

## Nokia Multi-Access Gateway

SR OS Release 23

The Nokia Multi-Access Gateway (MAG) is a high-performance and versatile subscriber management solution that supports the full range of wireline and fixed-wireless broadband services. It can be deployed as a broadband network gateway (BNG), fixed-wireless access gateway, or converged multi-access gateway on a wide range of Nokia's Service Routing platforms to efficiently address the scaling needs of any network. Standards-based Control and User Plane Separation (CUPS) enables to deploy MAG control plane functions on virtual servers and to seamlessly interwork with LTE/5G core systems.

### Key features

#### Applications and use cases

- IP over Ethernet (IPoE) and Point to Point Protocol over Ethernet (PPPoE) local session termination
- Layer 2 Access Concentrator (LAC)
- Layer 2 Tunneling Protocol Network Server (LNS)
- Layer 2 Tunneling Protocol Switch (L2TS)
- Trusted Wireless Access Gateway (TWAG)
- Fixed-wireless Serving Gateway, Packet Data Network Gateway (SPGW) and User Plane Function
- Network Enhanced Residential Gateway (NERG)
- Disaggregated BNG (CUPS)
- Converged cloud-native fixed and mobile control plane (BNG-CP/SPGW-CP/SMF)
- Converged multiservice edge of residential broadband and enterprise VPN services

#### Multi-access broadband support

- Wireline access: xDSL, FTTx, xPON, hybrid fiber coax (HFC)/distributed access architecture (DAA)
- Wireless access: Carrier Wi-Fi, 4G/LTE and 5G NR
- Fixed-mobile convergence: 5G Non-Stand Alone (NSA) and evolution to 5G Stand Alone (SA)

#### Integrated service functions

Enhanced broadband services capabilities:

- Local Dynamic Host Configuration Protocol (DHCP) server
- Carrier-grade Network Address Translation (NAT)
- Volumetric DDoS detection and mitigation
- Application assurance and analytics
- IPTV delivery optimization functions
- Virtual residential gateway support

## Scalable platform options

The Nokia MAG is designed to evolve with your business and operational needs. Granular software licensing options allow targeted service requirements and economic business models to be addressed.

Larger configurations and additional network functions can be easily enabled through software in combination with the wide range of available 7750 SR platform options.

Supported hardware platforms range from the Nokia 7750 SR-a and 7750 SR-e series at the low end, to the 7750 SR and 7750 SR-s edge routing platforms powered by Nokia's FP5 routing silicon at the high end.

Nokia FP5 silicon ensures multi-dimensional scalability and future evolution. Its 6 Tb/s packet processor and fully buffered ingress and egress shaping lets you deliver superior upstream and downstream throughput with granular per-subscriber and per-service QoS. FP5 design innovations deliver deterministic and assured performance at scale for all service combinations and usage conditions, without compromise.

## Proven and reliable software

The Nokia MAG leverages the advanced software design and proven capabilities of the SR OS, such as distributed symmetric multiprocessing (SMP), to maximize the use of multi-CPU architectures and a native 64-bit OS to maximize the access to multicore memory.

The Nokia MAG is the most trusted and widely deployed implementation in the industry and proven in hundreds of deployments. Flexible system redundancy protocols, load-balancing and fail-over mechanisms allow system availability and service reliability to be maximized.

## Operational flexibility

- Retail and wholesale deployment models
- Bridged and routed home gateway support
- Subscriber management on access VLANs, MPLS or EVPN signaled and MPLS/SR pseudowires
- IPoE and PPPoE session management (IPv4+v6)

- Data triggered authentication and session management
- Flexible authentication, accounting and credit control: DHCP, RADIUS, DIAMETER NASREQ, Gx, and Gy
- Various redundancy options with rapid failover

## Multiservice broadband delivery

The Nokia Multi-Access Gateway offers a rich set of features to optimize delivery cost, performance and reliability of broadband Internet, premium data, IPTV, and IP telephony services.

- Residential hierarchical QoS (HQoS)
- IP multicast with IGMP/MLD snooping and Multicast Admission Control
- Fast Channel Change and video retransmission
- Video quality monitoring and perfect stream

## Value-added application services

Upsell value-added application services with granular application-level policy control:

- Per-device and per-application QoS policies
- Layer 4 – Layer 7 stateful firewall services
- In-line DDoS detection and mitigation services
- Selective per-application usage rating options
- Subscriber redirection to captive portals
- Parental guidance and URL filtering
- Home device management support
- Home LAN extension to telco cloud

## Multi-access broadband edge convergence

Converge wireline and fixed-wireless access on a common broadband edge to deliver a seamless Gigabit broadband experience everywhere.

- Copper, fiber, and HFC access
- Carrier Wi-Fi hotspots and home spots with SSO
- 3GPP fixed-wireless access integration (4G/5G)
- Disaggregation and CUPS with 3GPP Sx/N4
- Converged cloud-native fixed and mobile control plane (BNG-CPF/SPGW-CPF/SMF)

## Network gateway functions

The Nokia Multi-Access Gateway can support a broad range of wireline and fixed-wireless access technologies in various deployment models, with multi-access convergence on a single edge. In addition, a variety of value-added network functions are supported to enrich the user experience. Gateway functions are configurable through software licenses and may require specific hardware support capabilities to be equipped in the network.

### Broadband Network Gateway (BNG)

Covers the core subscriber management functions for multiservice Ethernet-based broadband access aggregation for xDSL, FTTx, xPON, CMTS and WiMAX access defined in TR-101 and TR-178. The solution supports IPoE and PPPoE session management with IPv4 and/or IPv6 address assignment. Home gateways can be in bridged or routed mode and both static and dynamic host configuration are supported.

Authentication, authorization, and accounting of subscriber sessions can be performed via RADIUS, DHCP, DIAMETER, or a local database. HQoS enables granular per-service and per-subscriber policy control of upstream and downstream traffic to manage the available bandwidth for Internet access, IPTV/video and voice services. Auto-sensing VLANs enable dynamic subscriber service configuration.

Call-trace features allow for granular debugging of subscriber sessions.

### L2TP Network Server (LNS)

The LNS function enables broadband access wholesale. The BNG of the access wholesaler acts as a Layer 2 Access Server to aggregate subscriber traffic in Layer 2 tunnels that are handed off to the LNS operated by the ISP. Supported tunneling protocols include PPPoL2TP and Multi-Link PPPoL2TP.

### Trusted Wireless Access Gateway (TWAG)

Enables carrier Wi-Fi access as defined in BBF TR-291. Multiple access and tunneling options are supported including L2oGRE, L2TPv3, MPLS pseudowires and L2GREoIPSec. The solution supports both Open SSID with authentication through a captive portal, and Closed SSID through EAP-PEAP and EAP-SIM. Seamless inter-AP mobility across SSIDs is enabled by DHCP or SLAAC control triggers.

### Fixed-Wireless Access Gateway (FWAG)

This gateway adds the SPGW (4G/5G NSA) and SMF/UPF (5G SA) functions to integrate wireline and 3GPP fixed-wireless access as a seamless user experience. Wireline operators can deploy FWA to improve coverage in brownfield areas with last mile access plant limitations, and to rapidly expand services in greenfield areas.

Figure 1. Nokia Multi-Access Gateway functions and service features

#### Broadband gateway functions

DPI/Application Assurance (AA)

Video Quality Monitoring (VQM)

Network Address Translation (NAT)

Virtual Residential Gateway (vRGW/NERG)

Fixed-Wireless Access Gateway (FWAG)

Trusted Wireless Access Gateway (TWAG)

L2TP Network server (LNS)

Broadband Network Gateway (BNG/LAC)

#### Platform options



Disaggregated (CUPS)



Virtualized (Nokia VSR)



Physical (Nokia 7750 SR)

#### Enhanced service features



Application policy control



URL filtering/parental control



IPTV fast channel change/retransmit



Home-aware NAT/DHCP/UPnP



Home LAN extension to cloud



Per-device policy control



Usage-based policy and charging



Home and hot spot roaming



In-line volumetric DDoS mitigation



Multi-access broadband wholesale



Multi-access broadband retail

## Multi-access convergence

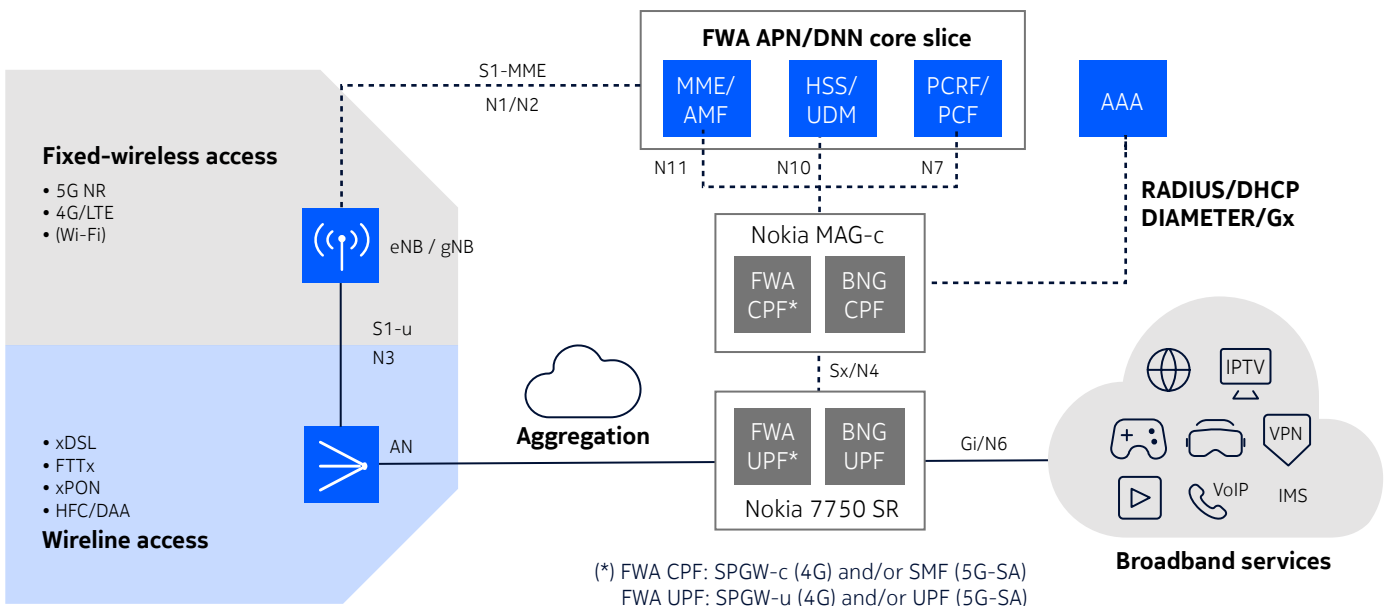
The Nokia Multi-Access Gateway offers a smooth evolution path for wireline and fixed-wireless access convergence on a multi-access broadband edge. Fiber-to-the-home is typically the preferred way to go, but trenching fiber is time consuming and the incremental cost of replacing legacy copper and coaxial access plant can be steep. Fixed-wireless broadband access can offer an attractive solution to overcome these last-mile wireline coverage and capacity issues. When complementing or substituting wireline broadband access, the fixed-wireless access gateway must support similar service characteristics and applications as a wireline broadband network gateway:

- Always-on service for up to a dozen devices per home such as TVs, PCs, tablets and game consoles
- Sustainability for high-bandwidth applications such as UHD broadcast TV, internet video streaming, personal video conferencing, and software downloads for PCs and game consoles

- Support for both unicast and multicast IP service delivery with HQoS on the same bearer.

The Nokia MAG solution is purpose-built for these requirements. Leveraging the same platform for both wireline and fixed-wireless access can yield significant cost and performance synergies, and seamlessly integrates FWA with existing AAA and NMS support infrastructure. The FWAG option adds Serving Gateway and Packet Data Network Gateway (SPGW) functionality for 4G/LTE and Session Management Function (SMF) and User Plane Function (UPF) for 5G fixed-wireless access, either as a stand-alone edge or as a converged multi-access broadband edge in combination with wireline access (see Figure 2).

Figure 2. Multi-Access Gateway for wireline and converged operators



## Network service functions

Several value-added network functions and services can be enabled by equipping Multiservice Integrated Service Adapters (ISAs) in platforms from the Nokia 7750 SR family. Alternatively, this functionality can be provided by External Service Adapters (ESAs) that can scale out in the telco cloud, and be inserted in the data path by selectively redirecting subscriber traffic from Nokia 7750 SR and 7750 SR-s BNG platforms.

### Network Address Translation (NAT)

Carrier-grade Network Address Translation allows conservation of IPv4 addresses and maintenance of IPv4 internet access while migrating to IPv6. Operators can apply L2-aware NAT as a fully integrated subscriber management option, and later move to Large Scale NAT, Dual-Stack Lite and NAT64. Deterministic NATP and various NAT logging options are available based on RADIUS, syslog and cflowd.

### DPI/Application Assurance (AA)

Layer 4–7 application identification using Deep Packet Inspection (DPI) and various other techniques ranging from basic 5-tuple header inspection to advanced behavioral analysis to identify encrypted or evasive applications.

Once identified, AA allows application of QoS policy on aggregate traffic or on a per-subscriber and per-application basis, and can generate reports on traffic volumes, application performance and policies implemented. Other AA applications are stateful firewalling, URL filtering (e.g. for parental guidance) and subscriber redirection to captive portals.

### Video IPTV (VIDEO)

A set of IPTV support functions to optimize performance and reliability of SD, HD and UHD broadcast TV services:

- Fast Channel Change buffering service
- Retransmission of dropped multicast packets
- Video monitoring
- Video backhaul packet repair (Perfect Stream)

### Virtualized Residential Gateway (VRGW)

The VRG functionality (see BBF TR-317) allows a bridged connection between home gateways on the customer premises and a virtual gateway (vG) instance in the telco cloud. The bridged home gateway model enables management visibility on individual user devices connected to the home LAN and enables per-device policy management.

Extending the home LAN into the telco cloud provides new options to manage and enhance the user experience by adding user functionality to the vG in the telco cloud. Users can, for example, directly connect to network-attached compute and storage such as game servers or PVRs.

## Disaggregation with Control and User Plane Separation

The Nokia Multi-Access Gateway can optionally be deployed as a disaggregated system with Control and User Plane Separation (CUPS) to offer several operational benefits:

- Efficient operation with a centralized controller (MAG-c) that can scale out in the cloud, while distributing user plane functions on routing appliances to optimize delivery performance.
- Carrier-grade reliability enabled by flexible and cost-effective UPF redundancy with 1:1 hot standby and 1:N warm standby, geo-redundant CPF instances, and non-stop forwarding on loss of connectivity between CPF and UPF.
- Simplified maintenance by decoupling control plane functions (CPFs) and user plane functions (UPFs); this makes it easier to manage their different life cycles and minimize the impact of hardware and software upgrades.
- Flexible scaling by deploying CPFs and UPFs on either physical or virtualized platforms and scale their capacity independently.
- Fixed-mobile convergence and wireline broadband integration with a LTE/5G Core by interfacing UPFs via the Sx/N4 interface with a common Session Management Function.

The CUPS functional architecture is defined in Broadband Forum specification TR-459 and separates the CPFs and UPFs using the following three interfaces:

- Management interface [Mi] using NETCONF/YANG MD-CLI for centralized management of distributed UP instances
- State Control Interface [SCi] using 3GPP Packet Forwarding Control Protocol (PFCP) to manage UP session state
- Control Packet Redirect Interface [CPri] using GTP-u tunneling protocol, which enables the UP to relay home gateway information to the CP

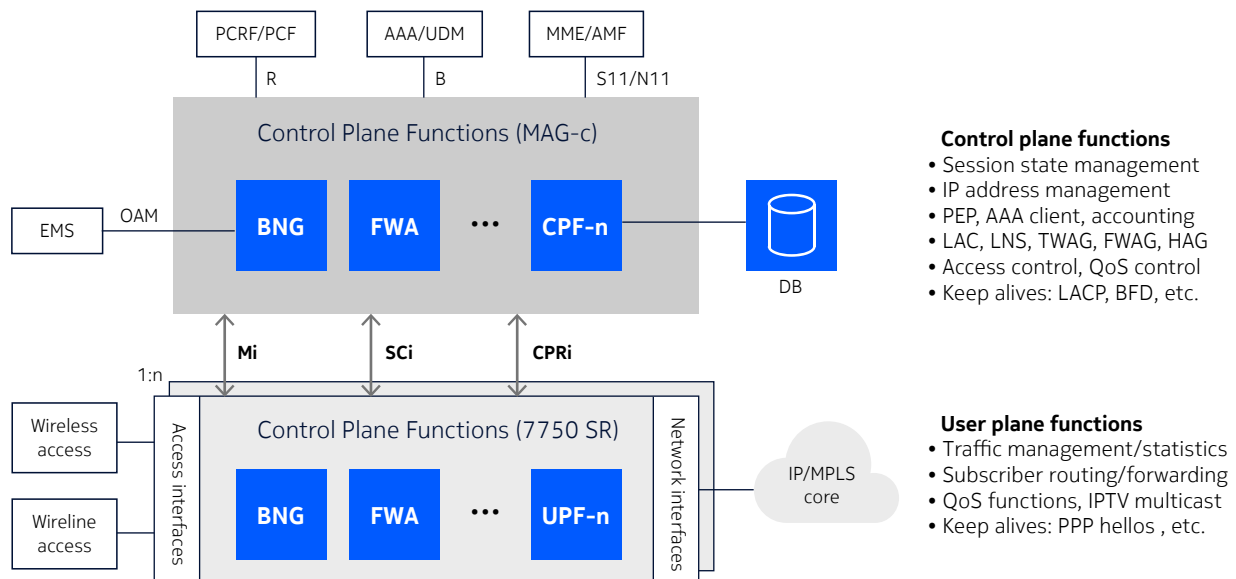
The Nokia CUPS solution can virtualize the MAG control plane functions and can centralize them in telco cloud data centers, while UPFs can be distributed on purpose-built network appliances closer to the end users. The virtualized CPFs operate in a stateless compute model that uses a Common Database to manage CP state information. This approach allows to easily scale out and load balance control plane capacity, and quickly recover from failure situations that trigger a reboot of any virtualized control functions.

The centralized MAG controller provides a single access point for managing all distributed UPF instances. This simplifies operations by making it easier to interface to external systems (i.e. PCRF, AAA) and allows for more efficient IP address allocation from a centralized pool. Operating common control plane functions across wireline and fixed-wireless access UPs supports the objective of delivering a seamless multi-access user experience and is instrumental for integrating wireline access with an 4G/LTE EPC or 5G core.

Packet Forwarding Control of the broadband UP is based on the 3GPP Sx/N4 interface with the necessary extensions to support broadband wireline access.

The optimal UP can be dynamically selected based on configurable traffic steering policies such as APN/DNN identifiers, IP address range, subscriber profile, traffic load or configured resources and services. This approach allows efficient off-loading of broadband internet and video traffic from the 5G Core and allows independent scaling (and placing) of fixed-wireless and mobile gateway network functions.

Figure 3. Disaggregated CUPS architecture (Broadband Forum TR-459)







## Support platforms

The Nokia Multi-Access Gateway is supported on a variety of routing platforms to meet different scaling requirements. Currently supported platforms include Nokia service routing platforms powered by FP custom silicon, as well as virtualized service routers based on x86-powered servers (see Table 1). Available platform capacity depends on hardware configurations such as line cards and the Control Processor Modules (CPM) running the MAG software.

Many different scaling dimensions and factors such as the service mix, deployment model and addressing scheme determine optimal platform choices and configurations. Please contact your Nokia sales representative for platform scaling details. For more details see the [Nokia 7750 SR platform data sheets](#).

Table 1. MAG platform scaling options

Routing platforms	Form factor	Capacity (FD)	Connectivity	ISA/ESA
<b>High density (FP5)</b>				
7750 SR-7s	6 slots, 16 RU	108 Tb/s	10/25/100/400/800GE	ESA
7750 SR-2se	2 slots, 5 RU	36 Tb/s	10/25/100/400/800GE	ESA
7750 SR-1se	1 slot, 3 RU	19.2 Tb/s	10/25/100/400/800GE	ESA
7750 SR-1x	Fixed, 2 RU	6 Tb/s	10/25/100/400/800GE	ESA
7750 SR-1	Fixed, 2 RU	2.8 Tb/s	10/25/100/400/800GE	ESA
<b>Mid density (FP4)</b>				
7750 SR-7s	6 slots, 16 RU	28.8 Tb/s	10/25/100/400GE	ESA
7750 SR-2s	2 slots, 5 RU	9.6 Tb/s	10/25/100/400GE	ESA
7750 SR-1s	1 slot, 3 RU	4.8 Tb/s	10/25/100/400GE	ESA
7750 SR-12e	9 slots, 22 RU	13.5 Tb/s	10/25/100/400GE	ISA/ESA
7750 SR-12	10 slots, 14 RU	8 Tb/s	10/25/100/400GE	ISA/ESA
7750 SR-7	5 slots, 8 RU	4 Tb/s	10/25/100/400GE	ISA/ESA
7750 SR-1	1 slot, 2 RU	1.5 Tb/s	10/25/100/400GE	ESA
<b>Low density (x86)</b>				
VSR appliance	1 RU server	variable	10/25/100GE	vISA

### 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.

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