containerized Multi-Access Gateway – controller

Release 26.7

cMAG-c Overview Guide

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Nokia is committed to diversity and inclusion. We are continuously reviewing our customer documentation and consulting with standards bodies to ensure that terminology is inclusive and aligned with the industry. Our future customer documentation will be updated accordingly.

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1.1 About this guide

This document provides an overview of the Nokia control and user plane separation (CUPS) solution. The Nokia containerized Multi-Access Gateway – controller (cMAG-c) functions as the control plane (CP) and has the ability to control SR OS-based user planes (UPs).

Note: This guide generically covers content for the release specified on the title page of the guide, and may also contain some content that will be released in later maintenance loads. See the applicable *cMAG-c Release Notes* for information about features supported in each load of the software release.

1.2 Conventions

This section describes the general conventions used in this guide.

1.2.1 Precautionary and information messages

The following information symbols are used in the documentation.

DANGER: Danger warns that the described activity or situation may result in serious personal injury or death. An electric shock hazard could exist. Before you begin work on this equipment, be aware of hazards involving electrical circuitry, be familiar with networking environments, and implement accident prevention procedures.

WARNING: Warning indicates that the described activity or situation may, or will, cause equipment damage, serious performance problems, or loss of data.

Caution: Caution indicates that the described activity or situation may reduce your component or system performance.

Note: Note provides additional operational information.

Tip: Tip provides suggestions for use or best practices.

1.2.2 Options or substeps in procedures and sequential workflows

Options in a procedure or a sequential workflow are indicated by a bulleted list. In the following example, at step 1, the user must perform the described action. At step 2, the user must perform one of the listed options to complete the step.

Example: Options in a procedure

1. User must perform this step.
2. This step offers three options. User must perform one option to complete this step.
   - This is one option.
   - This is another option.
   - This is yet another option.

Substeps in a procedure or a sequential workflow are indicated by letters. In the following example, at step 1, the user must perform the described action. At step 2, the user must perform two substeps (a. and b.) to complete the step.

Example: Substeps in a procedure

1. User must perform this step.
2. User must perform all substeps to complete this action.
   a. This is one substep.
   b. This is another substep.

2 Introduction to CUPS

The cloud-native version of the Multi-Access Gateway supports wireline use cases. The cMAG-c functions as the control plane in a CUPS architecture, managing user planes and using BBF-defined interfaces for subscriber and network configurations.

CUPS is a subscriber-focused architecture that was first adopted for mobile core. Initially, it appeared in the 4G long-term evolution (LTE) mobile core and later became the standard architecture for the 5G core. In 2019, the Broadband Forum (BBF) began standardization of the BNG CUPS architecture. Nokia was one of the pioneer contributors at BBF in BNG CUPS standardization, which led to the publication of TR-459 for broadband applications, TR-459.2 for NAT, and TR-459.3 for multicast. BBF continues to define new standardized features and solutions contributed by service providers and vendors.

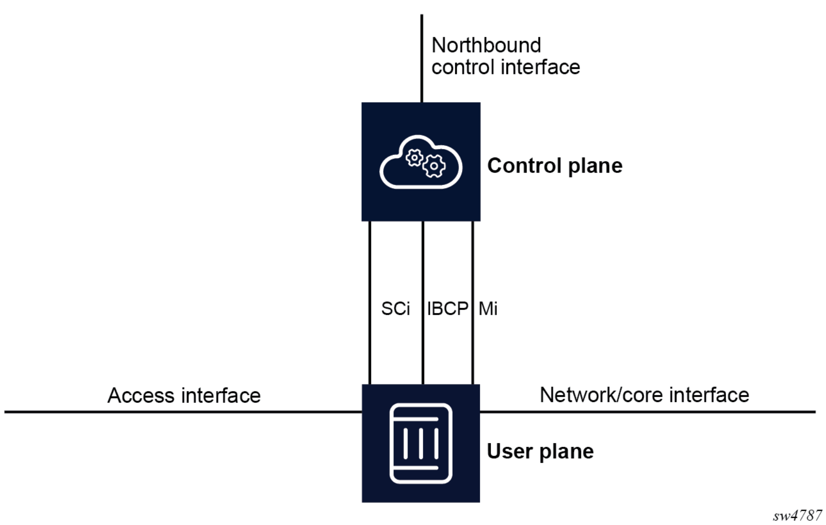
2.1 Multi-Access Gateway

Nokia offers the Multi-Access Gateway (MAG) solution with an access-agnostic core that supports both broadband wireline and fixed wireless use cases. Today, the MAG solution can be deployed in a virtualized network function (VNF) environment or a cloud-native (CN) environment. Nokia refers to the CN version of the MAG as the containerized MAG controller (cMAG-c). The cMAG-c supports wireline use cases, as defined by BBF.

The following figure shows a high-level CUPS architecture as defined in TR-459. The interfaces between the CP and the UP are:

- state control interface (SCi)
- in-band control plane (IBCP), also referred to as control packet redirect interface (CPRi)
- management interface (Mi)

Figure 1: Broadband wireline CUPS architecture



BBF defines BNG CUPS as a disaggregated BNG (DBNG), where the CP of the DBNG is known as the DBNG-CP and the UP of the DBNG is known as the DBNG-UP. The DBNG-CP in the context of this document is the Nokia cMAG-c. The following terms are used interchangeably in the industry: DBNG and BNG CUPS

2.1.1 cMAG-c control plane overview

The Nokia cMAG-c provides subscriber management functions including authentication, authorization and accounting (AAA), IP address management, and policy management. The cMAG-c has northbound control interfaces (NCIs) to communicate with external systems such as remote authentication dial-in user service (RADIUS) servers and policy services. The cMAG-c uses standard interfaces defined in TR-459 to interact with the UP for basic broadband functions. Nokia innovation includes many more added features to enrich functionalities, efficiency, resiliency, and performance improvements.

Note: Subscriber routing, including the IGP or BGP routing control plane, is located on the UP only. CUPS is only applicable to the subscriber management function within the BNG.

2.1.2 DBNG-UP overview

The Nokia 7750 SR platforms are equivalent to the BBF defined DBNG-UP, and are also referred to as MAG-u. The UP is responsible for subscriber data traffic forwarding, and it performs the following key functions:

- traffic management, including NAT and multicast replication
- policy enforcement, such as QoS and charging
- subscriber traffic statistics

The UP installs the subscriber forwarding rules communicated by the CP through the SCi.

Note: For the CUPS architecture, the subscriber routing function, which includes the IGP and BGP routing control and packet forwarding, remains entirely on the MAG-u. The cMAG-c can install subscriber routes on the UP but is not involved in controlling the routing function on the UP.

2.1.3 cMAG-c interfaces

The Nokia cMAG-c supports BBF defined standard CUPS interfaces.

State control interface

The SCi is responsible for programming subscriber data forwarding rules on the UP. The cMAG-c solution uses the 3GPP packet forwarding control protocol (PFCP) protocol as specified in 3GPP TS 29.244. 3GPP designed the PFCP to be fully extensible. To accommodate the broadband wireline use case, BBF extended the PFCP information elements (IEs) and published the extension in TR-459. Nokia extended the PFCP IE set to offer additional feature sets.

For wireline access, the SCi programs, at minimum, the following types of rules:

- control packet redirection rules – bidirectional rules to redirect subscriber wireline control packets, via the UP, from the residential gateway (RG) to the cMAG-c and from the cMAG-c to the RG

- subscriber data forwarding rules – bidirectional rules to forward subscriber traffic between the access interface and the network interface

In-band control plane interface

The purpose of the IBCP is to tunnel the control packets of the RG that are received on the UP to the cMAG-c, from the cMAG-c to the UP, and back to the RG. The tunnel encapsulation is the GPRS tunneling protocol - user plane (GTP-U) as specified in 3GPP TS 29.244. GTP-U is extended with an optional network service header (NSH) as defined in RFC 8300 to carry UP-specific metadata such as the ingress port. There are two types of IBCP tunnels:

- per-session IBCP tunnels
- common IBCP tunnels

The cMAG-c programs the IBCP tunnels through the SCi interface.

Management interface

The cMAG-c uses the Mi to program the DBNG-UP for everything that is not related to subscriber forwarding rules. BBF TR-459 has no specifications for this interface.

3 Nokia cMAG-c CUPS solution

The cMAG-c is a containerized CUPS control plane solution and is based on cloud-native software architecture.

The cMAG-c applications are divided into different microservices to achieve scalability, resiliency, and flexibility. Additional benefits of cloud-native architecture allow operators to:

- monitor the consumed resources and the performance of various broadband applications
- automatically scale pods based on performance needs or resources required
- apply the cloud-native clustering technology for resiliency and scheduling

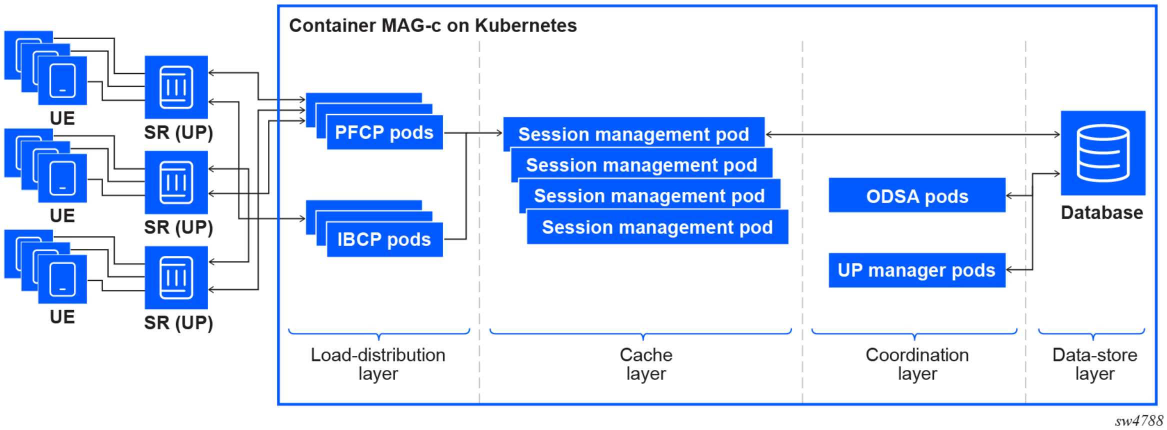
3.1 cMAG-c high level architecture

The cMAG-c offers the familiar operational experience of the Nokia TPSDA product line, which includes SR platforms and the MAG-c. However, the cMAG-c is designed from the ground up for a cloud-native environment. Specifically, the cMAG-c is a Kubernetes (k8s) application that addresses limitations found in classic software architecture by allowing a declarative approach for deploying, scaling, and managing application pods.

Similarly to all other cloud-native software, cMAG-c applications need to be divided in stateless and stateful components to maximize the flexibility of scaling up or down. To ensure maximum efficiency and scaling, the cMAG-c architecture is further divided up into the following layers:

- **load-distribution layer**
  The load distribution layer redirects all control packets received from the UP and distributes them to pods in the cache layer for processing.
- **cache layer**
  The cache layer holds the temporary state until the processing is complete. Its purpose is to avoid retrieval of the full subscriber state information from the database in the data store layer. The database stores multiple millions of subscriber sessions, and retrieving individual sessions from the data store layer takes more time compared to retrieving it from the cache layer. In addition, the session management pod is instantiated in this layer, and it holds sufficient cache information to complete the control processing currently in progress. When the subscriber session setup is complete, its data is transferred to the data-store layer for long-term storage. The goal of the cache layer is to ensure horizontal scaling of pods to handle the heaviest load of processing when it occurs.
- **coordination layer**
  The coordination layer consists of stateful pods, such as ODSA and the UP manager, and it is used to store stateful information about the subscriber such as the assigned address , circuit information, subscriber ID, and so on.
- **data-store layer**
  The data-store layer is responsible for the long-term data storage. This is a critical component for storing the subscriber state and the configuration of the overall system. The data-store layer is also a critical component for resiliency. When other layers experience failure, the data-store layer backs up data and provides all the information necessary to restore the subscriber state to any pods in the coordination layer.

Figure 2: cMAG-c high level architecture



With the architectural split shown in Figure 2: cMAG-c high level architecture, the cMAG-c achieves improved operation with all the advantages of cloud-native software, namely agility, scalability, and resiliency. Application pods can be destroyed or recreated freely and pod software upgrades are possible without shutting down the entire system.

The database is a crucial part of the cMAG-c architecture, because it stores both state information and system configuration in case of failure of any of the components of the load balancing, application pods, or cache layer. When the application pods are recreated, the database can restore the subscriber session by restoring the necessary state information in the application pods or cache. In addition, any new application pods can invoke the database for full state information.

For more information about the cMAG-c architecture, see the *cMAG-c Installation Guide*.

4 More information

Find references to documentation for more information about the cMAG-c.

See the *cMAG-c Guide to Documentation* or the *cMAG-c Release Notes* for a list of guides with more information about the cMAG-c installation.

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