

# PDI Optimization


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# Feature Summary and Revision History

## Revision History

**Note** Revision history details are not provided for features introduced before release 21.24.

| Revision Details | Release |
|---|---|
| First introduced | Pre 21.24 |

# Feature Description

The Packet Detection Information (PDI) Optimization feature allows the optimization of PFCP signaling, through Sx Establishment and Sx Modification messages, between the Control Plane and the User Plane function. Without PDI Optimization, the following common parameters are repeated in the PDI of all Packet Detection Rules (PDRs), for a given bearer, resulting in an unwanted increase in signaling between Control Plane and User Plane:

- Local F-TEID
- Network Instance
- UE IP address

- The PDI Optimization is achieved by consolidating the common parameters, in the PDI of the PDRs, into a single container that is called the Traffic Endpoint (Traffic Endpoint ID). The consolidated parameters from multiple PDRs are then referred to the Traffic Endpoint.
- The PDI Optimization is a CLI-controlled feature, and supported over the Sxa, Sxb, Sxc, Sxab, and N4 interfaces.

## Relationships

The PDI Optimization feature is a prerequisite for the following features:

- GTP-U Error Indication Support on User Plane.
- Sx Bulkstats
- CUPS Bulkstats Support

# How It Works

The Traffic Endpoint ID is unique within a PFCP session. When a PDI refers to a Traffic Endpoint, the parameters that are in the Traffic Endpoint is not provided in the PDI once again. The Control Plane function updates the Traffic Endpoint whenever applicable.

If a Traffic Endpoint is updated, all the PDRs that refer to this Traffic Endpoint in the User Plane function uses the updated information.

If the F-TEID allocation is performed in the User Plane function, the User Plane function allocates and stores the F-TEID associated to the Traffic Endpoint. When the User Plane function provides the allocated F-TEID to the Control Plane function in the PFCP Session Establishment response or PFCP Session Modification response message, the Control Plane function updates the Traffic Endpoint information that is stored in the Control Plane function with the received F-TEID.

The Control Plane function uses the Traffic Endpoint ID created in a different PFCP message only after getting the confirmation from the User Plane function of the Traffic Endpoint ID creation.

If the Control Plane function deletes a Traffic Endpoint, the User Plane function deletes all the PDRs that refer to the Traffic Endpoint that was deleted by Control Plane function. For Evolved Packet Core (EPC), the Remove Traffic Endpoint IE is used to delete a bearer for which multiple PDRs exist (with the same Traffic Endpoint ID).

The Traffic Endpoints is used as a mechanism to identify the bearers uniquely for a given Sx session on the User Plane. This is achieved with the help of Traffic Endpoint IDs that are associated with the PDRs of a bearer.

## PDI Optimization Changes on Control Plane

A new container, called Traffic Endpoint, is supported to carry the repeated PDI information of a given bearer. Each Traffic Endpoint is associated with a Traffic Endpoint ID. This ID is unique for a given Sx Session.

A new IE, Create Traffic Endpoint IE, is supported as part of Sx Establishment Request.

Following are the new IEs supported as part of Sx Modification Request:

- Create Traffic Endpoint IE
- Update Traffic Endpoint IE
- Remove Traffic Endpoint IE

Create PDR supports a new IE, Traffic Endpoint ID, that identifies either the ingress or the egress Traffic Endpoint of a bearer to which this PDR is associated.

A new IE, Created Traffic Endpoint IE, is supported as part of Sx Establishment Response and Sx Modification Response message.

## Create Traffic Endpoint IE

Following are the IEs in a Create Traffic Endpoint IE that are supported for a Pure-P call:

- Traffic Endpoint ID
- Local F-TEID
- Network instance
- UE IP address

Following are the IEs in a Create Traffic Endpoint IE that are supported for a Pure-S call:

- Traffic Endpoint ID
- Local F-TEID

**NOTE**: The Network instance and UE IP address IEs are currently not supported for a Pure-S call.

For a Collapsed call, Sxa Traffic Endpoints has IEs that are relevant to S-GW and Sxb Traffic Endpoints has IEs that are relevant to P-GW.

In addition to the 3GPP standards defined IEs, a private IE called "Bearer Info IE", is added to the Create Traffic Endpoint which includes:

- QCI of the bearer being created.
- ARP of the bearer being created.
- Charging ID of the bearer being created.

For a Pure-S call, there are two Traffic Endpoints that are created for each bearer of that PDN:

1. Create Traffic Endpoint for Ingress Traffic Endpoint, that is sent for the ingress F-TEID and referred by ingress S-GW PDR of the bearer.
2. Create Traffic Endpoint for Egress Traffic Endpoint, that is sent for the egress F-TEID and referred by egress S-GW PDR of the bearer.

For a Pure-S call, a bearer is uniquely identified on the User Plane that is based on Ingress and Egress Traffic Endpoint IDs of the bearer. The Traffic Endpoints also store the QCI, ARP, and Charging ID of the bearer.

For a Pure-P call, only one Traffic Endpoint is created for each bearer of that PDN. Create Traffic Endpoint for Ingress Traffic Endpoint, that is sent for ingress F-TEID and referred by ingress PDRs of the bearer. There is no separate egress Traffic Endpoint that is created for a Pure-P call as no Tunnel Endpoint ID is allocated on the P-GW egress. The same Traffic Endpoint is referred by both ingress and egress PDRs of a bearer. A

bearer is uniquely identified on the User Plane that is based on the Traffic Endpoint ID of the bearer. The Traffic Endpoint also stores the QCI, ARP, and Charging ID of the bearer.

For a Collapsed call, there are two Traffic Endpoints that are created for the S-GW leg of the call for each bearer. So, two Create Traffic Endpoints are sent for Ingress and Egress. The Sxa PDRs refer to these traffic endpoints based on the direction (ingress or egress). Only one Traffic Endpoint is created for the P-GW leg of the call for each bearer. The same Traffic Endpoint ID is referred by all Sxb PDRs of the bearer. For P-GW, Create Traffic Endpoint is sent for the ingress. The Traffic Endpoint IDs of Sxa and Sxb PDRs identify the bearer.

## Created Traffic Endpoint IE

This IE is present in Sx Establishment/Sx Modification Response to inform Control Plane about the F-TEIDs that were locally allocated by the User Planes for the various Traffic Endpoints that were created.

Following are the IEs in a Created Traffic Endpoint IE:

- Traffic Endpoint ID
- Local FTEID

The information that is received in Created Traffic Endpoint IE is processed by the Control Plane, and the F-TEIDs that are allocated by the User Plane are stored in the Control Plane for ingress and egress accordingly.

## Update Traffic Endpoint IE

This IE is present in Sx Modification Request to update the Traffic Endpoint information on the User Plane.

Following are the IEs in an Update Traffic Endpoint IE:

- Traffic Endpoint ID
- Local FTEID
- Network Instance
- UE IP address
- In addition to the 3GPP standards defined IEs, a private IE called "Bearer Info IE", is added to the Create Traffic Endpoint which includes:
- QCI of the bearer
- ARP of the bearer
- Charging ID of the bearer

**NOTE**: Currently, the Update Traffic Endpoint IE supports only the update of Private IE extensions, such as the Bearer Info IE. There are no use-cases wherein update of other information, such as Local FTEID, Network Instance, UE IP address, is required.

When the QCI/ARP of a particular bearer EPS-Bearer Identity (EBI) is modified, then the modified QCI/ARP along with the Charging ID is communicated to the User Plane with the help of Update Traffic Endpoint ID. A given Traffic Endpoint ID can be updated only if it was successfully created on the User Plane.

## Remove Traffic Endpoint IE

This IE is present in Sx Modification Request to remove a traffic endpoint. Traffic Endpoint ID is included in the Remove Traffic Endpoint IE. A given Traffic Endpoint ID can be removed only if it is successfully created on the User Plane.

For Pure-S, Pure-P, and Collapsed call, when a bearer is deleted on the Control Plane, the Traffic Endpoints that are associated with the bearer are removed with Remove Traffic Endpoints. There is no explicit requirement to send Remove PDRs and Remove FARs on that bearer.

On the User Plane, for a Pure-S call, Remove Traffic Endpoints deletes all the PDRs, FARs, and URRs of that bearer. For Pure-P and Collapsed call, Remove Traffic Endpoints deletes all the PDRs, FARs, QERs, and URRs of that bearer.

## PDI Changes in Create PDR

When PDI Optimization is enabled for the PDN, then the Traffic Endpoint ID is set in the PDI field of all PDRs of the bearers of the PDN. The PDI fields, such as F-TEID, PDN Instance, UE IP address, and so on, are not supposed to be filled and so, these fields are validated in the User Plane and error messages are posted in case of any validation failures. This is applicable for all interfaces, such as Sxa, Sxb, Sxab, N4, and Sxc.

# PDI Optimization Changes on User Plane

## Handling of Create Traffic Endpoint

When a Create Traffic Endpoint is received, the contents of the IE are validated for correctness. If validation fails, then an error message is sent back to the Control Plane.

Validations fail in the following cases:

- Basic IE validation failures.
- Traffic Endpoint exists with this Traffic Endpoint ID.
- CH-bit not set in the F-TEID IE inside Traffic Endpoint.
- PDN Instance is not valid.
- UE IP address is not valid.

When a Create Traffic Endpoint is successfully processed, then a local F-TEID is allocated by the User Plane and it is associated with the Traffic Endpoint. The Created Traffic Endpoint is sent back to Control Plane for this Traffic Endpoint with the F-TEID information and Traffic Endpoint ID.

When a Create Traffic Endpoint list is processed on the User Plane in Sx Establishment Request, PDI optimization is enabled for the lifetime of the Sx Session which cannot be changed midway.

## Handling of Update Traffic Endpoint

When an Update Traffic Endpoint is received, the contents of the IE are validated for correctness. If validation fails, then an error message is sent back to the Control Plane.

Validations fail in the following cases:

- Basic IE validation failures.

- Traffic Endpoint with its Traffic Endpoint ID does not exist.

**NOTE**: Currently, Update Traffic Endpoint updates only bearer information, such as QCI, ARP, and Charging ID on the User Plane. Update is not supported for any other Traffic Endpoint parameters.

## Handling of Remove Traffic Endpoint

When a Remove Traffic Endpoint is received, the contents of the IE are validated for correctness. If validation fails, then an error message is sent back to the Control Plane.

Validations fail in the following cases:

- Basic IE validation failures.
- Traffic Endpoint with its Traffic Endpoint ID does not exist.

When a Remove Traffic Endpoint is received, the PDRs associated with the Traffic Endpoint, FARs associated with the PDR, QERs associated with the PDR, and URRs associated with PDR are also removed.

To remove a bearer, the Control Plane sends Remove Traffic Endpoints for the Traffic Endpoints that are associated with the bearer resulting in the cleanup of the bearer-associated data on the User Plane.

The Control Plane does not explicitly send any Remove PDRs, Remove FARS, Remove QERS, or Remove URRs for a bearer removal. However, if the Control Plane does send Remove PDRs, Remove FARS, Remove QERS, or Remove URRs with Remove Traffic Endpoints, the message is accepted and successfully processed.

## Handling of Create PDR

When Sx Session has the PDI Optimization enabled, the Traffic Endpoint ID is set for Create PDR. If not, an error response is sent back to the Control Plane. The Create PDR validation fails in the following cases:

- Basic IE validation failures.
- Create PDR does not have Traffic Endpoint ID set in the PDI IE.
- Create PDR has valid F-TEID IE in PDI IE.
- Create PDR has valid PDN Instance IE in PDI IE.
- Create PDR has valid UE IP address IE in PDI IE.

For a Sx Session with PDI optimization disabled, the Create PDR is validated for various other fields. If Traffic Endpoint ID is valid in PDI, then an error response is sent back to the Control Plane as Traffic Endpoint ID should not be present for a Sx Session with the PDI optimization being disabled.

# Session Recovery and ICSR

## Control Plane

Session Recovery and ICSR are supported for the Traffic Endpoint IDs of all bearers of a PDN. The Traffic Endpoint IDs are recovered for all bearers of a given PDN. This support is provided for Pure-S, Pure-P, and Collapsed call. With this, PDI optimization enabled status for a PDN is also recovered. Full Checkpoint is used for check-pointing and recovery of the Traffic Endpoints IDs of bearers.

### User Plane

Session Recovery and ICSR are supported for the Traffic Endpoints on the User Plane for all bearers. All the Traffic Endpoints, that are associated with a given Sx Session, are recovered. For a given Traffic Endpoint, the associated PDR list is also recovered. For a given PDR, the associated Traffic Endpoint ID is recovered.

## Standards Compliance

The PDI Optimization feature complies with the following standard: 3GPP TS 29.244 V15.5.0 (Interface between the Control Plane and the User Plane Nodes).

## Limitations

The PDI Optimization feature has the following limitations:

- The Network instance and UE IP address IEs are currently not supported for a Pure-S call.
- The Update Traffic Endpoint IE supports only the update of Private IE extensions, such as the Bearer Info IE. Update of other information, such as Local F-TEID, Network Instance, UE IP address, are not supported.
- The Update Traffic Endpoint updates only bearer information, such as QCI, ARP, and Charging ID on the User Plane. Update is not supported for any other Traffic Endpoint parameters.

# Configuring the PDI Optimization Feature

This section describes how to configure the PDI Optimization feature.

## Enabling PDI Optimization

Use the following CLI commands to enable the feature.

```
configure
  context context_name
    sx-service service_name
      [ no ] sx-protocol pdi-optimization
      end
```

**NOTES**:

- **no**: Disables PDI optimization.
- By default, the CLI command is disabled.
- PDI Optimization is enabled or disabled at PDN level. PDI Optimization is enabled for each PDN based on the configuration in sx-service. The PDN is PDI Optimization-enabled if the configuration is enabled while processing Sx Establishment Request on the Control Plane.
- Configuration changes will not have any effect on the PDN. The configuration that is applied while processing Sx Establishment Request will be maintained throughout the lifetime of the PDN. In a multi-PDN call, each PDN has the configuration applied while PDN is set up.

- On the User Plane, there is no separate configuration to determine whether the PDN has PDI Optimization-enabled. When Create Traffic Endpoint IE is received in Sx Establishment Request for a Sx session, then the Sx session is considered to have PDI Optimization-enabled throughout the lifetime of the session. This will not change dynamically midway, and validations are done accordingly. In case of any validation failures, Error Response is sent back to the Control Plane.
- When there are multiple Create Traffic Endpoint IEs with the same Traffic Endpoint ID, the first Create Traffic Endpoint IE is processed, and rest are ignored. The same behavior is applicable for Created Traffic Endpoint IE, Update Traffic Endpoint IE, and Remove Traffic Endpoint IE.

## Verifying the PDI Optimization Feature Configuration

To verify if the PDI Optimization feature is enabled or disabled, use the **show sx-service all** CLI command. The output of this show command has been enhanced to display the following:

- SX PDI Optimisation: [Enabled/Disabled]

# PDI Optimization OAM Support

This section describes operations, administration, and maintenance information for this feature.

## Show Command Support

The following show CLI commands are available in support of PDI Optimization feature.

### show subscribers user-plane-only callid <call_id> pdr all

The output of this CLI command has been enhanced to display the following field: Associated Create Traffic Endpoint-ID(s)

### show subscribers user-plane-only callid <call_id> pdr full all

The output of this CLI command has been enhanced to display the following field:

- Create Traffic Endpoint-ID
  - Bearer QOS
    - QCI
    - ARP
    - Charging Id