



# Topology-based Gateway Selection

This chapter provides information about the Topology-based Gateway (GW) Selection feature supported by both the Gn/Gp-SGSN and the S4-SGSN. The feature enables an SGSN to select a co-located GW node or topologically (geographically) closer GW nodes.

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## Feature Description

Topology-based GGSN or co-located P-GW selection is provided in the Gn/Gp-SGSN and topology-based P-GW and S-GW selection is provided in the S4-SGSN.

Selecting a co-located or topologically (geographically) close GW node results in lower latency and prevents unnecessary traversal of the packets in the network.

### For the Gn/Gp-SGSN

For the Gn/Gp-SGSN, topology-based GW selection is supported for the following call flows:

- **1st Primary Activation** to select the GGSN or co-located P-GW that is topologically (geographically) closer to the SGSN.
- **Subsequent Primary Activation** to select the GGSN or co-located P-GW that is topologically closer to the SGSN.



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**Important** If there are multiple PDN connections, topology-based selection begins on the first active GGSN or co-located P-GW.

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### For the S4-SGSN

For the S4-SGSN, topology-based GW selection is supported for the following call flows:

- **1st Primary Activation** to select the topologically closer or co-located S-GW / P-GW node pair.
- **Subsequent Primary Activation** to select the P-GW that is topologically closer or co-located to the already selected SGW.

- **Intra RAU** to select the S-GW that is topologically closer or co-located to the already selected P-GW.
- **Intra SRNS** to select the S-GW that is topologically closer or co-located to the already selected P-GW.
- **Inter New SGSN RAU** to select the S-GW that is topologically closer or co-located to the already selected P-GW.
- **Inter New SRNS** to select the S-GW that is topologically closer or co-located to the already selected P-GW.
- **IRAT** to select the S-GW that is topologically closer or co-located to the already selected P-GW.




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**Important** If there are multiple PDN connections, topology-based GW selection begins on the first active P-GW.

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## How It Works

Selection of a co-located node or a topologically closer node is based on string comparison of canonical node names included in two or more sets of records received in a DNS S-NAPTR query result.

A canonical node name (a multi-labeled substring of the hostname) is a unique name representing a node. For comparison, the canonical node names are derived from the hostnames received in the DNS records. For co-located nodes, the canonical node names strings must be exactly same. Each node may have different hostnames assigned to each supported interface based on service and protocol.

According to 3GPP TS 29.303 [4.3], hostnames must adhere to the following format:

```
<topon|topoff>.<single-label-interface-name>.<canonical-node-name>
```

for example:

```
topon.s5-gtp.pgw.dc.central.bang.kar.3gppnetwork.org.
```

- "topon" indicates that the canonical node name can be used for topology match.
- "second-label-interface-name" of "s5-gtp" indicates that this hostname belongs to S5 interface supporting GTP protocol.
- "canonical-node-name" is the portion "pgw.dc.central.bang.kar.3gppnetwork.org"

The canonical node name is obtained by stripping off the first two labels.

## First Primary Activation - Gn/Gp-SGSN

Topology matching is applicable only for primary activation for the Gn/Gp-SGSN and is based primarily on canonical node name comparison. Canonical node name for the SGSN must be defined as part of the SGSN Global configuration (see *Configuring Topology-based GW Selection for Gn/Gp-SGSN*). The canonical node names for the GGSN and/or the P-GW are the substring of hostnames received in the DNS results with query using APN-FQDN. Topology-based GW selection can only be achieved in the Gn/Gp SGSN through S-NAPTR query, which must be enabled as part of the feature configuration. If the SGSN's canonical node name is not configured, then GW selection will proceed as though topology is not enabled.

## Primary Activation - S4-SGSN

First primary activation involves selection of both the P-GW and S-GW nodes.

If "topology" is configured (see *Configuring Topology-based GW Selection for S4-SGSN*), then the S4-SGSN shall apply topology-based selection for the P-GW and the S-GW node selection. If "weight" is configured, then the highest degree node pair is selected. If CSR fails, then the next highest degree node pair is selected, which maybe a different P-GW and S-GW node pair than the pair previously selected.

## Primary Activation for Subsequent PDN

For a UE, all PDN connections must use the same S-GW. So, in subsequent PDN connections the S-GW is already selected. Therefore, topology will be applied to find the closest P-GW to the selected S-GW.

If the 'topology' option is configured (part of **gw-selection** configuration - see *Configuring Topology-based GW Selection for S4-SGSN*) and the hostname for the existing S-GW has the "topoff" prefix, then the co-located S-GW/P-GW node will be selected, if available.

## Intra RAU, New SGSN RAU, Intra SRNS, New SRNS, IRAT

Assuming 'topology' option is configured (see *Configuring Topology-based GW Selection for S4-SGSN*) then for all of these procedures selection of the S-GW node will be based on the available P-GW. Therefore, the SGSN will do DNS with RAI-FQDN to get the list of S-GW hostnames and apply topology matching to determine the hostname of an available P-GW.

Before performing the topology matching, the SGSN checks to determine if the existing S-GW address is available in the DNS result. If the S-GW address is listed as available, then the SGSN continues with the S-GW. If the S-GW address is not listed as available in the query results, then the SGSN looks for an S-GW that is co-located or a topologically-closer to the available P-GW.

We must also consider how the P-GW hostname is selected when multiple PDN connections are available. Currently, the SGSN selects the first available valid P-GW hostname from the list of PDN connections. For in-bound roamers, the PDN connection belongs to the home network P-GW will not be used for topology matching.

## Limitations

- Topology matching is not applicable for inbound roamers with home routed PDN connections, as the hostnames are under different operator's administrative control.
- Topology-based GW selection may not be applicable if the P-GW and/or the S-GW address is locally configured or if the static P-GW address is received from the HSS (because the hostname/canonical node name would not be available for topology matching).

## Standards Compliance

This feature complies with the following standards:

- TS 23.060 version 10
- TS 29.303 version 10
- TS 29.274 version 10

# Configuring Topology-based GW Selection

Topology-based GW selection is configured via the SGSN's CLI.

Configuration for this feature includes one or more of the following tasks, depending on the type of SGSN:

- enabling topology-based selection,
- enabling co-location-based selection,
- enabling weight (considering degree and order of GW listing in the DNS record) as a selection factor,
- configuring GW-type preference for selection,
- configuring canonical name (Gn/Gp-SGSN only),
- enabling S-NAPTR queries for GGSN selection (Gn/Gp-SGSN only).

For details on all of the command listed below, refer to the release-specific *Command Line Interface Reference*.

## Configuring GW Selection

Configuring this feature is done at the call control profile level for both S4-SGSN and Gn/Gp-SGSN.

The **gw-selection** command in the call control profile configuration mode configures the parameters controlling the gateway selection process for both the Gn/Gp-SGSN and the S4-SGSN.




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**Important** When configuring for a Gn/Gp-SGSN, use the P-GW options to identify either a GGSN or a co-located P-GW.

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```
configure
  call-control-profile profile_name
    gw-selection { { co-location | pgw weight | sgw weight | topology
  } [ weight [ prefer { pgw | sgw } ] ] }
  end
```

Notes:

- **co-location** enables the SGSN to select topologically closer P-GW and S-GW nodes, irrespective of the 'topon' or 'topoff' prefix being present in the hostname received in the results of the DNS query.
- **pgw weight** enables the SGSN to apply load balancing during selection of P-GW nodes.
- **sgw weight** enables the SGSN to apply load balancing during selection of S-GW nodes.
- **topology** enables the SGSN to select topologically closer P-GW and S-GW nodes, only when 'topon' prefix is present in the hostname received as part of the DNS query results.
- **weight** enables load balancing during selection of a node. When topology is applicable, **weight** instructs the SGSN to apply weight-based selection only on node pairs with the same degree and order.
- **prefer** instructs the SGSN to consider weight values for preferred GW type (P-GW or S-GW) during the first primary activation.

## Verifying the GW Selection Configuration

Use the following command to display and verify the GW selection configuration in the call control profile configuration. The output of this command displays all of the profile configuration and the GW-selection portion is towards the bottom of the display.

```
show call-control-profile full name profile_name
```

## Configuring DNS Queries for the Gn/Gp-SGSN

Configuring the required S-NAPTR query functionality for the Gn/GP-SGSN involves enabling the S-NAPTR query function and

Use the follow commands to enable the SGSN to use GGSN S-NAPTR queries. This capability is defined on a per APN basis.

```
configure
  apn-profile profile_name
    apn-resolve-dns-query snaptr [ epc-ue    non-epc-ue ]
  end
```

Notes:

- **epc-ue** - S-NAPTR queries applicable for EPC-capable UE.
- **non-epc-ue** - S-NAPTR queries applicable for non-EPC-capable UE.
- If neither of the keywords are included, then S-NAPTR query is applicable to all UE, both EPC-capable UE and non-EPC capable UE.

Use the following commands to identify the context where the DNS-client is configured. If this is not done then the S-NAPTR DNS query will look for the DNS-client configuration in the context where the SGTP service is configured.

```
configure
  call-control-profile profile_name
    dns-pgw context context_name
  end
```




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**Important** Issuing this series of commands assumes that you have already created a DNS-client instance with the **dns-client** command in the Context configuration mode and you have configured the DNS-client with the commands in the DNS-Client configuration mode.

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## Verifying the DNS Queries Configuration for the Gn/Gp-SGSN

Use the following commands to display and verify the S-NAPTR DNS Query configuration in the APN profile configuration and the call control profile configuration.

```
show apn-profile full name profile_name
show call-control-profile full name profile_name
```

## Configuring DNS Queries for the S4-SGSN

Use the following commands to identify the context where the DNS-client is configured. If this is not done then the S-NAPTR DNS queries based on either APN-FQDN or RAI-FQDN will look for the DNS-client configuration in the context where the eGTP service is configured.

```
configure
  call-control-profile profile_name
    dns-pgw context context_name
    dns-sgw context context_name
  end
```




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**Important** Issuing this series of commands assumes that you have already created a DNS-client instance with the **dns-client** command in the Context configuration mode and you have configured the DNS-client with the commands in the DNS-Client configuration mode.

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**Important** It is recommended to execute the S4 SGSN configuration commands during the maintenance window. After configuring the node, re-start the node to activate the configuration commands. This will ensure that the node is in a consistent state and S4 SGSN service instability scenarios are avoided.

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## Verifying the DNS Queries Configuration for the S4-SGSN

Use the following commands to display and verify the S-NAPTR DNS Query configuration in the call control profile configuration.

```
show call-control-profile full name profile_name
```

## Configuring the Canonical Node Name for the Gn/Gp-SGSN

In order for the Gn/Gp-SGSN to support Topological Gateway Selection, use the following commands to define the SGSN's canonical node name in the SGSN's configuration. (This is not needed for the S4-SGSN).

```
configure
  sgsn-global
    canonical-node-name canonical_node_name
  end
```

Notes:

- *canonical\_node\_name* is a fully or properly qualified domain name for example `sgsn.div.bng.kar.3gppnetwork.org`

## Verifying the Canonical Node Name Configuration

Use the following commands to display and verify the canonical node name configuration. It is easy to find as it is the first item in the display.

```
show sgsn-mode
```

# Monitoring Topology-based GW Selection

The following show command displays the hostname(s) for selected S-GW and P-GW. A small sampling of the output is displayed as an example.

## show subscribers [ gprs-only | sgsn-only ] full

```
SGW u-teid: [0x80000001] 2147483649
SGSN u-teid: [0x80000001] 2147483649
SGW HostName: topon.s4.sgw.campus.bng.kar.3gppnetwork.org
PGW HostName: topon.s5.pgw.campus.bng.kar.3gppnetwork.org
Charging Characteristics:
Normal Billing
```

show subscribers [ gprs-only | sgsn-only ] full