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Nokia Multi-Access Gateway controller

SR OS Release 24

The Nokia Multi-Access Gateway controller (MAG-c) enables disaggregated deployment of the Nokia fixed-wireless access (FWAG) and wireline broadband network gateway (BNG). Standards-based Control and User Plane Separation (CUPS) allows for independent scaling of control and user plane functions, and seamless interworking with 3GPP 5G/LTE service-based architectures.

The Nokia MAG-c lets you converge fixed-wireless and wireline access services and deliver an affordable, reliable and seamless broadband experience to every customer. It provides you with a disaggregated and virtualized control plane that can independently scale on general purpose compute servers and seamlessly integrates with your 5G Core in standalone or non-standalone mode. The MAG-c leverages Nokia's market-leading 7750 Service Router (SR) family equipped with purpose-built FPx network silicon to efficiently scale distributed user plane functions and optimize service performance and reliability.

Feature highlights

- Standards-based CUPS solution compliant with 3GPP Release 16 and Broadband Forum TR-459
- 5G standalone (SA) and non-standalone (NSA) SBI interworking: N11/S11, N10, S7/Gx, N40.
- FWA: Combined Session Management Function (5G SMF) and Serving Gateway and Packet Data Network Gateway control plane (4G SPGW-c).
- Wireline: Broadband Forum TR-459 compliant disaggregated BNG CUPS control plane (CPF).
- Centralized IPv4/6 address pool management and sharing between FWA and BNG subscribers
- Dynamic SMF selection via NRF (DNN or slice) and dynamic UPF selection based on location (TAI), local policy or optional PDU session type.
- Geo-redundancy and session load-balancing across selected UPF, with headless forwarding mode in case of CP-UP connection failure.
- Observability with model-driven telemetry, per UE call-trace and per call-model data (PCMD).

Applications and benefits

The Nokia MAG-c addresses broadband needs for mobile, wireline and converged network operators:

- Deliver seamless broadband retail or wholesale services across 4G/5G FWA and wireline access.
- Cover both residential (Internet, IPTV, VoIP) and enterprise needs (Internet, L2/L3 VPN, cloud).
- Converge subscriber and session management on a shared 5G service-based architecture.
- Flexible scaling by deploying CPFs and UPFs on either physical or virtualized platforms and scale their capacity independently.
- Simplify maintenance by decoupling control and user plane functions and cater to their different hardware and software life cycles.
- Leverage Nokia service routers to efficiently scale FWA and BNG user plane functions.
- Carrier-grade reliability and deterministic QoS to ensure an always-on service experience.

Control and User Plane Separation

Disaggregation of control and user plane functions is mandated by 3GPP for 5G fixed-wireless access gateways and optional for 4G/LTE Serving and PDN gateways. Broadband Forum TR-459 applies the same 3GPP architecture principles to disaggregate wireline BNGs and separate CPFs and UPFs:

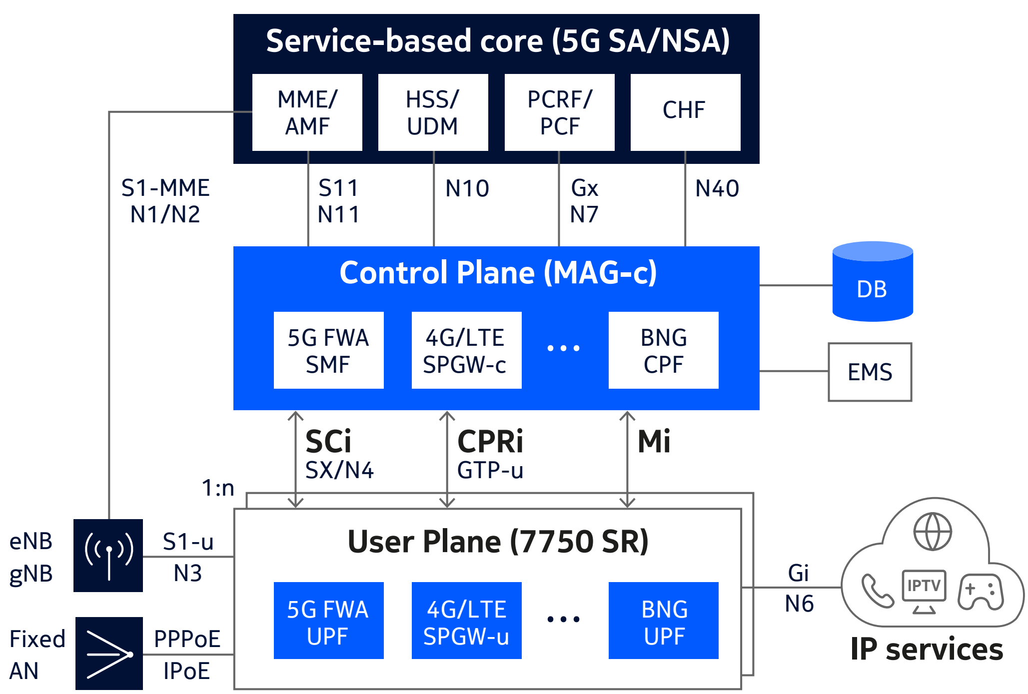
- State Control Interface [SCi], using 3GPP Packet Forwarding Control Protocol (PFCP) to manage UP session state with extensions for the wireline access UPF (disaggregated BNG).
- Control Packet Redirect Interface [CPRi] using GTP-u tunneling protocol, which enables the UPF to relay home gateway information to the CPF.
- Management interface [Mi] for centralized management of distributed UPF instances.

The Nokia MAG-c virtualizes control plane functions for 5G FWA (SMF), 4G/LTE FWA (SPGW-c) and BNGs. The MAG-c can be deployed in telco cloud data centers, while UPFs can be distributed on purpose-built routing platforms closer to the end users.

The virtualized CPFs operate in a state-efficient 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-c controller provides a single access point for managing all distributed UPF instances, making it easier to interface to external systems (i.e. NMS, AAA). It also allows for more efficient IP address allocation from centralized pools. The optimal UPF can be dynamically selected based on configurable policies such as APN/DNN identifiers, subscriber location, UP load, slice, or configured resources and services. Leveraging dedicated, physical UPFs for FWA users allows for independent scaling of fixed-wireless and mobile broadband applications, while efficiently off-loading low revenue and high-volume Internet and IPTV traffic from the 5G packet core.

Figure 1. Disaggregated CUPS architecture for fixed-wireless and wireline access convergence



Multi-access convergence

Broadband access is essential for enabling people to connect with each other and the cloud, but no single access technology can cover all connectivity needs. 5G fixed-wireless access has emerged as an option for expanding broadband capacity and coverage for underserved homes and businesses in areas where trenching fiber is too costly or time consuming. Notable use cases are:

- Spot coverage in high-density urban population centers and public venues.
- Expand capacity for underserved homes with legacy copper and coaxial access
- Expand coverage in rural areas and manage the cost and lead time of new fiber deployments.

To complement (or compete with!) wireline access, residential broadband services delivered over 5G FWA must support an equivalent service mix and user experience at a comparable price point:

- Limited mobility requirements (X2 handover) as residential gateways are stationary devices.
- Maintain multiple user devices per connection such as TVs, PCs, game consoles and tablets.
- Concurrent use of high-bandwidth applications like IPTV and Internet for several hours per day.
- Monthly data usage averaging up to a Terabyte per home, with pre-paid flat rate charging.

FWA user plane scalability is a challenge for mobile operators because the bandwidth requirements of residential broadband services can rapidly surpass mobile traffic, even at low subscriber take rates.

Table 1. Comparing 5G fixed-wireless and mobile broadband characteristics

Service characteristic	Fixed-wireless broadband	Mobile broadband
Devices per session	10+ per home (TVs, PC, etc)	1 (smart phone)
Session duration	Always-on, static	Short, dynamic
Average bandwidth	Order of Mbps	Order of Kbps
Monthly data usage	Hundreds of Gigabytes	Several Gigabytes
Data plan	Unlimited	Usage quota

The MAG-c addresses these scaling challenges by allowing operators to scale 5G FWA user plane traffic on the same type of high-performance routing platforms of the Nokia 7750 SR family as being used for wireline BNG applications.

5G/LTE FWA user plane traffic (S1-u/N3 interface) is terminated directly on the line cards, with 5G QoS support for Session Aggregate Maximum Bit Rate (AMBR), per Service Data Flow (SDF) policing and per QoS Flow Id (QFI) shaping.

When comparing scaling properties of virtualized and physical user plane functions, our modeling shows that 5G FWA UPFs on Nokia 7750 Service Routers with FP5 silicon consume up to 5x less rack space and 6x less energy than virtualized server appliances with general purpose CPUs. Operators can choose to run FWA and BNG UPF instances on dedicated service routers or to converge UPFs on common edge routers for optimal cost synergies.

The MAG-c SMF and BNG Control Plane Functions can seamlessly integrate with a 5G service-based core in standalone and non-standalone mode.

The MAG-c can be deployed as Virtualized Network Functions (VNF) on general purpose servers in a telco data center, or it can be deployed on dedicated MAG-c appliances.

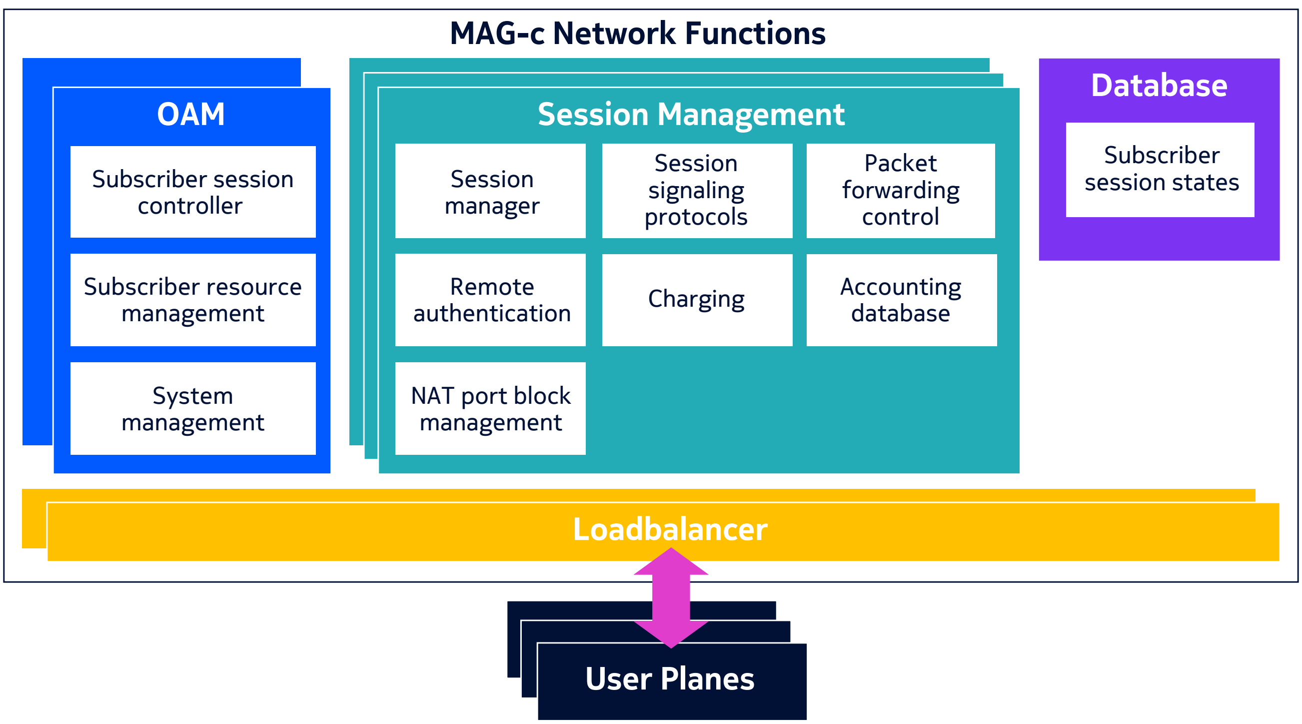
Deployment architecture

The Nokia MAG-c deployment architecture emphasizes management simplification:

- A single management interface to operate, maintain and manage the entire CUPS solution.
- Grouping functions to process subscriber sessions efficiently and responsively.
- Extensible to support additional use cases in future.

The MAG-c provides a centralized location for managing subscriber authentication, policies, and accounting settings. The solution set up requires minimal provisioning effort and enables zero-touch subscriber forwarding. The MAG-c is the central brain, keeping track of UP resource consumption and health status in real time. It load-balances new subscriber sessions between UPFs and determines when fail-over is needed.

Figure 2. MAG-c functional deployment architecture



The MAG-c network functions are architected in functional blocks to accommodate flexible scaling:

- OAM. Centralized subscriber session control, resource management and policy enforcement
- Session management of IPoE, PPPoE, L2TP and FWA sessions and related protocols such as DHCP, SLAAC, GTP, PFCP, LCP, NCP, PAP and CHAP.
- Centralized database to store session state on behalf of all Session Management functions
- Load balancing of control packets and automatic scaling in/out of MAG-c network functions.

Any Nokia SR OS routing platform can act as the User Plane and support the following functions:

- BNG user plane
- 4G/LTE Serving and PDN Gateway user plane
- 5G User Plane Function

MAG-c supports the 3GPP Session Control Interface with Broadband Forum TR-459 wireline extensions for PFCP to facilitate converged FWA and BNG CUPS deployments. SR OS routers can simultaneously act as a disaggregated UP and a standalone BNG to selectively migrate existing subscribers to CUPS.

Deployment specifications

Supported CPU models

- Intel® Xeon® with one or more CPU sockets

Virtualized MAG-c (VNF deployment)

- Linux Kernel-based Virtual Machine (KVM)
- Red Hat Enterprise Linux (RHEL) 7.x or higher
- Libvirt toolset; including virsh to create VMs

VNF I/O virtualization

- VirtIO (with Linux KVM)
- SR-IOV NICs: Intel X710 (10G), XXV710 (10/25G); 100GE: Mellanox Connect X6, X6 DX, X6 LX

Please refer to the MAG-c Installation guide for system dimensioning and deployment recommendations.

Appliance-based MAG-c deployment

The MAG-c can alternatively be deployed on the Nokia MAG-c Appliance as a prepackaged and self-contained control plane solution in a 1+1 redundant HPE Proliant 1 RU server configuration.

Please refer to the MAG-c Appliance datasheet for more information.

UPF platform specifications

Currently supported platforms include Nokia service routing platforms powered by FP custom silicon (see Table 1). For more details see the Nokia 7750 SR product page and the BNG CUPS User Plane Function Guide.

Table 2. UPF platform scaling options

Routing platforms	Form factor	FD capacity (BNG)	FD capacity (FWAG)	Connectivity
FP5-based				
7750 SR-7s	6 slots, 16 RU	108 Tb/s	54 Tb/s	10/25/100/400/800GE
7750 SR-2se	2 slots, 5 RU	36 Tb/s	18 TB/s	10/25/100/400/800GE
7750 SR-1se*	1 slot, 3 RU	19.2 Tb/s	9.6 Tb/s	10/25/100/400/800GE
7750 SR-1x*	Fixed, 2 RU	6.0 Tb/s	3.0 Tb/s	10/25/100/400/800GE
7750 SR-1	Fixed, 2 RU	2.8 Tb/s	1.4 Tb/s	10/25/100/400/800GE
FP4-based				
7750 SR-7s	6 slots, 16 RU	28.8 Tb/s	14.4 Tb/s	10/25/100/400GE
7750 SR-2s	2 slots, 5 RU	9.6 Tb/s	4.8 Tb/s	10/25/100/400GE
7750 SR-1s	1 slot, 3 RU	4.8 Tb/s	2.4 Tb/s	10/25/100/400GE
7750 SR-12e	9 slots, 22 RU	13.5 Tb/s	6.8 Tb/s	10/25/100/400GE
7750 SR-12	10 slots, 14 RU	8 Tb/s	4 Tb/s	10/25/100/400GE
7750 SR-7	5 slots, 8 RU	4 Tb/s	2 Tb/s	10/25/100/400GE
7750 SR-1	1 slot, 2 RU	1.5 Tb/s	750 Gb/s	10/25/100/400GE

* Recommended platforms for optimal capacity and port density mix

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.

With truly open architectures that seamlessly integrate into any ecosystem, our high-performance networks create new opportunities for monetization and scale. 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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