Nokia 7730 SXR-R series Service Interconnect Routers

Release 26

The Nokia 7730 Service Interconnect Router (SXR)-R[1] series of routing platforms is designed for telecommunications service providers, AI and cloud providers, and mission-critical enterprise networks. Powered by Nokia FPcx routing silicon, it delivers high performance, high port density, and feature-rich capabilities in compact, modular, temperature-hardened form factors.

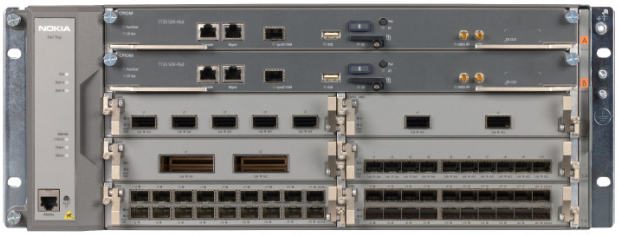
Overview

Networks are evolving to distribute network functions closer to users, while network operations are shifting toward a NetOps model. At the same time, critical enterprise applications are moving to the cloud, increasing expectations for highly reliable, always-on IP connectivity and services.

These evolving requirements are addressed by the Nokia 7730 SXR-R series. The platform is packed with advanced capabilities that enhance network scale, services, security, flexibility, and resiliency required in IP access, aggregation, and edge platforms.

At the heart of the platform is the fully programmable FPcx network processor, delivering deterministic performance, advanced multi-level QoS, in-service upgradability, and security capabilities beyond what is possible with off-the-shelf forwarding engines. Together with the extensible and resilient SR Linux network operating system (NOS), it is optimized for IP access, aggregation, and smaller edge applications.

7730 SXR-R6dl



7730 SXR-R6d

1 The 7730 SXR-R series is part of the 7730 SXR product family. The 7730 SXR-1 series data sheet is also available.

The fully modular platform, featuring control and fabric redundancy, addresses a broad range of deployment scenarios with adapters that provide flexible speed, optic, and density options. Scaling up to 3.6 Tb/s of full-duplex (FD) capacity, it supports a wide range of interface speeds and optics with flexible breakout capabilities, including 400G QSFP-DD, 100G QSFP28, 50G SFP56, 25G SFP28, 10/1G SFP+/SFP, and 1G cSFP. This enables high-density 10GE, 25GE, 50GE, 100GE, and 400GE networking environments. Support for pluggable 100G ZR and 400G ZR/ZR+ digital coherent optics (DCO) modules further extends deployment flexibility.

The platform delivers exceptional port density for 1GE to 100GE services in compact, ruggedized, extended-temperature, EMC-hardened systems with deterministic connectivity, advanced timing and synchronization, and granular service scale.

Combined with Nokia SR Linux, the platform provides a robust foundation and the NetOps building blocks needed to streamline IP network operations through cloud-native architectures and automation at scale.

Network processor-based architecture

At 5.0 Tb/s full duplex (FD), the Nokia FPcx provides right-sized capacity for next-generation access, aggregation and edge applications. With its fully programmable pipeline, the FPcx supports high-speed connectivity using 112G/56G SERDES technology, enabling fast and efficient data transport while maintaining low power consumption, measured in watts per gigabit (W/G).

The FPcx network processor (NP) consists of eight independent clusters, each capable of running its own code. This unique architecture provides exceptional flexibility to address both current and future requirements. The independent operation of these clusters enables FPcx-powered platforms to be upgraded in service with with no impact on data plane forwarding (Note: this is a future software deliverable).

A 100 percent programmable NP will always drive the lowest TCO with respect to any other silicon type. By eliminating hard-coded forwarding logic, the FPcx architecture mitigates the impact of future standards evolution and enables networks to adapt efficiently to changing requirements. This flexibility extends to the independent operation of each cluster, allowing resources to be allocated according to network demands and enabling in-service software upgrades (ISSUs) on a cluster-by-cluster basis, even on a simplex network processor. With zero hard-coded logic, FPcx silicon can support future protocols and services without requiring platform replacement.

With 8 GB of egress buffering and up to 192 MB of ingress buffer memory, the effectively fully buffered architecture of the FPcx provides an order-of-magnitude greater buffering capability than typical merchant silicon. This translates directly into improved network performance, including enhanced upstream and downstream throughput under demanding traffic conditions.

Scale and performance

The centralized architecture of the Nokia 7730 SXR-R6d and SXR-R6dl is built around a single FPcx chipset on each Control Processor Input/Output Module (CPIOM). The CPIOM combines control plane and data plane functions in a single field-replaceable unit (FRU). Each platform supports up to six Media Dependent Adapters (MDAs).

The CPIOM is interchangeable between the SXR-R6d and SXR-R6dl platforms, while the MDAs and fan modules are chassis-specific. The platforms are designed to maximize faceplate density, supporting up to 80 physical ports per MDA on the 7730 SXR-R6d and SXR-R6dl, respectively.

All MDAs, fan modules, accessory kits, and cables from the Nokia 7250 IXR-R6d and IXR-R6dl are fully reusable, with the CPIOM serving as the distinguishing component that identifies a system as a 7730 SXR. As a result, a 7250 IXR-R6d and IXR-R6dl can be upgraded to a 7730 SXR-R6d and SXR-R6dl through a CPIOM replacement.

This upgrade significantly enhances system capabilities by leveraging the determinism, scale, advanced QoS, buffering, performance, and in-service upgradability enabled by Nokia's FPcx silicon. When deployed with the innovative active-active CPIOM architecture of the 7730 SXR-R6d and SXR-R6dl, the platform operates at up to 3.6 Tb/s full duplex FD while delivering additional performance benefits compared to active-standby CPIOM designs.

FPcx is designed for deterministic operation, providing predictable performance under all loading conditions. High-scale service routing, granular access control lists (ACLs), hardware-based OAM, and industry-leading statistics granularity combine to deliver advanced capabilities without performance trade-offs. It also supports multi-level quality of service (QoS) capabilities, including up to seven levels of hierarchical QoS (H-QoS) and industry-leading queue and policer scale to help ensure predictable service performance.

With 6–12x more on-chip buffer memory and 2–4x greater memory bandwidth per bit than typical merchant ASICs, FPcx delivers superior scaling and QoS, and low-latency packet processing while providing lossless buffering for bursty, lower-priority traffic.

Network density and longevity

The modular architecture used by routers in the 7730 SXR-R series supports a variety of deployment options. High-density Ethernet cards deliver network connectivity from 100 FE to 400 GE with all speeds in-between including full breakout options. In addition, full support for coherent optics, including 400G QSFP-DD ZR/ZR+ and 100G ZR, provides extended-reach connectivity, lowering total operational costs. Side-to-side airflow with a fan filter and redundant fan design increases system lifetime. Side-to-side airflow and a shallow system design depth provide compatibility with 300 mm ETSI-compliant cabinets.

All-in-one system synchronization

The 7730 SXR-R series provides precise frequency and time synchronization to meet the stringent requirements of 4G/5G mobile base stations and other mission-critical networks. It improves timing accuracy over packet networks by combining built-in architectural features with port-based time stamping, dual-band Global Navigation Satellite System (GNSS) capabilities, ITU-T Synchronous Ethernet (SyncE) and the Nokia Bell Labs IEEE 1588v2 algorithm.

Synch performance achieved in the 7730 SXR-R includes G.8272 PRTC-B for GNSS and G.8262.1 eEEC for SyncE. Combined with advanced QoS capabilities, the platform provides granular traffic control that reduces packet delay and delay variation, helping ensure the accuracy and reliability of packet-based synchronization technologies.

IP Network security

The 7730 SXR-R series enhances network security with advanced DDoS mitigation. It uses large-scale ACLs to filter DDoS traffic without impacting the performance of any functions or services running on the platform. Combined with Nokia Deepfield Defender, the solution quickly mitigates DDoS attacks at the network edge cost-effectively, eliminating the need to redirect traffic to a scrubbing center.

As part of a multi-layered defense-in-depth approach to IP cryptography, the 7730 SXR-R series addresses networking requirements for end-to-end secure and trusted quantum-safe connectivity. The platform supports IEEE 802.1AE MACsec and the MAC Security Key Agreement 802.1X protocol (combined with quantum-safe preshared key cryptography), to deliver quantum-safe network connectivity.

To extend this capability, the 7730 SXR-R series enhances IEEE 802.1AE MACsec with Nokia's ANYsec technology (Note: MACsec and ANYsec are future deliverables). Leveraging the Nokia FP5 E5 MACsec ASIC positioned in front of the FPcx network processor, the platform enables Nokia's proven flow-based encryption capabilities to new deployment scenarios while providing a consistent security architecture across the network.

With Trusted Platform Module (TPM) 2.0 technology and capabilities to support secure boot and measured boot, security is not only a network wide value add but is built into the DNA of every single platform.

For harsh environments

The 7730 SXR-R series supports extended temperature range, hardened mechanicals and robust EMC design. These systems meet IEEE 1613/1613.1, IEC 61850-3 and EN 50121-4 standards for power substation and railway environments.

For extra environmental protection, PCB enhanced plating (PEP) is included on the 7730 SXR series to provide robustness without the need for conformal coating.

Service Routing with SR Linux

Nokia SR Linux is a Linux®-based open, extensible and resilient NOS that enables scalability, flexibility and efficiency in wide area and data center network environments. The Nokia 7730 SXR-R implements Nokia SR Linux.

Ground-up, model-driven architecture delivers extensibility

SR Linux is designed from the ground up with a management architecture that meets the demands of a model-driven world where visibility—and the scalability and granularity of that visibility— are paramount.

SR Linux features a completely model-driven architecture for flexible and simplified management and operations. SR Linux delivers an extensible and open infrastructure that allows applications to define and declare their own schemas, enabling the retrieval of fine-grained system state and setting of configuration.

Modular, state-sharing architecture

SR Linux uses an unmodified Linux kernel as the foundation on which applications share state via a publish/subscribe (pub/sub) architecture. The Nokia pub/sub architecture is implemented using generalized Remote Procedure Call (gRPC), protocol buffers (protobufs) and the Nokia Impart Database (IDB).

The Nokia IDB is a lightweight database that is optimized to handle high volumes of messages while protecting against any one application slowing down the whole system.

Field-proven protocol stacks ensures resiliency

SR Linux leverages field-proven protocol stacks from the Nokia Service Router Operating System (SR OS), which has a strong pedigree in IP routing. By using field-proven protocol stacks, planning and operations teams can immediately benefit from the stability, scalability and interoperability of a resilient NOS.

In Wide Area Networks (WAN), SR Linux delivers a rich set of IP routing, MPLS and Segment Routing labeled forwarding capabilities together with EVPN for both IP and MAC-VRF transport. These capabilities include extensive EVPN and OAM features that can power the most demanding, dynamic and reliable Ethernet and IP/MPLS networks.

Scalable streaming telemetry

SR Linux was built with an open, scalable telemetry framework at its core, internally using gRPC, gRPC Network Management Interface (gNMI) and protobufs. Because SR Linux is natively model-driven, it is immediately ready for streaming telemetry without requiring any translation layers.

Superior CLI programmability and integration of third-party applications

Operations teams can leverage command line interface (CLI) plugins to completely customize the way the CLI operates, plugging in Linux commands or pulling the state/configuration from various locations.

SR Linux allows third-party applications to be fully integrated into the system and given all the same benefits as Nokia applications. This includes consistent configuration via YANG, telemetry support, life-cycle management and visibility of system resources.

SR Linux offers a state-of-the-art NetOps Development Kit (NDK) for data center teams to develop new applications and operational tools in the language of their choice with deep programmatic access to, and control of, the entire system.

Network automation

The Nokia Network Services Platform (NSP) provides IP network automation, a consistent user experience, and comprehensive management capabilities across all Nokia IP routing platforms, including the 7730 SXR-R series. The NSP reduces risk and accelerates deployment through prepackaged software and services. It also offers a rich set of service management capabilities that automate new service delivery, streamline operations, and reduce operating costs.

Standards-based software-defined networking (SDN) interfaces enable best-path computation to be offloaded to SDN controllers such as the NSP. Operating as path-computation clients (PCCs), the 7730 SXR-R collects and reports per-link and per-service delay, jitter, and loss metrics, together with port-utilization levels, for efficient path computation by a path-computation element (PCE) function in the SDN controller.

Technical specifications

Table 1. Nokia 7730 SXR-R series specifications

Feature	7730 SXR-R6d	7730 SXR-R6dl
System throughput: Full duplex IMIX traffic	Up to 3.6 Tb/s with active-active redundant control-processor input/output modules (CPIOMs)	
MDA slot capacity	600 Gb/s	
Card slots	Six (compact slots)	Six (full slots)
Media Dependent Adapters (MDAs)	• 1 x 400G QSFP-DD + 2 x 100G QSFP28* • 5 x 100G QSFP28* • 18 x 25G SFP28/SFP+* • 20 x 10G SFP+/SFP* • 1 x 400G QSFP-DD + 2 x 100G QSFP28 (MACsec/ANYsec)** • 6 x 100G QSFP28 (MACsec/ANYsec)** • 10 x 50G SFP56/SFP28/SFP+** • 32 x 1G cSFP (GE/FE)**	• 1 x 400G QSFP-DD + 2 x 100G QSFP28* • 5 x 100G QSFP28* • 18 x 25G SFP28/SFP+* • 20 x 10G SFP+/SFP* • 1 x 400G QSFP-DD + 2 x 100G QSFP28 (MACsec/ANYsec)** • 6 x 100G QSFP28 (MACsec/ANYsec)** • 10 x 50G SFP56/SFP28/SFP+** • 46 x 10G SFP+/SFP** • 80 x 1G cSFP (GE/FE)** • 32 x 1G cSFP (GE/FE)**
Optical breakouts	• 4 x 100G, 2 x 100G, 4 x 25G, 4 x 10G (on QSFP-DD connectors) • 4 x 25G, 4 x 10G (on QSFP28 connectors)	• 4 x 100G, 2 x 100G, 4 x 25G, 4 x 10G (on QSFP-DD connectors) • 4 x 25G, 4 x 10G (on QSFP28 connectors)
Control interfaces	Console, management, SyncE/1588, USB, GNSS in, 1PPS out, SD slot	
Security	• DDoS mitigation via large-scale ACLs • TPM 2.0 • MACsec (IEEE 802.1AE MACsec and IEEE 802.1X MAC Security Key Agreement)** • Enhanced IEEE 802.1AE MACsec (ANYsec)**	• DDoS mitigation via large-scale ACLs • TPM 2.0 • MACsec (IEEE 802.1AE MACsec and IEEE 802.1X MAC Security Key Agreement)** • Enhanced IEEE 802.1AE MACsec (ANYsec)**
Timing and synchronization	• Includes Stratum 3E oscillator • ITU-T Synchronous Ethernet (SyncE) • ITU-T G.8262.1 (eEEC) • IEEE 1588v2 PTP clock types: Boundary, Grandmaster • IEEE 1588v2 PTP profiles: – ITU-T G.8275.1 – ITU-T G.8275.2 with Assisted Partial Timing Support (APTS) • PTP encapsulations: – Ethernet – UDP/IPv4/IPv6 • RFC 5905 Network Time Protocol (NTP) • SyncE/IEEE1588 input and output timing port • Pulse-per-second (1PPS) output timing • Integrated GNSS receiver: – ITU-T G.8272 PRTC-B dual-band GNSS receiver	
Common connectors/indicators (on the fan tray)	• Alarm input/output • Alarm cutoff/lamp test (ACO/LT) button • Power status (A & B), fan and alarm LEDs	
Memory buffer size	192 MB ingress buffer, 8 GB egress buffer per CPIOM. In a redundant system with an active-active configuration, these numbers are doubled (2 x CPIOMs, each with an active data plane).	

* Shared MDAs with the 7250 IXR-6d/6dl
** Future deliverable

Table 1. Nokia 7730 SXR-R series specifications (Continued)

Feature	7730 SXR-R6d	7730 SXR-R6dl
Enhanced statistics collection	Full-scale	
Common equipment redundancy	Control, forwarding, power feeds, cooling fans	
Dimensions	• Height: 4 RU, 17.8 cm (7.0 in) • Width: 44.5 cm (17.5 in) • Depth: 26.4 cm (10.4 in) • Rack-mountable in a 48.2-cm rack, 30-cm depth (standard 19-in equipment rack, 12-in depth)	• Height: 7 RU, 31.1 cm (12.25 in) • Width: 44.5 cm (17.5 in) • Depth: 26.4 cm (10.4 in) • Rack-mountable in a 48.2-cm rack, 30-cm depth (standard 19-in equipment rack, 12-in depth)
Power	• DC input (two feeds, rated): -48 V DC / -60 V DC • AC power solutions available: 100 V AC to 240 V AC, 50 Hz/60 Hz	
Cooling	• One tray of fans with redundancy • Safety electronic breaks on removal • Right-to-left airflow • Front-to-back airflow (optional with add-on ancillaries) • Fan filter	
Normal operating temperature range	-40°C to +65°C (-40°F to +149°F) sustained	
Shipping and storage temperature	-40°C to +70°C (-40°F to +158°F)	
Normal humidity	5% to 95%, non-condensing	
PCB Enhanced Plating (PEP)	Yes	

Table 2. Nokia 7730 SXR-R6d/R6dl and shared Nokia 7250 IXR-R6d/R6dl MDAs

Adapter name	Details	
1-port 400GE + 1-port 100G	1 x 400G QSFP-DD + 1 x 100G QSFP28	
5-port 100GE	5 x 100G QSFP28/QSFP+	
10-port 50GE*	10 x 50G/25G/10G SFP56/SFP28/SFP+	
18-port 25GE	18 x 25G/10G SFP28/SFP+	
46-port 10GE* (7730 SXR-R6dl)	46 x 10/1G SFP+/SFP	
20-port 10GE/1GE	20 x 10/1G SFP+/SFP	
80-port 1GE* (7730 SXR-R6dl)	80 x 1G cSFP (GE/FE)	
32-port 1GE*	32 x 1G cSFP (GE/FE)	

* Future deliverable

Table 3. Maximum platform density

Ethernet interface	7730 SXR-R6d	7730 SXR-R6dl
400GE	6	6
100GE	36	36
50GE	60	60
25GE	144	144
10GE	120	276
GE/FE	192	480

Note: Some scale values may depend on future MDA availability.

Software features

The Nokia 7730 SXR-R series supports, but is not limited to, the following features.[2]

Open Linux support

- Support for unmodified Linux kernel
- Linux control groups (cgroupsv2)

Layer 2 features

- Ethernet IEEE 802.1Q (VLAN) and 802.1ad (QinQ) with support for jumbo frames
- EVPN VLAN aware bundle
- EVPN-MPLS on MAC-VRF
- EVPN-MPLS multi-homing (all-active, single-active)
- EVPN-VPWS MPLS (including Link Loss Forwarding)
- EVPN-VPWS MPLS multi-homing
- EVPN-VPWS FAT label
- Pseudowires on MAC-VRF
- Pseudowires on VPWS
- FAT label for Pseudowires
- Configurable TPID on interfaces
- QinQ bridged subinterfaces
- VLAN manipulation (pop, push, preserve, one or two tags, ingress and egress)
- MAC-VRF Proxy-ARP/ND MPLS
- L2CP transparency
- Split-Horizon-Groups on MAC-VRF

Layer 3 features

- IPv4/v6 routing
  - Static, aggregate routes
  - IP unnumbered interfaces
  - Dual-stack Interior Gateway Protocol (IGP)
  - Multi-topology IS-IS v4/v6
  - Open Shortest Path First (OSPFv2 and OSPFv3)
  - Multiprotocol BGP (MP-BGP)
- BGP with iBGP/eBGP: Support for IPv4/v6, including:
  - Core Prefix Independent Convergence (PIC)
  - Route reflector
  - Dynamic prefix-based neighbors
  - BGP unnumbered
  - eBGP multi-hop
  - Add-paths for IPv4 and IPv6 routes
  - BGP route flap damping
  - Rapid withdrawal
  - eBGP fast failover
  - Multi-hop eBGP sessions
  - Path MTU discovery
  - Advertise IPv4 routers with IPv6 next-hops
  - BGP Prefix/Shared SID
- BGP-Link State (BGP-LS)
- BGP Labeled Unicast (BGP-LU) IPv4/IPv6 AF with next-hop-self
- IPv6 flow label hashing
- Layer 3 VPNs:
  - IP-VRF: Multiple VRF support
  - IP-VPN (VPN-IPv4 and VPN-IPv6 families) and EVPN Interface-less (EVPN-IFL) support
  - Multi-instance IP-VRF and EVPN-IFL in the same service
  - Inter-AS option B and Next Hop Self RR support
  - EVPN IFL IP Aliasing and unequal ECMP
- ARP/ND synchronization via EVPN on L3 interfaces (draft-ietf-bess-evpn-l3mh-proto)
- Routing policy:
  - Structured rules for accepting, rejecting and modifying routes that are learned and advertised to routing peers
  - Routes can be matched based on prefix lists, autonomous system (AS) path regular expressions, BGP communities, Address Family Indicator/Subsequent Address Family Indicator (AFI/SAFI) protocol, etc.

2 This section provides an overview of key features supported. Some platforms may have feature exclusions or exceptions. Consult Nokia documentation for detailed feature support and interdependencies.

- Policy-based forwarding based on DiffServ Code Point (DSCP) and/or IP protocol
- Route leaking between network instances

- Traffic steering to next-hop, network instance
- Multicast:
  - Internet Group Management Protocol (IGMP) v1/2 with SSM translation, IGMPv3
  - Multicast Listener Discovery (MLD)v1 with SSM translation, MLD v2
  - PIM, PIM SSM
  - NG-mVPN with mLDP
    - Selective PMSI, Inclusive PMSI
  - IGMP-MLD Policy
  - Multicast IPv4 and IPv6 policy

Tunnels: MPLS data plane

- LER and LSR with both IPv4 and IPv6 NHLFEs
  - Unnumbered subinterfaces
  - Null label
  - Load balancing in both LER and LSR roles
- SR-ISIS with MT=0/2
- Segment Routing (SR) flexible algorithms
- Loop-free Alternate (LFA), Topology Independent LFA (TI-LFA)
- Colored/uncolored SR-MPLS TE-Policy
  - Explicit-path support with a mix of strict and loose hops
  - Local CSPF based path computation
  - Label stack reduction, exclude SRLG, delay metric
- PCE computed, PCC initialized LSPs
  - B-SID insertion/stitching
- Seamless BFD with 10ms timers
  - Hold up and down timers
- LSP redundancy with Active, Standby, and Secondary Segment-Lists
- LSP stats
  - BGP-LU
  - TE policy
  - Shared SID
- Make-before-Break (MBB)
- Fast Re-Route (FRR) protection via LFA, TI-LFA
- Tag-set (a.k.a. admin-tag) for steering services/ shortcuts LDP
- Link-LDP with ISIS IPv4/v6 and OSPFv2/v3
  - Downstream unsolicited label distribution with ordered control
  - LFA fast reroute and remote LFA
  - BFD for I-LDP and t-LDP with 10ms timers
  - FEC-originate, per peer import and export policies, LDP-IGP synchronization
- Targeted LDP support

Tunnels: SRv6 data plane

- End/uN (node SID)
- End.X/uA (Adj SID)
- End.DT4/uDT4 (IPv4 VRF, IPv4 Base)
- End.DT6/uDT6 (IPv6 VRF, IPv6 Base)
- End.DT46/uDT46 (IPv4 and IPv6 VRF, IPv4 Base)
- End.DX2/uDX2 (EVPN-VPWS)
- SRv6 IS-IS shortest path tunnel support MT=2
- Protection:
  - LFA
  - Remote LFA
  - TI-LFA with SRH insertion
- Penultimate Segment Popping (PSP) of SRH
- Ultimate Segment Popping (USP) of SRH
- Ultimate Segment Decapsulation (USD)
- Hash output insertion into the flow-label field at the ingress PE route
- Hashing based on the flow label at the transit P router
- Flexible algorithm: admin-group include and exclude, IGP, TE, and latency metric
- Flexible algorithm-aware locator summarization in IS-IS

Quality of Service

- Intelligent packet classification based on combination of dot1p/dscp/mpls criteria on any type of subinterface
- MPLS QoS via EXP to forwarding class mapping
- 16 forwarding classes per sub-interface
- Ingress per forwarding class sub-interface policing
- Ingress dscp based remarking
- Ingress per subinterface rate limiting with 2 level policer hierarchies (per-FC and per CVLAN)
- Egress marking, and dscp-based reclassification
- 12 queues per sub-interface
- Egress per subinterface Queuing/scheduling:
  - Strict priority
  - Weighted round robin (WRR)
  - Explicit Congestion Notification (ECN)
  - 4 hierarchy levels: FC queue/aggregate/multi-aggregate (SVLAN)/interface
  - Sophisticated egress: Buffer management with Weighted Random Early Detection (WRED) at queue/interface-pool/fp-pool levels
- QoS classification and marking based on DiffServ Code Point (DSCP)
- QoS classification and marking based on IEEE 802.1p
- Priority Flow Control (PFC)
- Ingress DSCP remarking
- Multi-field classification
- Ingress per subinterface rate limiting with 2 level policer hierarchies (per-FC and per CVLAN)

Flow monitoring

- IPFIX

Operations, administration and maintenance

- Two-Way Active Measurement Protocol (TWAMP) server and session reflector
- Simple TWAMP (STAMP)
  - Link Measurement
  - Performance Monitoring
- STAMP session reflector
- STAMP OAM Performance Monitoring (PM) IP delay and loss measurement
- STAMP Link Measurement
- Ethernet Connectivity Fault Management (CFM); Up/Down MEP
  - Fault Mgmt, CCM, LBM, LT
  - Performance monitoring, delay and jitter
- Link Layer Discovery Protocol (LLDP) on all interfaces
- Mirroring interface/subinterface source to local/remote destination
- Mirroring Sources from interface/sub-interface or ingress ACL
- Bi-directional forwarding detection (BFD) and micro-BFD (mBFD)
  - 10ms timer support
  - Asynchronous BFD liveliness support for all dynamic and static routing
  - Seamless BFD (S-BFD)
  - Micro-BFD for LAG
- LSP ping and traceroute for LDP and SR-ISIS tunnels
- LSP ping and traceroute for IPv4 or IPv6
- VRF routes ping and traceroute for IPv4 or IPv6 default network instance
- Routes ping and traceroute of a SID or locator

System management and automation

- Native model-driven architecture, configuration candidates, exclusive mode, checkpoints and rollbacks
  - Support for SR Linux and OpenConfig data models
- Management interfaces: gNMI, gRPC Routing Information Base Interface (gRIBI), JSON-RPC and CLI (transactional, Python CLI and CLI plugins)
- gRPC network operations interface (gNOI)
- gRPC Network Security Interface (gNSI)
- Global and per-user CLI environment configuration
- P4 runtime packet extraction and injection
- SNMPv2c and SNMPv3 gets and traps
- Per-user configurable options for CLI

- Local, RADIUS and TACACS+ authentication, authorization and accounting with role-based access control (RBAC)
- Remote Authentication Dial-In User Service (RADIUS) support for AAA
- Terminal Access Controller Access Control System (TACACS+) AAA with VSAs or privilege levels
- Password complexity policies and lockout management
- Access to common Linux utilities: Bash, cron and Python
- Logging infrastructure for local and remote logs including Syslog RFC 5424 support
- Facility alarms for equipment status
- Syslog RFC 5424
- Telemetry
  - Subscription-based telemetry for modeled data structures, either on change or sampled
  - sFLOW
- Telemetry-driven event management
- Python-based Zero Touch Provisioning (ZTP)
- Address management: Dynamic Host Configuration Protocol (DHCP) v4/v6 relay
- Dynamic Host Configuration Protocol (DHCP) v4/v6 relay
- DHCP v4/v6 server with static allocations

NetOps Development Kit (NDK)

- gRPC and protobuf-based interface for tight integration
- Leverages SR Linux model-driven architecture
- Direct access to other application functionality, e.g., forwarding information base (FIB), LLDP and BFD
- Native support for streaming telemetry

Load balancing and resiliency

- Support for redundant, control, fabric, fan and power configurations
- Active/active forwarding with transparent failover to single active
- BGP fast reroute using labeled/unlabeled unicast routes
- Link aggregation: Link Aggregation Group (LAG) and Link Aggregation Control Protocol (LACP)
- Equal Cost Multi Path (ECMP) for IPv4 and IPv6 forwarding
- Graceful restart client for IS-IS, BGPv4/v6
- VRRP v2 and v3 support

Security

- Distributed and aggregated ACLs and policers for control and management plane
- Layer 3, Layer 4 Control Plane Policing (CoPP)
- IPv6 router advertisements guard
- MAC security (MACsec) and Internet Protocol Security (IPsec) (Future deliverable)
- Secure boot
- Disk encryption
- Measured boot
- TPM Initial Device Identity (IDevID) and Initial Attestation Key (IAK)
- IEEE 802.1x EAP, including per host authentication

Standards compliance[3]

Environmental specifications

- ATIS-0600015.03
- ATT-TP-76200
- ETSI EN 300 019-2-1; Storage Tests, Class 1.2
- ETSI EN 300 019-2-2; Transportation Tests, Class 2.3
- ETSI EN 300 019-2-3; Operational Tests, Class 3.2
- ETSI EN 300 753 Acoustic Noise Class 3.2
- GR-63-CORE
- GR-3108-CORE
- VZ-TPR-9205
- VZ.TPR.9203 (CO)

3 System design intent is according to standards listing. Refer to product documentation for detailed compliance status.

Safety

- IEC/EN/UL/CSA 62368-1
- AS/NZS 62368.1
- IEC/EN 60825-1
- IEC/EN 60825-2
- IEC 60529 IP20

Electromagnetic compatibility

- AS/NZS CISPR 32 Class A
- ATIS-0600315
- BSMI CNS13438 Class A
- BT GS-7
- ETSI EN 300 386
- EN 55032 Class A
- EN 55035
- ETSI ES 201 468
- ETSI EN 300 132-2
- EN 301 489-1
- EN 301 489-19 (GNSS)
- FCC Part 15 Class A
- GR-1089-CORE
- ICES-003 Class A
- IEC/EN 61000-6-2
- IEC/EN 61000-6-4
- IEC CISPR 35
- IEC CISPR 32 Class A
- IEC/EN 61000-4-2 ESD
- IEC/EN 61000-4-3 Radiated Immunity
- IEC/EN 61000-4-4 EFT
- IEC/EN 61000-4-5 Surge
- IEC/EN 61000-4-6 Conducted Immunity
- IEC/EN 61000-4-11 Voltage Interruptions
- KCC Korea-Emissions & Immunity (In accordance KS C 9832/KS C 9835)
- VCCI Class A

Radio

- EN 303 413 (GNSS)
- KS X 3124

Power utility substations

- IEEE 1613 (Exception, forced air system)
- IEEE 1613.1
- IEC 61000-6-5
- IEC 61850-3 (Normal environnemental conditions)
- IEC/AS 60870.2.1

Railway

- AREMA (with some exceptions; refer to product documentation)
- EN 50121-4
- IEC 62236-4

Directives, regional approvals and certifications

- Directive 2011/65/EU Restriction of the use of certain Hazardous Substances in Electrical and Electronic Equipment (Recast) Directive (including Commission Delegated Directive (EU) 2015/863)
- Directive 2012/19/EU Waste Electrical and Electronic Equipment (WEEE)
- Directive 2014/30/EU Electromagnetic Compatibility (EMC)
- Directive 2014/35/EU Low Voltage Directive (LVD)
- Directive 2014/53/EU Radio Equipment Directive (RED)
- MEF certification:

  For a list of Nokia CE 1.0-, CE 2.0- and CE3.0-certified products, refer to the MEF certification registry.
- NEBS Level 3
- BSMI Mark – Taiwan
- CE Mark - Common Europe
- CRoHS - China RoHS
- KC Mark - South Korea
- RCM Mark – Australia
- VCCI Mark – Japan
- UKCA Mark – United Kingdom

About Nokia

At Nokia, we create technology that helps the world act together.

As a B2B technology innovation leader, we are pioneering networks that sense, think and act by leveraging our work across mobile, fixed and cloud networks. In addition, we create value with intellectual property and long-term research, led by the award-winning Nokia Bell Labs.

Service providers, enterprises and partners worldwide trust Nokia to deliver secure, reliable and sustainable networks today – and work with us to create the digital services and applications of the future.

Nokia OYJ
Karakaari 7
02610 Espoo
Finland
Tel. +358 (0) 10 44 88 000

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