optimized performance for advanced features: SR, EVPN, security
- Improved service visibility with telemetry

Adaptable platform to address emerging requirements
Optimized for CPRI Transport Over Ethernet

Fronthaul RoE Structure Agnostic Modes (Type 0 & Type 1)

- Optimized to enable RoE Structure-Agnostic Tunneled Mode (Type 0)
  - Compatible with all RAN suppliers’ equipment.

- Extensible to support RoE Structure-Agnostic Line Code Aware Mode (Type 1)
  - Can be tailored with RAN vendor specific CPRI information to reduce fronthaul bandwidth by 20%.

- Customizable to enable additional/future use cases
  - Programmable to extend functionality to support unique RAN interworking requirements
Precise Timing and Synchronization
Accurate and reliable timing for 5G networks

How do we deliver Sync for 5G networks?

**ANSWER**

Advanced throughput optimization techniques such as Inter-Cell Interference Cancelation, MIMO coordinated multi-point data delivery require precise time synchronization.

- CPRI protocol delivers phase and frequency synchronization, eCPRI/RoE does not.
- eCPRI/RoE Interworking use cases require RAN transport to provide phase and frequency synchronization including diverse delivery of accurate timing.

Cisco Fronthaul Routers support **stringent phase and frequency synchronization** requirements with up to **Class C timing** capabilities.
Converged Services
Optimizing transport performance for fronthaul applications

- **Converge services** onto a single transport network.
- **Segment Routing** provides traffic steering and policing capabilities to optimize traffic path based on static and/or dynamic computations including latency.
- **Frame preemption** with 802.1Qbu/TSN assures that Fronthaul and Midhaul traffic can be prioritized over less latency sensitive flows.
Comparing TCO for fronthaul
Packet vs optical fronthaul solutions

Packet-based fronthaul
Optical-based fronthaul

TCO Savings

+65% ROADM
+46% P2P Active DWDM
+40% P2P Passive DWDM
+13% P2P Passive CWDM

Source: ACG – An Economic Comparison of Fronthaul Architectures for 5G Networks
Consistent End-to-End IP Network
Simplifies and improves reliability of the architecture and operations

Extending the architecture into the RAN transport

Automation & Orchestration

Converged SDN Transport

IOS XR

Converged Infrastructure
SR | BGP VPN
End-to-end simplicity
Open & programmable
Open & Automated Management
Outcome-driven automation

Flexible NSO function packs
To automate provisioning of multi-vendor domains

Open APIs and management interfaces
To enable full operational lifecycle of the products

Cisco Crosswork portfolio
To provide full suite of FCAPs applications

Closed-loop and outcome-driven automation, on premises and in the cloud. Simple integration into legacy RAN management domains & other NMS/OSS systems.
Cisco CX Delivers Expert Guidance & Services
For every stage of your 5G journey

Customer Experience Lifecycle

Advise
- Find and prioritize your key initiatives and plan your 5G rollout.
- Knowledge transfer for Segment Routing

Implement
- Strategy & Analysis
  - Assess your infrastructure to determine L2-LDP-SR interoperability or transformation, and how you’re placed to get there including risks, gaps, roles and responsibilities.
  - Proof of Concept options
- Design
  - Determine the Architecture for 5G Mobile Backhaul with Baseline mobile backhaul infrastructure (Flex-Algo, QoS, ODN, AS), Clocking, Edge compute transport
- Assessment
  - Validate solutions

Optimize
- Optimization
  - Maximize your investment, audit your network, resolve issues preemptively and access extensive training resources.
  - Plan and migrate to 540/560, ASR9k with Lightspeed, NCS 5500, Spitfire, with support every step of the way.

Deployment @Scale
- Deployment @Scale
  - Plan, test and deploy software and solutions for MBH Infrastructure
  - NSO based Automation for Deployment & Operational needs
  - Deploy Segment Routing MPLS without impacting existing services
- Validation
  - Certify and validate your software and MBH solutions.

Maintain
- Support
  - Enhance IT operations and maximizes uptime to consistently and securely keep your business running smoothly.

Cisco NSO & Crosswork Network Automation
Industry’s most comprehensive, closed-loop, mass-scale automation solutions that embraces multi-vendor networks
Why Cisco for Fronthaul?

- Packet-based solution with high-speed, Ultra-Low Latency Forwarding to meet and exceed fronthaul requirements
- Converges services while optimizing fronthaul resources
- Flexible and programmable architecture to support RAN innovation
- Simplifies and improves reliability of network operations by extending IP through RAN transport
Additional Resources

• For more information on 5G transport please go to www.cisco.com/go/5g-transport
