NOKIA

7750 SERVICE ROUTER

VIRTUALIZED SERVICE ROUTER

BNG CUPS USER PLANE FUNCTION 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 Getting started

1.1 About this guide

This guide describes the Nokia SR OS User Plane Function (UPF) in a Broadband Network Gateway (BNG) Control and User Plane Separation (CUPS) system. The BNG CUPS UPF is based on the fundamentals of the BNG and reuses fundamental QoS and forwarding concepts, while moving the control plane handling to the BNG CUPS Control Plane Function (CPF).

See the *7450 ESS, 7750 SR, and VSR Triple Play Service Delivery Architecture Guide* for more information about BNG.

See the *CMG BNG CUPS Control Plane Function Guide* for an overview of the BNG CUPS solution and the BNG CUPS CPF.

This guide is organized into functional chapters that provide concepts and descriptions of the implementation flow, as well as Command Line Interface (CLI) syntax and command usage.

Note: This guide provides configuration examples based on MD-CLI syntax.

The topics and commands described in this document apply to the following SR OS products:

- 7750 SR
- Virtualized Service Router

See the *SR OS R22.x.Rx Software Release Notes*, part number 3HE 18412 000 *x* TQZZA, for a list of unsupported features by platform and chassis.

Command outputs shown in this guide are examples only; actual displays may differ depending on supported functionality and user configuration.

Note: The BNG CUPS UPF supports configuration using classic CLI and MD-CLI. This guide provides configuration examples based on MD-CLI syntax only.
The SR OS CLI trees and command descriptions can be found in the following guides:

- *7450 ESS, 7750 SR, 7950 XRS, and VSR Classic CLI Command Reference Guide*
- *7450 ESS, 7750 SR, 7950 XRS, and VSR MD-CLI Command Reference Guide*
- *7450 ESS, 7750 SR, 7950 XRS, and VSR Clear, Monitor, Show, and Tools Command Reference Guide* (for both MD-CLI and Classic CLI)

Note: This guide generically covers Release 22.*x*.R*x* content and may contain some content that is released in later maintenance loads. See the *SR OS R22.x.Rx Software Release Notes*, part number 3HE 18412 000 *x* TQZZA, for information about features supported in each load of the Release 22.*x*.R*x* software.

1.2 Conventions

This section describes the general conventions used in this guide.

1.2.1 Precautionary and information messages

The following are information symbols 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 PFCP association

This chapter provides an overview of the BNG CUPS UPF Packet Forwarding Control Protocol (PFCP) association configuration, heartbeat and headless mode operation, and operational management and debugging options.

2.1 UPF PFCP association

A BNG CUPS UPF requires an active PFCP association with the BNG CUPS CPF. Through the PFCP association, the BNG CPF installs the rules that determine how the BNG UPF forwards subscriber traffic.

The BNG UPF requires the PFCP association to be preconfigured using the **configure subscriber-mgmt pfcp association** command.

Each PFCP association is linked to a specific peer, interface, and router instance. The loopback interface is the recommended interface because it allows resiliency over multiple physical interfaces.

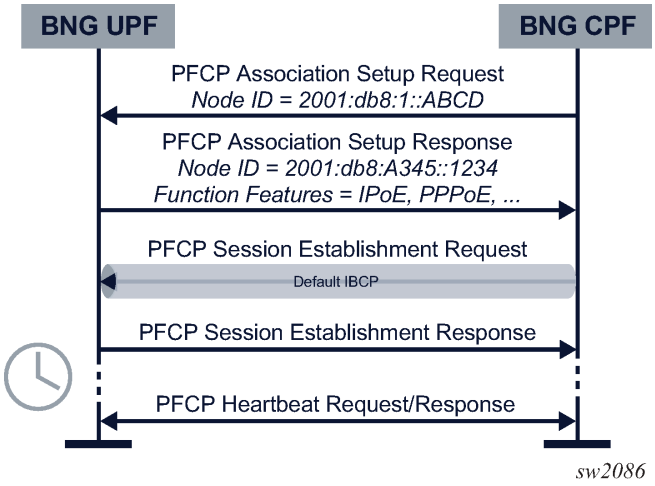
As soon as the PFCP association is configured and administratively enabled, the UPF connects to the BNG CPF by sending PFCP Association Setup Request messages. The UPF sends the messages periodically, until the association is either set up or administratively disabled.

To configure the retry interval for the PFCP association setup, the **association-setup-retry** command is used.

The UPF can also set up the PFCP association when it receives a PFCP Association Setup Request from the configured peer. However, the UPF does not accept an association setup from a non-configured peer.

Figure 1: BNG UPF PFCP association setup flow shows the PFCP association setup flow for the BNG UPF.

Figure 1: BNG UPF PFCP association setup flow



The PFCP protocol supports node identification using node IDs. The node ID can be either an IP address or a FQDN. By default, the IP address of the linked interface is chosen; however, this can be overridden using the **node-id** command. All the UPFs in a deployment require different node IDs.

PFCP messages sent for an active association use the following configuration under the PFCP association **tx** command:

- The **ttl** command defines the outgoing TTL.
- The **timeout** command defines the request message timeout (T1).
- The **retries** command defines the number of times a request message is retried (N1).

Note: For heartbeat messages, N1 and T1 are configured separately. For correct operation, N1 and T1 must be configured identically on both the BNG CPF and UPF. See the *CMG BNG CUPS Control Plane Function Guide* and the *7750 SR MG and CMG CLI Reference Guide* for more information about the BNG CUPS CPF configuration.

The QoS of the outgoing PFCP messages is managed through **sgt-qos** command configuration in the routing instance used by the PFCP. In the **application** list command, a **pfcp** keyword can be mapped to its own DSCP value (default NC2), after which that DSCP value can be mapped to a specific Forwarding Class (FC).

See the *7450 ESS, 7750 SR, 7950 XRS, and VSR Quality of Service Guide*, section "QoS for Self-Generated (CPU) Traffic on Network Interfaces" for more information about QoS configuration.

When a PFCP association is administratively disabled, it is not immediately brought down. The BNG UPF requests a graceful CPF release and keeps the PFCP association up until the BNG CPF removes it, or the association release timeout expires.

To configure the PFCP association release timeout, use the **association-release-timeout** command.

To force an immediate PFCP association removal, configure the **association-release-timeout** to **none**.

The following example shows a BNG UPF PFCP association configuration.

```
[gl:configure subscriber-mgmt pfcp association "BNG-CPF"]
A:admin@DUT-B# info detail
    admin-state enable
 ## description
    association-setup-retry 1
    association-release-timeout 3600
    path-restoration-time 180
    node-id {
     ## fqdn
     ## use-ip-address
    }
    interface {
        router-instance "to_cp"
        name "endpoint"
    }
    peer {
        ip-address 17.17.17.10
    }
    heartbeat {
        interval 60
        timeout 5
        retries 4
    }
    tx {
        timeout 5
        retries 3
```

```
        ttl 255
    }
```

2.2 PFCP heartbeats and headless mode

The following concepts define the connectivity between the BNG UPF and the BNG CPF:

- **PFCP association**
  One PFCP association is allowed per BNG UPF and BNG CPF. The identifiers of the association are the BNG UPF and BNG CPF node IDs.
- **PFCP path**
  Multiple PFCP paths are possible per association. The identifier of a PFCP path is the pair of IP addresses that are used to communicate between the BNG UPF and the BNG CPF. Paths are not negotiated but are learned while using PFCP signaling.

  See UPF PFCP association for information about how PFCP associations are negotiated.

Note: The terms PFCP path and PFCP association are often used interchangeably because there is typically only one PFCP path per PFCP association.

The BNG UPF only uses one IP address, but starts heartbeats for each PFCP path it learns. The frequency, timeout, and retry values of the heartbeats are configured for the PFCP association using the **interval**, **retries**, and **timeout** commands in the **configure subscriber-mgmt pfcp association heartbeat** context.

If a heartbeat fails, the BNG UPF starts a timer based on the **path-restoration-time** command configuration under the PFCP association. If the timer expires or is not configured, all sessions associated with that path are removed. If the path recovers before the timer expires, the timer is canceled, and no sessions are removed.

Note: For correct operation, the heartbeat configuration must be identical on both the BNG UPF and BNG CPF. Nokia strongly recommends configuring the **path-restoration-time** to at least twice the sum of the **heartbeat interval** plus the total timeout (**heartbeat retries** x **heartbeat timeout** = N1 x T1).

To expedite the detection of path failures, enable BFD using the **bfd-expedited-path-down** command in the **configure subscriber-mgmt pfcp association** context. When enabled, the system starts a BFD session for each known PFCP path on the BNG UPF. If the system detects a BFD failure, it immediately brings down the associated path. BFD does not affect the path recovery detection, which requires the configuration of PFCP heartbeats. BFD-based path down detection requires the configuration of the **path-restoration-time** command under the PFCP association.

2.3 Default IBCP session

The BNG UPF always enables the IPoE and PPPoE BBF function features. A compatible BNG CPF uses this as an indication to set up a default IBCP tunnel to send control plane packets, such as DHCP discover or PADI, that do not match an existing session. The default tunnel is signaled as a special PFCP session without a PDN type. The special PFCP session can apply traffic-matching rules the same as any other PFCP session for which the BNG UPF applies rules.

Packets sent over the default In-band Control Plane (IBCP) tunnel include local BNG UPF parameters that are inserted in a network service header. The network service header is inserted between the GTP-U header and the encapsulated control packet. These parameters include the following:

- **MAC address**

  This is the MAC address that is associated with the capture SAP on which the IBCP packet was received. The BNG CPF uses the MAC address as a source MAC address when sending control packet responses. In case of inter-UPF resiliency, the BNG CPF can ignore this MAC address and use the FSG MAC address instead. For more information about inter-UPF resiliency, see BNG UPF resiliency.

- **Layer 2 access ID**

  The Layer 2 access ID (also known as the logical port) identifies the local port, the LAG, or the pw-port that is used by the capture SAP. The BNG CPF reflects this parameter as is when setting up a session so the BNG UPF installs the session in this context. To simplify provisioning on the BNG CPF, you can provide an alias for the L2 access ID. The alias must be unique within the BNG UPF and cannot overlap with any identifier such as a port or a LAG name.

  To configure the L2 access ID alias, use the **configure service vpls capture-sap pfcp l2-access-id-alias** command.

See IBCP for more information about IBCP.

2.4 Operational commands and debugging

This section describes commands that can be used for operational and debugging purposes.

To display the number of PFCP associations and sessions, use the **show subscriber-mgmt pfcp summary** command.

To display PFCP message statistics, including information about packets that are received and transmitted and any transmission errors, use the **show subscriber-mgmt pfcp statistics** command.

To reset the PFCP association statistics to zero, use the **clear subscriber-mgmt pfcp-association statistics** command.

To display information including association-level parameters such as function features and node IDs, use the **show subscriber-mgmt pfcp association** command.

To display path state information, use the **show subscriber-mgmt pfcp peer** command.

See PFCP heartbeats and headless mode for information about the distinction between PFCP association and path.

To display default IBCP tunnel information, use the **show subscriber-mgmt pfcp session default-tunnel** command.

To display details about a specific PFCP session, use the **show subscriber-mgmt pfcp session detail** command. This command provides an overview for the PFCP parameters of the session. Various filters can be applied to narrow a specific session or set of sessions.

See Operational commands for more information about basic operational commands.

To forcefully remove a PFCP session, use the **clear subscriber-mgmt pfcp-session** command.

Caution: Although it is possible to forcefully remove a PFCP session, Nokia does not recommend invoking this command in a live network because this may cause the BNG CPF to be

out of sync with the UPF. If the UPF contains a session that is not on the CPF, it is preferable to first run a manual PFCP audit.

To perform basic PFCP debugging, use the **debug subscriber-mgmt pfcp** command. The output of this command allows inspection of PFCP packets received and transmitted. As well, any session-specific failure is reported in the PFCP response to the BNG CPF, which can display the specific error as part of session debugging.

3 Session management

This chapter provides an overview of the common and fixed access session functionality.

3.1 Subscribers, QoS, and filters

The BNG CUPS automatically links sessions together into subscribers, based on the QoS Enforcement Rule (QER) Correlation ID it receives in the PFCP session. If the BNG CUPS UPF does not receive a QER Correlation ID, it assumes there is only one session per subscriber.

The usual subscriber-management processing applies, as described in the *7450 ESS, 7750 SR, and VSR Triple Play Service Delivery Architecture Guide*, sections "QoS for subscribers and hosts" through "Configuring IP and IPv6 filter policies for subscriber hosts".

The PFCP may pass the following parameters:

- subscriber and SLA profile names; if these are not provided the name "default" is used

  Note: You must always configure the SLA and subscriber profiles for use with BNG CUPS; for example, **configure subscriber-mgmt sla-profile control cups** or **configure subscriber-mgmt sub-profile control cups**. This disables any feature that is not supported within BNG CUPS.

- direct QoS overrides of QoS objects such as aggregate-rate, schedulers, arbiters, queues, and policers
- SLA filter overrides, either by name or ID
- intermediate destination ID

PFCP can also signal GBR and MBR values directly in the QER, which is not linked directly to a specific QoS object. If the QER applies to the entire session, you can map the MBR and GBR to a direct QoS object PIR or CIR override using the **configure subscriber-mgmt sla-profile** *name* **pfcp-mappings session-qer** command. The BNG CUPS CPF signals the QER rate, for example, to install a session-AMBR (5G) or APN-AMBR (4G) for FWA sessions.

3.2 IBCP

Most BNG session types have one or more control plane messages that are sent in-band and therefore arrive directly on the UPF. Because the BNG UPF cannot handle these messages, they are forwarded to the BNG CPF. To accomplish this, the BNG CPF installs specific Ethernet or IP filter rules that match these packets; for example, by matching UDP destination port 67 to extract DHCP. These packets are encapsulated in GTP-U and sent to the CPF. Similarly, the BNG CPF sends downstream In-Band Control Plane (IBCP) packets over GTP-U toward the BNG UPF.

For upstream traffic, the BNG UPF sends any control plane messages that do not match a session over a default tunnel. See Default IBCP session for information about how this tunnel is signaled. If the control plane messages do not match the default tunnel rules, the messages are dropped.

When a session is created, either out-of-band or via a trigger over the default tunnel, the BNG CPF installs per-session control plane rules for both upstream and downstream. Packets that match the upstream rules are forwarded to the BNG CPF using the signaled GTP-U parameters. For downstream rules, the BNG UPF allocates a TEID that the BNG CPF can use to send packets. The BNG UPF does not support a default downstream IBCP tunnel.

The upstream IBCP (including default) follows the **sgt-qos dscp application** configuration, using the **ibcp** keyword on the router or VPRN. A specific DSCP value (default NC2) can be provisioned and mapped to a specific FC, as usual.

See the *7450 ESS, 7750 SR, 7950 XRS, and VSR Quality of Service Guide*, section "QoS for Self-Generated (CPU) Traffic on Network Interfaces" for more information.

Downstream IBCP packets are handled directly in the data path. Ingress QoS is applied based on the provisioning. Egress QoS depends on the session type. The session types are as follows:

- **fixed access sessions**

  Egress QoS packets bypass per-session processing, including egress QoS and filters. Egress QoS is instead based on the QoS configuration of the capture SAP that is linked to the session.

- **FWA sessions**

  Egress QoS packets go through regular per-session processing and are subject to the QoS and filters provisioned in the SLA profile.

3.3 IP gateway, services, and routing

In many deployments, a BNG UPF acts as a direct IP gateway for sessions. The BNG CPF provides all the IP addresses and framed routes using the PFCP protocol. To assist with forwarding, the BNG CPF also signals the following information using the PFCP protocol:

- name of the preprovisioned IES or VPRN service in which forwarding must occur
- aggregate routes that the BNG UPF announces in routing protocols to attract traffic

  Note: The BNG CPF guarantees that no addresses from the aggregate routes are assigned to sessions on another BNG UPF. See the *7450 ESS, 7750 SR, 7950 XRS, and VSR Unicast Routing Protocols Guide* for more information about route policies.

- IPv4 gateway address, which is typically a dedicated address within the aggregate route
- IPv6 gateway link-local address, only one of which is supported per VPRN or IES

The BNG UPF runs the appropriate routing protocols and responds to ARP/ND for the gateway addresses. For the purpose of exporting routes, the operator can distinguish all CUPS routes using the **pfcp** option for the **configure policy-options policy-statement entry from origin** command. Additionally, the operator can further distinguish routes using the following options for the **protocol** command in the same context:

- **sub-mgmt** option for session IP addresses and prefixes, as signaled in the UE IP Address IE in PFCP
- **managed** option for framed routes, as signaled in the Framed-Route IE in PFCP

  Note: When using the **pd-as-framed-route** option on the BNG CPF, an IPv6 PD prefix uses the **managed** option (instead of the **sub-mgmt** option) because the BNG UPF cannot distinguish the PD framed route from a regular framed route.

- **direct** option for all other routes, such as aggregate routes and gateway addresses

3.4 Statistics reporting

Statistics reporting uses the PFCP Usage Reporting Rule (URR) mechanism. The BNG UPF supports a single URR to count all statistics that are related to a session. The BNG UPF supports sending the following statistics for the URR:

- Aggregate octet counters are always signaled.
- Aggregate packet counters are signaled, if enabled by the CPF.
- Per-queue and per-policer statistics are signaled, if enabled by the CPF. The specific counters depend on the statistics mode (**stat-mode**) configured in either the QoS policy or SLA profile.

All counters, including aggregates, are based on QoS counters and are therefore affected by QoS modifiers, such as the **packet-byte-offset** command.

The BNG UPF sends reports for a URR in the following cases:

- The BNG CPF explicitly queries the UPF via a PFCP Session Modification Request.
- The periodic URR reporting is enabled and the BNG UPF sends unsolicited PFCP Session Report Request messages.

PFCP statistics are reported in an incremental manner. This means that only new statistics after the last report are signaled. To achieve this, the BNG UPF baselines the counters on every report. Consequently, it is not possible to manually clear statistics on the BNG UPF using the **clear service statistics subscriber** command. Other operational commands (for example, **show service active-subscribers detail**) only show the accumulated statistics on the BNG UPF.

Because statistics are based on QoS counters, sessions sharing the same SLA Profile Instance (SPI) also share statistics, and a report for one session baselines the counters for the entire SPI. As a result, per-session statistics on the BNG CPF are not correct when sharing an SPI; however, their aggregate counts are correct. The BNG CPF must provide the appropriate aggregate level (for example, subscriber-level accounting). When an SPI changes, the BNG UPF reports the final SPI statistics in PFCP if instructed to do so by the BNG CPF.

Hardware failures are automatically taken into account for statistics reporting. Statistics generated after the last report are irretrievably lost. However, as a result of the incremental reporting, the BNG CPF does not lose any older counters and does not see a sudden reset. That is, aggregate counters on the BNG CPF never decrease as a result of a hardware failure. However, the BNG UPF local statistics as seen in **show** commands reset upon a hardware failure, and therefore a mismatch of BNG CPF counters may result.

3.5 Operational commands

Most of the traditional BNG operational commands, as described in the *7450 ESS, 7750 SR, and VSR Triple Play Service Delivery Architecture Guide*, apply to the CUPS BNG UPF. The significant exceptions to this rule are operational commands related to specific protocols (such as DHCP, DHCPv6, RADIUS, and PPPoE), because a BNG CUPS UPF is not aware of these states.

The primary BNG CUPS UPF operational commands are as follows:

- **show service active-subscribers**

This command contains several sub-commands that provide details about a specific subscriber or session within a subscriber. These commands incorporate information about CUPS subscribers. Information that is only available on the BNG CPF is not shown on the BNG UPF (for example, details on RADIUS and metadata such as **remote-id** and **circuit-id**).

- **show subscriber-mgmt statistics**

  This command contains several sub-commands that provide a wide variety of statistics on various granularity levels. These commands are extended to incorporate BNG CUPS statistics.

IBCP statistics can be displayed via the PFCP statistics using the **show subscriber-mgmt pfcp statistics** command.

Operational commands that are specific to PFCP associations are described in Operational commands and debugging.

3.6 SAP and group interface templates

The system auto-provisions any required objects, which means that subscriber interfaces, group interfaces, and SAPs do not need to be provisioned. These objects are hidden from configuration and are not modifiable. Aside from the capture SAP, the only required configuration is the VPRN or IES where IP forwarding occurs.

You can manage SAP creation by configuring a SAP template under the **configure subscriber-mgmt sap-template** command. The SAP template supports the configuration of the following:

- The **hold-time** command delays the deletion of the SAP after the last PFCP session is removed. The **infinite** option can be configured for the **hold-time** but it is not recommended. Idle SAPs can be cleared using the **idle-saps** option under **clear subscriber-mgmt sap-template**.
- The **cpu-protection** and **dist-cpu-protection** commands configure CPU protection; see the *7450 ESS, 7750 SR, 7950 XRS, and VSR System Management Guide*, section "Centralized CPU protection and distributed CPU protection" for more information about CPU protection.

Note: On platforms where CPU protection and distributed CPU protection are not supported, these commands are ignored.

Similarly, group-interface creation can be manipulated by configuring a group interface template under the **configure subscriber-mgmt group-interface-template** command. When setting up a PFCP session, a template name is passed using PFCP. If the template name is absent, the system falls back to the name "default".

A group interface template allows the configuration of the following:

- **ip-mtu**; is applied to outgoing packets
- **urpf-check**; see *7450 ESS, 7750 SR, 7950 XRS, and VSR Router Configuration Guide,* section "Unicast reverse path forwarding check"
- **icmp**
- **remote-proxy-arp**; see *7450 ESS, 7750 SR, 7950 XRS, and VSR Router Configuration Guide*, section "Proxy ARP"

Note: The SAP and group interface templates must be configured on the BNG UPF (as well as the name "default") to ensure that the session setup does not fail.
Changing the configuration of a template does not automatically change all created SAPs or group interfaces.

3.6.1 Mixing different encapsulation sessions on the same port

The BNG UPF supports the following mix of encapsulation sessions:

- on a :*.* capture SAP: dot1q and null encapsulation sessions

  Note: To support this, the user must set the **configure service system extended-default-qinq-sap-lookup** command to **true** on the systems where this is not the default.

- on a :* capture SAP: null encapsulation sessions

The system internally creates SAPs with :N.0, :0.0, and :0 encapsulation to support the mix. The user can apply the SAP templates to these SAPs similarly to any other SAPs.

Traffic as seen on the wire typically does not include an S-tag or C-tag with a tag value explicitly set to zero because the absence of a tag is equal to a zero tag. Occasionally, an explicit zero tag is included; for example, when a dot1p or DEI bit needs to be set in the tag header. The internally created SAPs interact with such traffic as follows:

- Because generated traffic never includes an explicit zero tag, it is not possible to set a dot1p or DEI bit in the tag header.
- Traffic with a C-tag value explicitly set to zero is always dropped, even if it matches an internally created :N.0 or :0.0 SAP.
- Traffic with only the S-tag value explicitly set to zero is handled if it matches either a :0 or a :0.0 SAP. This kind of traffic matches the same session as if it was received without any S-tag.

3.7 Fixed access sessions

To enable fixed access sessions, you must provision a capture SAP under the VPLS service with appropriate values for trigger-packet and a link to the PFCP association. The triggers are mandatory and are not automatically derived from the default IBCP tunnel.

Sessions without any encapsulation are supported on a dot1q capture SAP. The system creates internal constructs to correctly handle sessions without encapsulation. These sessions can be combined with dot1q encapsulated sessions on the same capture SAP.

The following example shows trigger-packet provisioning in a PFCP association configuration.

```
A:admin@DUT-B# info
    pfcp {
        association "BNG-CPF"
    }
    trigger-packet {
        pppoe true
    }
```

To identify sessions in the data plane, the BNG CPF must provide the following parameters:

- The logical port (also known as the Layer 2 access ID) identifies the port, the LAG, or the pw-port where the session is terminated. The BNG CPF knows the correct logical port because the BNG UPF includes this logical port in the IBCP packets sent over the default IBCP tunnel. See Default IBCP session.
- The VLAN tags, along with the logical port, identify a SAP where the session is terminated, also known as a Layer 2 circuit (l2-circuit). The BNG CPF must signal all the VLAN tags to match the encapsulation type provisioned for the port; for example, only signaling an s-tag for a q-in-q port is not allowed. As an exception, the BNG CPF can install sessions without any VLAN tags on a dot1q capture SAP, as described at the beginning of this section.
- The source MAC address is required.
- The PPPoE session ID is used for PPPoE only.
- The IP anti-spoofing IP address is optionally used to enable IP anti-spoofing. While this can be signaled per session, the BNG UPF only supports a single anti-spoof type per SAP. When a second session on the same SAP has a conflicting anti-spoof indication, the setup fails. IP anti-spoofing is not supported for framed routes.

For PPPoE, the BNG UPF can perform LCP keep-alive offload, if supported and signaled by the BNG CPF. The BNG UPF automatically signals support for this feature when the PFCP association is created.

3.8 Fixed wireless access sessions

To configure Fixed Wireless Access (FWA) sessions, the operator must provision a GTP UPF data endpoint using the **gtp upf-data-endpoint** command in the **service vprn**or **router** context. The endpoint must reference an interface in the routing instance where GTP-U tunnels to the RAN are set up. Additionally, an FPE construct is required to enable datapath functions in the router. The FPE must be configured as type **multi-path**. See the 7450 ESS, 7750 SR, 7950 XRS, and VSR Interface Configuration Guide for more information.

The system automatically creates all the required constructs to correctly handle FWA sessions. Additionally, the system load-balances sessions over each FPE path, using the path that is the least loaded when the session is set up.

The following example shows provisioning of a UPF data endpoint and multipath FPE.

```
[gl:/configure service vprn "to_ran" gtp upf-data-endpoint]
A:admin@BNG-UPF# info
    interface "gtp_u_endpoint"
    fpe 1
[gl:/configure fwd-path-ext fpe 1]
A:admin@BNG-UPF# info
    multi-path {
        path 1 {
            pxc 1
        }
    }
    application {
        sub-mgmt-extension true
    }
```

Unlike in fixed access sessions, a default IBCP tunnel is not used for FWA sessions because the initial session setup is out-of-band and does not involve the BNG UPF. Per-session IBCP is supported to forward DHCP (Deferred Allocation), ICMPv6 RS/RA, and DHCPv6 packets.

3.9 Routed subscriber sessions

Enterprise IP VPNs often use BGP to exchange routing information, for example, between headquarters and branch offices. Providing BGP connectivity to an enterprise router via a residential access connection requires BGP peering over a BNG CUPS subscriber session. To configure this on the BNG CUPS UPF, use a static BGP neighbor that has as its neighbor address the fixed IPv4 or IPv6 WAN address of the subscriber session.

Example configuration

```
# configure service vprn 1000
    --- snip ---
    subscriber-interface "_tmnx_cups_1131076" fwd-service 2148278386
    /fwd-subscriber-interface "_tmnx_cups_1131075" wan-mode mode128
        description "default subscriber interface template"
        private-retail-subnets
        address 10.0.240.254/20
        ipv6
        exit
    exit
    bgp
        group "enterprise-1"
            neighbor 10.0.0.1
                family ipv4
                local-address 10.0.240.254
                type external
                local-as 65536
                peer-as 65501
            exit
        exit
        no shutdown
    exit
    no shutdown
```

BNG CUPS subscriber sessions support static BGP neighbors for the following:

- BGPv4 neighbors with IPv4 and IPv6 address families
- BGPv6 neighbors with IPv4 and IPv6 address families
- IPoE and PPPoE sessions
- numbered and unnumbered interfaces
- single-hop and multi-hop BGP neighbors

4 Network Address Translation

This chapter provides an overview of Network Address Translation (NAT) functionality for BNG CUPS.

4.1 Residential NAT for BNG CUPS

For BNG CUPS, NAT responsibilities are divided between the BNG CPF and BNG UPF.

The role of the BNG CPF is to associate the subscriber session with NAT during the session authentication phase. This process consists mainly of allocating the outside IP address and port-block to the NAT subscriber session. These parameters are submitted to the BNG UPF through the PFCP association.

The BNG UPF performs NAT on the data traffic. On the BNG UPF, NAT runs on MS-ISA service adapters, including the Integrated Service Adapter (ISA), Virtual ISA (vISA), and Extended Service Adapter (ESA). For the inside IP addresses, the incoming data traffic is sprayed across ISAs. This traffic spraying is based on the subscriber context, which typically represents a residence. For the outside IP addresses, the NAT prefix that is received from the BNG CPF is segmented into smaller subnets and equally distributed across ISAs. This approach requires fair load distribution of traffic across service adapters in the upstream and downstream directions.

Note: In this document, all service adapter types are referred to as ISAs, except when it is necessary to identify a specific type. See the *7450 ESS, 7750 SR, and VSR Multiservice Integrated Service Adapter and Extended Services Appliance Guide* for more information about MS-ISA service adapters.
See the *CMG BNG CUPS Control Plane Function Guide* for more information about NAT terminology and an overview of Residential NAT that describes the division of NAT responsibilities between the BNG CPF and BNG UPF.

4.2 UP NAT policy template

A UP NAT policy template contains parameters that define NAT behavior for a group of subscribers within a NAT pool. This NAT behavior includes support for ALGs, setting limits for the number of NAT flows per subscriber, protocol timer definitions, flow-based logging, watermarks, and so on. The UP NAT policy configuration allows the NAT behavior to be customized for different groups of subscribers within the same NAT pool.

Although the UP NAT policy template is configured on the BNG UPF, its assignment to the NAT-enabled session is performed on the BNG CPF during the authentication phase, using a reference in the CP NAT profile configuration.

The roles of the CP NAT profile and UP NAT policy can be summarized as follows:

- The CP NAT profile is configured on the BNG CPF and identifies NAT subscribers during the authentication phase. Parameters defined in the CP NAT profile affect the selection of the NAT pool within a specific outside routing context. This includes the allocation of the outside IP addresses, port-blocks, and NAT mode of operation (NAPT or 1:1). These resources are managed by the BNG CPF.

- The UP NAT policy template is configured on the BNG UPF and is used to define NAT behavior for a group of subscribers within a NAT pool. This behavior is closer to the NAT translation in the forwarding plane (for example, ALGs and protocol timers).

4.3 Guidelines for configuring NAT subscribers in the sub-profile

Many NAT configuration parameters are defined in the UP NAT policy template (**up-nat-policy**) or the CP NAT profile (see UP NAT policy template). There are also some parameters that may be used for NAT configuration that require further granularity of definition, such as the UPNP policy that enables the dynamic port forward allocation. If a UPNP policy is used for NAT, it must be defined in the **configure subscriber-management sub-profile** context, as shown in the following example.

```
configure {
   subscriber-management {
       sub-profile name {
           upnp-policy policy-name
       }
   }
}
```

4.4 Guidelines for configuring NAT groups

A NAT group represents a collection of ISAs that are used to process NAT traffic for subscribers. NAT traffic is distributed over multiple ISAs in a NAT group to achieve better performance and scale. BNG CUPS supports a single NAT group per BNG UPF, however, other NAT groups can be configured in the system outside CUPS.

A NAT group is a mandatory configuration. After the NAT group is defined, it must be referenced by a PFCP association. A NAT group is configured using commands in the **configure isa nat-group** context.

See Provisioning residential NAT for BNG CUPS for a configuration example.

4.5 Guidelines for configuring accounting and logging

Aggregated NAT logging based on port blocks is performed on the BNG CPF, and flow-based logging can be enabled on the BNG UPF. Because a number of logs are produced in flow logging, flow logs are exported directly from the ISA, bypassing the BNG CPF and the CPM on the BNG UPF. The BNG UPF supports flow logging in IPFIX format.

An IPFIX export policy must be configured in the **configure service ipfix export-policy** context, as shown in the following example.

```
configure {
   service {
      ipfix {
         export-policy policy1
       }
   }
}
```

After the export policy is configured, it must be associated with a UP NAT policy, as shown in the following example.

```
configure {
   service {
      nat {
         up-nat-policy natpolicy1 {
             flow-log-policy {
                 ipfix exportpolicy1
             }
         }
      }
   }
}
```

4.6 Guidelines for configuring watermarks

The following watermarks are supported on the BNG UPF:

- The session-level watermarks on the member ISA level monitor the NAT flow usage against the configured limit per member ISA. They are configured using the NAT group, as shown in the following example.

```
configure {
   isa {
      nat-group id {
         session-limits {
             watermarks {
                 high number
                 low number
             }
         }
      }
   }
}
```

- The session-level watermarks on the subscriber level monitor the NAT flows usage against the configured limit per subscriber. They are configured using the UP NAT policy, as shown in the following example.

```
configure {
   service {
      nat id {
         up-nat-policy name {
             session-limits {
                 watermarks {
                    high number
                    low number
                 }
             }
         }
      }
   }
}
```

- The port usage watermarks on the subscriber level are used to monitor port usage against the configured limit per subscriber. They are configured using the UP NAT policy, as shown in the following example.

```
configure {
   service {
      nat id {
         up-nat-policy name {
             port-limits {
                 watermarks {
                    high number
                    low number
                }
             }
         }
      }
   }
}
```

- On the BNG CPF, a watermark threshold can be configured in either absolute value or percentages to monitor micronet usage within a NAT outside pool. See the *CMG BNG CUPS Control Plane Function Guide* for more information.

4.7 Guidelines for configuring intra-chassis redundancy

ISA redundancy on the BNG UPF level supports the following modes of operation:

- **N:M active/standby mode**

  M number of standby ISAs protect *N* number of active ISAs.

- **all active mode**

  This mode supports failure of up to two ISAs simultaneously. During an ISA failure, the configuration from the failed ISA is distributed over the remaining operational ISAs.

Both modes are stateless which means that NAT binding must be re-established after the switchover.

ISA redundancy is configured in the **configure isa nat-group** context and active/standby mode is enabled using the following commands.

```
configure {
   isa {
      nat-group id {
         mda mda-id
             redundancy {
                 active-mda-limit number
                 intra-chassis {
                     active-standby
                }
             }
         }
      }
   }
```

These commands associate MDAs with the NAT group, set the mode of operation to active/standby, and configure the number of active ISAs in the NAT group. Any ISAs within the NAT group that are in excess of the configured number are automatically considered standby.

All active mode is enabled using the following commands.

```
configure {
   isa {
      nat-group id {
         mda mda-id
             redundancy {
                 active-mda-limit number
                 intra-chassis {
                     active-active {
                        failed-mda-limit number
                     }
                  }
              }
           }
        }
```

4.8 Provisioning residential NAT for BNG CUPS

Prerequisites

Review the residential NAT for BNG CUPS overview information; see Network Address Translation.

A UP NAT policy is required; it can be created (exist) for the UPF or it is sufficient to use the default parameters. See Guidelines for configuring NAT groups.

To configure residential NAT on BNG CUPS, perform the following minimum configuration steps:

Procedure

Step 1. Configure the CPF as described in the *CMG BNG CUPS Control Plane Function Guide*.

Step 2. Configure the UPF.

a. Configure the NAT policy template.

```
configure {
   service {
      nat {
         up-nat-policy “pol-1” {

         }
      }
   }
```

b. Configure the NAT group, including the ISA redundancy mode.

```
configure {
   isa {
      nat-group 1 {
         mda 1/2
         mda 3/1
         mda 2/2
         redundancy {
             active-mda-limit 2
             intra-chassis {
                active-standby
             }
         }
```

```
      }
   }
}
```

c. Associate the NAT group created in step 2.b with the PFCP interface.

```
configure {
    subscriber-mgmt {
       pfcp {
           association "profile-1" {
               nat {
                  nat-group 1
               }
       }
   }
}
```

5 BNG UPF resiliency

Resiliency based on Fate Sharing Group

The BNG CPF groups the sessions in Fate Sharing Groups (FSGs). All sessions in an FSG share their fate, that is, they become active or standby together. The BNG CPF provides the following parameters to the BNG UPF per FSG:

- FSG ID
- status (active or standby)
- unique FSG MAC address also known as a virtual MAC
- list of associated sessions and one or more aggregate routes associated with these sessions. For more information, see IP gateway, services, and routing.
- FSG template

When the BNG CPF does not provide an FSG template, the template with the name default is used. If there is no default template, the setup of the FSG and any associated session fails.

To configure FSG templates, use the **configure subscriber-mgmt up-resiliency fate-sharing-group-template** command.

After this, the active BNG UPF and standby BNG UPF are used in the context of a single FSG. Each BNG UPF can have multiple FSGs and can have a different status for each FSG.

To attract traffic from the access network, an active BNG UPF replies to ARP requests or ND messages for any IP gateway associated with the FSG. A standby BNG UPF never replies to those ARP or ND messages. To expedite convergence upon switching from standby to active, the new active BNG UPF sends Gratuitous ARP (GARP) messages using one of the IP gateway addresses for the FSG, or the system IP address if no IP gateway is known.

To configure the granularity of GARP messages for q-in-q SAPs, use the **configure subscriber-mgmt up-resiliency fate-sharing-group-template gratuitous-arp** command. You can configure the BNG UPF to send a single GARP message per SAP or per outer tag.

To correctly draw traffic to the active BNG UPF, the **fsg-active** and **fsg-standby** options are added to the **state** command in the **configure policy-options policy-statement entry from** context. All routes received from PFCP, including per-session framed routes, have one of these values as parameter. You can use this parameter to adjust values in routing export policies; for example, adjust a metric or a preference to the needs of the used routing protocol.

The following reduced configuration example shows a simplified policy that sets a metric of 100 for active routes and a metric of 200 for standby routes.

```
[gl:/configure policy-options policy-statement "upf_resiliency_aware_export"]
A:admin@BNG-UPF# info
    entry 20 {
        from {
            origin pfcp
            state fsg-active
        }
        action {
            action-type accept
```

```
            metric {
                set 100
            }
        }
    }
    entry 30 {
        from {
            origin pfcp
            state fsg-standby
        }
        action {
            action-type accept
            metric {
                set 200
            }
        }
    }
```

An active BNG UPF always forwards traffic in both directions. It uses the FSG MAC as source MAC for downlink unicast traffic. A standby BNG UPF by default forwards downlink traffic using its local port MAC as source MAC and drops all received uplink traffic. You can modify the default behavior in the following ways:

- To shunt downlink traffic from the standby to the active BNG UPF and have the active BNG UPF forward that downlink traffic, do the following:
  - Configure a redundant interface using the **configure subscriber-mgmt up-resiliency fate-sharing-group-template redundant-interface** command.
  - Configure the same shunt ID on the active and the standby BNG UPF using the **configure service ies subscriber-mgmt multi-chassis-shunt-id** or **configure service vprn subscriber-mgmt multi-chassis-shunt-id** command depending on the service (IES or VPRN).
- To enable forwarding of uplink traffic by the standby BNG UPF, use the **configure subscriber-mgmt up-resiliency fate-sharing-group-template uplink-forwarding-while-standby** command.

Caution: Enabling the **uplink-forwarding-while-standby** command can lead to packet replication toward the core network. To prevent the possibility of packet replication toward the core network, provision the access network not to replicate unicast packets to the BNG UPF.

When the standby BNG UPF forwards uplink traffic, it can significantly lower packet loss during transition scenarios. The following examples illustrate this benefit:

- If the current active BNG UPF fails and an access node detects this faster than the BNG CPF (for example, using BFD), the access node can start sending packets to the standby BNG UPF before that BNG UPF has become active. When the **uplink-forwarding-while-standby** command is enabled, the uplink packets are not lost because the standby BNG UPF forwards them.
- During scheduled maintenance, the BNG CPF can switch the roles of the active and standby BNG UPF while both are healthy. For some time, the access node continues to send packets to the previously active BNG UPF that has become the standby BNG UPF. When the **uplink-forwarding-while-standby** command is enabled, the uplink packets are not lost because the previously active BNG UPF still forwards them. When the **uplink-forwarding-while-standby** command is disabled, the previously active BNG UPF drops the packets until the access node learns the path to the new active BNG UPF (using GARP).

The resiliency based on FSG does not use the SRRP protocol, but the system internally consumes an SRRP instance for each unique combination of FSG, port, and group interface template. To avoid potential

conflicts with pre-configured SRRP instance IDs, define a range of SRRP instance IDs for the inter-UPF resiliency functionality using the **configure redundancy srrp auto-srrp-id-range** command.

BNG UPF health reporting

The BNG UPF can send health reports to the BNG CPF using PFCP Node Report messages. The BNG CPF uses the health reports to determine the need for a BNG UPF status change (active or standby). Per FSG, the BNG CPF selects the active and the standby BNG UPF. For example, the BNG CPF can base its decision on link failures in the access network.

The BNG UPF supports health reports for the following contexts:

- **per network instance**
  Configure the health monitoring using the commands in the **configure service ies subscriber-mgmt up-resiliency** or **configure service vprn subscriber-mgmt up-resiliency** context, depending on the service. The health reports per network instance can, for example, be used to indicate the status of the network where the subscriber is serviced.
- **per Layer 2 access ID**
  Configure the health monitoring using the commands in the **configure service vpls capture-sap pfcp up-resiliency** context. The health reports per Layer 2 access ID can, for example, be used to indicate the status of the access links.

Each health report generates a single byte health value between 0 (unhealthy) and 255 (healthy). The base health value is 255 and decreases with the number of failed members in the operation group x the configured health drop number for the operational group.

Whenever a member of the operational group changes its state (fails or recovers), the BNG UPF calculates the health value and sends an updated report to the BNG CPF.

To configure the operational group and the health drop number, use the **monitor-oper-group** and the **monitor-oper-group health-drop** commands in the above mentioned contexts.

For more information about operational groups, see 7450 ESS, 7750 SR, 7950 XRS, and VSR Layer 3 Services Guide: IES and VPRN, sections *Object grouping and state monitoring*.

With the following example configuration, the BNG UPF sends health reports for Layer 2 access ID (port) lag-access. The operational group has five members (port 1/1/20 to port 1/1/24) and the health value decreases with 51 per failed member, that is, with 20% of the base health value.

```
[gl:/configure port 1/1/20]
A:admin@BNG-UPF# info
    oper-group "lag_access_health"
[gl:/configure port 1/1/21]
A:admin@BNG-UPF# info
    oper-group "lag_access_health"
[gl:/configure port 1/1/22]
A:admin@BNG-UPF# info
    oper-group "lag_access_health"
[gl:/configure port 1/1/23]
A:admin@BNG-UPF# info
    oper-group "lag_access_health"
[gl:/configure port 1/1/24]
A:admin@BNG-UPF# info
    oper-group "lag_access_health"
[gl:/configure service vpls "access" capture-sap lag-access:*.* pfcp up-resiliency]
A:admin@BNG-UPF# info
    monitor-oper-group "lag_access_health" {
        health-drop 51
    }
```

With the following example configuration, the BNG UPF sends health reports for network instance HSI. The health drop number is not configured, that is, the default value of 255 is used. The health is based on a BFD session that is used to check if the BNG UPF is isolated from the rest of the network. When the BFD session is up, the health value equals 255, otherwise, the health value equals 0.

```
[gl:/configure service oper-group "hsi-bfd"]
A:admin@BNG-UPF# info
    bfd-liveness {
        router-instance "to_uplink_router"
        interface-name "endpoint"
        dest-ip 203.0.113.10
    }
[gl:/configure service vprn "hsi" subscriber-mgmt up-resiliency]
A:admin@BNG-UPF# info
    monitor-oper-group "hsi-bfd" {
    }
```

The BNG UPF sends a health report for every status change in the operational group. Additionally, it sends all health reports periodically (every 60 seconds) and when a PFCP audit is requested.

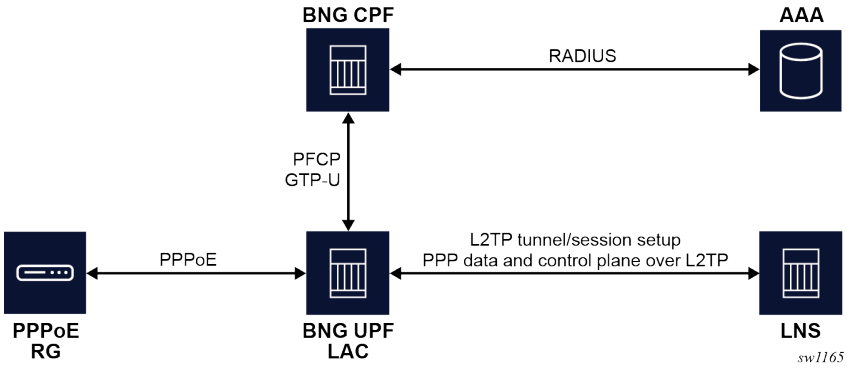
6 Layer 2 Tunneling Protocol

The BNG CUPS environment supports L2TP functionality.

6.1 UPF-triggered L2TP access concentrator

The BNG CUPS UPF supports PPPoE LAC sessions with L2TP control plane signaling running on the BNG CUPS UPF. This relies on the SR L2TP functionality described in the *7450 ESS, 7750 SR, and VSR Triple Play Service Delivery Architecture Guide*, section *Layer 2 Tunneling Protocol (L2TP)*.

Figure 2: L2TP LAC network components



To run a PPPoE LAC session with L2TP control plane signaling on the BNG UPF, the BNG CPF provides the following parameters during the PFCP session data plane setup:

- list of potential L2TP Network Server (LNS) tunnel endpoints
- common or per-LNS parameters such as retry timers, preferences, and authorization IDs; see the *CMG BNG CUPS Control Plane Function Guide* for more information about how to configure these parameters
- per-session PPP LCP and PPP authentication attributes to be sent by proxy to the chosen LNS, so the LNS can avoid renegotiating LCP and authentication with the PPPoE session
- unique name to identify the tunnel group over shared sessions

The BNG UPF performs normal L2TP tunnel management over the group of tunnels, including deny list management, as described in the *7450 ESS, 7750 SR, and VSR Triple Play Service Delivery Architecture Guide*, section *Traffic Steering on L2TP LAC*. To accomplish this, the BNG UPF creates an internal L2TP group in the VPRN service or base router provided by the PFCP. This internal group is not configurable, but common parameters configured under **configure router l2tp** or **configure vprn** *service-name* **l2tp** are applied to the setup of the tunnels. If a parameter is configured locally and also in PFCP, the PFCP parameter takes precedence. To set up tunnels, the **l2tp** context must also be administratively enabled in the router or VPRN.

Based on the tunnel management, the BNG UPF selects a tunnel for the session, or creates the tunnel if it does not exist, and an L2TP session is created for that specific PPPoE session. After the tunnel and

session setup are complete, a response including the following parameters is sent to the triggering PFCP message for operational management on the BNG CPF:

- L2TP tunnel and session IDs of both the LAC and the LNS
- LNS and LAC hostnames, also known as auth IDs
- L2TP tunnel and session IDs for both LNS and LAC
- Call Serial Number (CSN)

After the connection is established, the PPP data packets are forwarded to the LNS. The PFCP message instructs the BNG UPF to stop sending PPP control plane messages to the BNG CPF, and to send them to the LNS instead. Only the PPPoE discovery packets are forwarded to the BNG CPF. For example, a PADT packet is handled by the BNG CPF, while an LCP terminate packet is handled by the LNS.

If L2TP session or tunnel setup fails, the normal L2TP backoff and deny list behavior applies. If the setup fails for all provided tunnels, an explicit PFCP error message is sent to the BNG CPF. However, the BNG UPF does not time out the PFCP message if the setup takes too long, for example, because multiple LNSs are unreachable. The BNG triggers an explicit delete after the PFCP message times out, using its local PFCP N1 or T1 configuration. If a delete is received for an in-progress setup, the setup is aborted.

Note: An aborted setup does not count as a tunnel timeout and the tunnel is not placed in automatic deny lists for timeout hold-off purposes. You must configure the **max-retries-not-estab** command to ensure that the total timeout does not exceed the PFCP session timeout on the BNG CPF. See the *CMG BNG CUPS Control Plane Function Guide* for more information about how to correctly align the timeouts.

7 Lawful intercept

This chapter provides an overview of the Lawful Intercept (LI) functionality for BNG CUPS.

7.1 Overview of the LI implementation on the BNG UPF

To perform LI for BNG CUPS, configurations are required on both the BNG CUPS CPF and UPF:

- The CPF supports reporting of subscriber and LI events; see the *CMG BNG CUPS Control Plane Function Guide* and the *7750 SR MG and CMG CLI Reference Guide* for more information about BNG CUPS CPF configuration.
- The UPF supports the provisioning of LI targets and mirroring of LI packets.

After the LI mediation gateway identifies an LI subscriber through the CPF-reported events, the provisioning of the LI subscriber can be performed directly on the UPF, using the **configure li li-source** commands as described in the *7450 ESS, 7750 SR, 7950 XRS, and VSR OAM and Diagnostics Guide*. Provisioning can be performed using CLI or SNMPv3, however, SNMPv3 is the preferred platform.

Note: In CUPS architecture, the UPF creates a new subscriber ID every time the subscriber or LI subscriber logs in. For this reason, it is highly recommended to use a mediation device to automate the LI configuration. It is not recommended to perform LI configuration through CLI on the UPF.

When the BNG CUPS CPF is configured, it notifies the LI mediation device about the UP subscriber IDs and IP addresses. The LI mediation device sends an SNMPv3 command directly to the UPF IP address to set up an LI target. Li targets typically include the following parameters:

- mirror destination service; can be a layer 3 encapsulation or a SAP
- subscriber ID; for example, " _cups_549"

  Note: The UPF automatically appends " _cups_" to the auto-generated subscriber ID.

- ingress and egress direction
- session ID and intercept ID, which allow the LI mediation device to correlate subscriber events and mirrored packets (optional); see the *7450 ESS, 7750 SR, 7950 XRS, and VSR OAM and Diagnostics Guide*, section "Lawful Intercept" for information about additional parameters

When the subscriber logs out, the LI mediation device removes the subscriber from the LI source through SNMPv3. When the same subscriber logs in again, the system auto-generates a new UPF subscriber ID.

For the procedure to configure SNMPv3 and BNG CUPS, see Provisioning SNMPv3 and LI subscribers for the BNG CUPS UPF.

7.2 Provisioning SNMPv3 and LI subscribers for the BNG CUPS UPF

Prerequisites

Before you begin, review Overview of the LI implementation on the BNG UPF.

To provision SNMPv3 and LI subscribers for the BNG CUPS UPF, perform the following steps:

Procedure

Step 1. Create the SNMPv3 group for LI.

Step 2. Provision an LI administrator for the UPF with both LI access and SNMP access.

Step 3. Associate the SNMPv3 group created in step 1 with the LI administrator.

See the *7450 ESS, 7750 SR, 7950 XRS, and VSR System Management Guide*, for more information about LI users and SNMPv3 setup.

Step 4. Provision the LI subscriber directly on the UPF, using the **configure li li-source** commands.

See the *7450 ESS, 7750 SR, 7950 XRS, and VSR OAM and Diagnostics Guide* for information about user plane LI management and procedures.

See the *CMG BNG CUPS Control Plane Function Guide* and the *7750 SR MG and CMG CLI Reference Guide* for information about the related BNG CUPS CPF configuration.

8 Standards and protocol support

Note:
The information provided in this chapter is subject to change without notice and may not apply to all platforms.

Nokia assumes no responsibility for inaccuracies.

8.1 Access Node Control Protocol (ANCP)

draft-ietf-ancp-protocol-02, *Protocol for Access Node Control Mechanism in Broadband Networks*

RFC 5851, *Framework and Requirements for an Access Node Control Mechanism in Broadband Multi-Service Networks*

8.2 Application Assurance (AA)

3GPP Release 12, *ADC rules over Gx interfaces*

RFC 3507, *Internet Content Adaptation Protocol (ICAP)*

8.3 Bidirectional Forwarding Detection (BFD)

draft-ietf-idr-bgp-ls-sbfd-extensions-01, *BGP Link-State Extensions for Seamless BFD*

RFC 5880, *Bidirectional Forwarding Detection (BFD)*

RFC 5881, *Bidirectional Forwarding Detection (BFD) IPv4 and IPv6 (Single Hop)*

RFC 5882, *Generic Application of Bidirectional Forwarding Detection (BFD)*

RFC 5883, *Bidirectional Forwarding Detection (BFD) for Multihop Paths*

RFC 7130, *Bidirectional Forwarding Detection (BFD) on Link Aggregation Group (LAG) Interfaces*

RFC 7880, *Seamless Bidirectional Forwarding Detection (S-BFD)*

RFC 7881, *Seamless Bidirectional Forwarding Detection (S-BFD) for IPv4, IPv6, and MPLS*

RFC 7883, *Advertising Seamless Bidirectional Forwarding Detection (S-BFD) Discriminators in IS-IS*

RFC 7884, *OSPF Extensions to Advertise Seamless Bidirectional Forwarding Detection (S-BFD) Target Discriminators*

8.4 Border Gateway Protocol (BGP)

draft-gredler-idr-bgplu-epe-14, *Egress Peer Engineering using BGP-LU*

draft-hares-idr-update-attrib-low-bits-fix-01, *Update Attribute Flag Low Bits Clarification*

draft-ietf-idr-add-paths-guidelines-08, *Best Practices for Advertisement of Multiple Paths in IBGP*

draft-ietf-idr-best-external-03, *Advertisement of the best external route in BGP*

draft-ietf-idr-bgp-flowspec-oid-03, *Revised Validation Procedure for BGP Flow Specifications*

draft-ietf-idr-bgp-gr-notification-01, *Notification Message support for BGP Graceful Restart*

draft-ietf-idr-bgp-ls-app-specific-attr-16, *Application-Specific Attributes Advertisement with BGP Link-State*

draft-ietf-idr-bgp-ls-flex-algo-06, *Flexible Algorithm Definition Advertisement with BGP Link-State*

draft-ietf-idr-bgp-optimal-route-reflection-10, *BGP Optimal Route Reflection (BGP-ORR)*

draft-ietf-idr-error-handling-03, *Revised Error Handling for BGP UPDATE Messages*

draft-ietf-idr-flowspec-interfaceset-03, *Applying BGP flowspec rules on a specific interface set*

draft-ietf-idr-flowspec-path-redirect-05, *Flowspec Indirection-id Redirect* – localised ID

draft-ietf-idr-flowspec-redirect-ip-02, *BGP Flow-Spec Redirect to IP Action*

draft-ietf-idr-link-bandwidth-03, *BGP Link Bandwidth Extended Community*

draft-ietf-idr-long-lived-gr-00, *Support for Long-lived BGP Graceful Restart*

RFC 1772, *Application of the Border Gateway Protocol in the Internet*

RFC 1997, *BGP Communities Attribute*

RFC 2385, *Protection of BGP Sessions via the TCP MD5 Signature Option*

RFC 2439, *BGP Route Flap Damping*

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openconfig-bgp-peer-group.yang version 3.0.1, *OpenConfig BGP Peer Group Module*

openconfig-bgp-policy.yang version 4.0.1, *OpenConfig BGP Policy Module*

openconfig-if-aggregate.yang version 2.0.0, *OpenConfig Interfaces Aggregated Module*

openconfig-if-ethernet.yang version 2.0.0, *OpenConfig Interfaces Ethernet Module*

openconfig-if-ip.yang version 2.0.0, *OpenConfig Interfaces IP Module*

openconfig-if-ip-ext.yang version 2.0.0, *OpenConfig Interfaces IP Extensions Module*

openconfig-igmp.yang version 0.2.0, *OpenConfig IGMP Module*

openconfig-interfaces.yang version 2.0.0, *OpenConfig Interfaces Module*

openconfig-isis.yang version 0.3.2, *OpenConfig IS-IS Module*

openconfig-isis-policy.yang version 0.3.2, *OpenConfig IS-IS Policy Module*

openconfig-isis-routing.yang version 0.3.2, *OpenConfig IS-IS Routing Module*

openconfig-lacp.yang version 1.1.0, *OpenConfig LACP Module*

openconfig-lldp.yang version 0.1.0, *OpenConfig LLDP Module*

openconfig-local-routing.yang version 1.0.1, *OpenConfig Local Routing Module*

openconfig-mpls.yang version 2.3.0, *OpenConfig MPLS Module*

openconfig-mpls-ldp.yang version 3.0.2, *OpenConfig MPLS LDP Module*

openconfig-mpls-rsvp.yang version 2.3.0, *OpenConfig MPLS RSVP Module*

openconfig-mpls-te.yang version 2.3.0, *OpenConfig MPLS TE Module*

openconfig-network-instance.yang version 1.1.0, *OpenConfig Network Instance Module*

openconfig-network-instance-l3.yang version 0.11.1, *OpenConfig L3 Network Instance Module* – static routes

openconfig-packet-match.yang version 1.0.0, *OpenConfig Packet Match Module*

openconfig-pim.yang version 0.2.0 *OpenConfig PIM Module*

openconfig-platform.yang version 0.12.2, *OpenConfig Platform Module*

openconfig-platform-fan.yang version 0.1.1, *OpenConfig Platform Fan Module*

openconfig-platform-linecard.yang version 0.1.2, *OpenConfig Platform Linecard Module*

openconfig-platform-port.yang version 0.3.3, *OpenConfig Port Module*

openconfig-platform-transceiver.yang version 0.7.1, *OpenConfig Transceiver Module*

openconfig-procmon.yang version 0.4.0, *OpenConfig Process Monitoring Module*

openconfig-relay-agent.yang version 0.1.0, *OpenConfig Relay Agent Module*

openconfig-routing-policy.yang version 3.0.0, *OpenConfig Routing Policy Module*

openconfig-rsvp-sr-ext.yang version 0.1.0, *OpenConfig RSVP-TE and SR Extensions Module*

openconfig-system.yang version 0.9.1, *OpenConfig System Module*

openconfig-system-logging.yang version 0.3.1, *OpenConfig System Logging Module*

openconfig-system-terminal.yang version 0.3.0, *OpenConfig System Terminal Module*

openconfig-telemetry.yang version 0.5.0, *OpenConfig Telemetry Module*

openconfig-terminal-device.yang version 1.7.3, *OpenConfig Terminal Optics Device Module*

openconfig-vlan.yang version 2.0.0, *OpenConfig VLAN Module*

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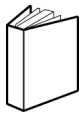

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