Overview

The Evolved Packet Core (EPC) network is evolving and moving toward Control User Plane Separation (CUPS) based architecture where User-Plane and Control-Plane are separate node for P-GW, S-GW, and TDF products. The User Plane and Control Plane combined together provide functionality of a node for other elements in the EPC network. However, keeping them separate has numerous advantages from the network point of view – support different scaling for Control-Plane and User-Plane, support more capacity on per session level in User-Plane, and so on.

This chapter highlights high-level details, call flows, and configurations related to the Sx Interface implementation for P-GW, S-GW, and SAEGW products.

- Product Description, on page 1
- How It Works, on page 1

Product Description

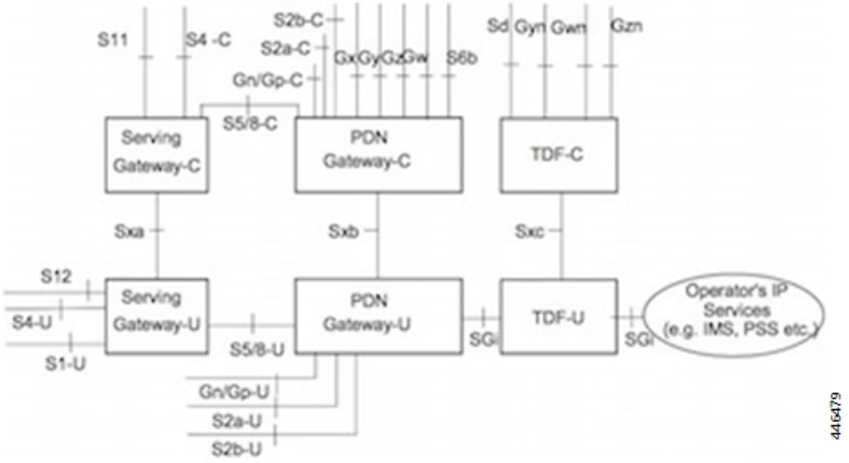
Sx is the interface between the Control-Plane and User-Plane in a split P-GW, S-GW, and TDF architecture in an Evolved Packet Core (EPC) that provides Packet Forwarding Control Protocol (PFCP) service. One of the main tasks of the Sx interface is to enable the Control-Plane function to instruct the User-Plane function about how to forward user data traffic.

How It Works

The following section provides a brief overview of the Sx service works.

Architecture

The following illustration provides a reference model in the case of separation between Control-Plane and User-Plane.



Note

- The -C or -U suffix appended to S2a, S2b, S5 and S8 existing reference points only indicate the Control-Plane and User-Plane components of those interfaces.
- The architecture only depicts the case when the Control-Plane and User-Plane functions of all S-GW, P-GW and TDF nodes are split. It also supports scenarios where the Control-Plane and User-Plane function of only one of these nodes is split while the Control-Plane and User-Plane function of the other interfacing node is not split. For example, it supports a scenario where the Control-Plane and User-Plane of the P-GW is split while that of the S-GW is not split. This split architecture of a node does not put any architectural requirements on the peer nodes with which it interfaces.
- TDF is an optional functional entity.

The following sections describe the services supported on the Sx Interface.

Sx Service

The Sx Service provides an interface mentioned as the following reference points:

- **Sxa:** Reference point between SGW-C and SGW-U.
- **Sxb:** Reference point between PGW-C and PGW-U.
- **Sxc:** Reference point between Traffic Detection Function-C (TDF-C) and TDF-U.

The Sx service is agnostic of the interface it supports. A single Sx service instance is capable of running on Sxa, Sxb, and Sxb interfaces. The Sx service runs in two different modes:

- Sx-Control instance
- Sx-Data instance

The Sx service is associated with the SAEGW service at the Control-Plane and User-Plane service at the User-Plane. There is one-to-one mapping of the Sx service with the Control-Plane and Data Plane.

The association of the SAEGW service occurs as follows:

```
saegw-service saegw-service
      associate sgw-service sgw-service
      associate pgw-service pgw-service
      associate gtpu-service control_gtpu up-tunnel
      associate sx-service sxc
```

The association of the User-Plane service occurs as follows:

```
user-plane-service user-plane-service
      associate gtpu-service sx-gtpu-service pgw-ingress
      associate gtpu-service sx-sgw_ingress_gtpu sgw-ingress
      associate gtpu-service sx-sgw_egress_gtpu sgw-egress
      associate gtpu-service control_gtpu cp-tunnel
      associate sx-service sxu
```

At the Control-Plane for SAEGW service (legacy SAEGW Service), CUPS-enabled flag in EGTPC service determines whether SAEGW is CUPS enabled or not. If SAEGW service is CUPS enabled, then Sx service is a mandatory parameter for SAEGW service to start. Only having association at the SAEGW service does not make Sx a mandatory parameter for SAEGW service.

If Sx service is a mandatory parameter (because of CUPS-enabled flag), then Sx service stop and Sx IP address brings down the SAEGW service.

For information about configuring the Sx Service, see the “Configuring Sx Service” section.

Sx-u Interface

This section explains the interaction between the Sx-u Interface, User-Plane-service, and SAEGW-service.

Sx-u is the User-Plane interface over the Sxa and Sxb reference points. The protocol used on the Sx-u Interface is GTP-U. Both IPv4 and IPv6 transport is supported.

At the User-Plane, Sx-u service is a mandatory parameter for User-Plane service to start. Being a mandatory parameter, Sx-u Interface stops and Sx-u IP address brings down the User-Plane service.

The Control-Plane establishes one Sx-u tunnel per function or session as described in the section below.

Sx-u Tunnel per PDN session

Control-Plane establishes one Sx-u tunnel per PDN session for router advertisement and router solicitation messages.

In this scenario, Control-Plane uses the existing Sx tunnel per PDN (created during GTP-C initial attach procedure) for installing Packet Detection Rule (PDR) or Forwarding Action Rule (FAR) related to data forwarding between the Control-Plane and User-Plane functions on the User-Plane.

For information about configuring the Sx-u Interface, see the *Configuring Sx-u Interface* section.

Sx Demux

The Sx Demux provides session de-multiplexing functionality on the Data plane. One instance of Sx Demux is started per context. When implemented, the Sx Demux supports the following behavior:

1. Works as Sx Control-Plane Demux when implemented on the Control-Plane and supports handling of Node level messages such as Prime PDF Management Messages.
2. Works as Sx Data Plane Demux when implemented on the Data Plane and supports:
    - Handling of Session level messages such as Session Establish Request.
    - Handling of Session level messages such as Session Establish Request.

3. Works as Sx Data Pane Demux performing load balancing of Session Establish Request between all Session Managers.
4. Supports default PFCP packet receiver port 8805.

The Sx service is associated with SAEGW service at Control-Plane and is associated with User-Plane Service at User-Plane. Sx Demux is initiated when the first Sx service is created with the minimum mandatory parameter in the context.

The Sx Demux functions as follows:

- **When working as Sx Data Demux**

  The Session Manager (Data Plane) sends the add session response indicating addition of new session and delete session request on deletion of session on Session Manager. Sx Data Demux maintains session count per session manager.

- **When working as Sx Control Demux**

  The Sx Control Demux uses Prime PDF Management Messages (proprietary messages) to communicate static and dynamic rule configuration from Control-Plane to associated Data plane.

Proprietary Sx Messages Information

Proprietary Prime PFD message format

	Bits							
Octets	8	7	6	5	4	3	2	1
1	Version			Spare	Spare	Spare	MP=0	S=0
2	Message Type							
	47 Prime PFD Management Request							
	48 Prime PFD Management Response							
3	Message Length (1st Octet)							
4	Message Length (2nd Octet)							
5	Sequence Number (1st Octet)							
6	Sequence Number (2nd Octet)							
7	Sequence Number (3rd Octet)							
8	Spare							

Cisco PFD Management Request

Information elements	**P**	**Condition / Comment**	**IE Length**	**IE ID**

Config Action	M	1 – Add configuration 2 – Delete Configuration	1 Byte	202
Co-Relation id	M	unique number which will represent transaction id. During Split buffer message, correlation id will be same so that receiver can combine buffer.	2 Byte	203
Number of Sub Part	O	N – Indicates Total number of sub parts	1 Byte	204
Sub Part index	O	Indicates the part number going into this message.	1 Byte	205
Content TLV	M	Type – Indicates Rule-Def, Charging Action or Action priority line - 1 Byte Length – Length of Content - 2 Byte Value – Actual Buffer conent - Max size 3000 Bytes	3003 byte	 206

Cisco PFD Management Response

Information elements	P	Condition / Comment	IE Length	IE ID
PFCP Cause	M	1 Success 0 Failure	1 byte	19
CoRelation id	M	Unique number – same as request message. Indicates to sender that this correlation has been received.	2 byte	203

Sub Part Index	O	Indicates the part number received into this message. This will be only present when Split mode is used.	1 byte	205

Header information

Proprietary Sx Stats Query Req/Rsp/Ack

Table 1: PFCP Header format for Node level Query Message

Octets	8	7	6	5	4	3	2	1
1	Version			Spare	Spare	Spare	MP=0	S=0
2	Message Type 44 Sx Stats Query Request 45 Sx Stats Query Response 46 Sx Stats Query Ack/NAck							
3	Message Length (1st Octet)							
4	Message Length (2nd Octet)							
5	Sequence Number (1st Octet)							
6	Sequence Number (2nd Octet)							
7	Sequence Number (3rd Octet)							
8	Spare							

PFCP Header format for Subscriber/Session level Query Message

Octets	8	7	6	5	4	3	2	1
1	Version			Spare	Spare	Spare	MP=0	S=1
2	Message Type 44 Sx Stats Query Request 45 Sx Stats Query Response							
3	Message Length (1st Octet)							
4	Message Length (2nd Octet)							
5	Session Endpoint Identifier (1st Octet)							
6	Session Endpoint Identifier (2nd Octet)							
7	Session Endpoint Identifier (3rd Octet)							
8	Session Endpoint Identifier (4th Octet)							

9	Session Endpoint Identifier (5th Octet)
10	Session Endpoint Identifier (6th Octet)
11	Session Endpoint Identifier (7th Octet)
12	Session Endpoint Identifier (8th Octet)
13	Sequence Number (1st Octet)
14	Sequence Number (2nd Octet)
15	Sequence Number (3rd Octet)
16	Spare

IEs and Message Formats

Stats reporting framework shall use the messages and IE types as outlined below.

Table 2: Information Elements in Sx Stats Query Request Message

Information elements	P	Condition / Comment	IE Type	IE ID
Correlation ID	M	Unique number, which will represent transaction ID	Correlation ID	203
Stats Request	C	This IE shall be present if the Node Report Type indicates a statistics report request.	Stats request	209

Table 3: Information Elements in Sx Stats Query Response Message

Information elements	P	Condition / Comment	IE Type	IE ID
PFCP Cause	M	1 Success , 0 Failure	PFCP Cause	
Correlation ID	M	Unique number, which will represent transaction ID. During Split buffer message, Correlation ID will be same for all the messages so that receiver can identify uniquely the request to which the responses correspond.	Correlation ID	203

Stats response	C	This IE shall be present if the Node Report Type indicates a statistics report response.	Stats response	212

Table 4: Information Elements in Sx Stats Query Ack/NAck

Information elements	P	Condition / Comment	IE Type	IE ID
Correlation ID	M	Unique number, which will represent transaction ID.	Correlation ID	203
Stats Ack/NAck	M	This IE shall be present to inform Ack/NAck to peer.	Stats response ACK/NACK	213

Sx Interface Private Information Element (IE) List

IE Type: 176

IE Name: PFCP_IE_QER_BURST_SIZE

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 176 (decimal)							
3 to 4	Length = n							
5 to 8	Uplink burst							
9 to 12	Downlink burst							

IE Type: 177

IE Name: PFCP_IE_QER_CONFORM_ACTION

IE Format and Encoding Information

	Bits

Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 177 (decimal)							
3 to 4	Length = n							
5 to 5	Uplink action							
	Spare: 3			val: 5				
6 to 6	Downlink action							
	Spare: 3			val: 5				
7 to 7	Uplink DSCP value							
8 to 8	Downlink DSCP value							

IE Type: 178

IE Name: PFCP_IE_QER_EXCEED_ACTION

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 178 (decimal)							
3 to 4	Length = n							
5 to 5	Uplink action							
	Spare: 3			val: 5				
6 to 6	Downlink action							
	Spare: 3			val: 5				
7 to 7	Uplink DSCP value							
8 to 8	Downlink DSCP value							

IE Type: 192

IE Name: PFCP_IE_SRCIP

IE Format and Encoding Information

	Bits

Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 192 (decimal)							
3 to 4	Length = n							
5 to 5	Spare: 5					is_mpl:1	is_v4:1	is_v6:1
6 to 9	Ipv4 Address							
10 to 25	Ipv6 Address							
26 to 26	MPL							

IE Type: 198

IE Name: PFCP_IE_EXTENDED_INTR_INFO

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 198 (decimal)							
3 to 4	Length = n							
5 to 5	Spare: 6						Xid : 1	Poi_id : 1
6 to 9	Poi id Value							
10 to 137	Xid Value							

IE Type: 199

IE Name: PFCP_IE_SECONDARY_PDR_ID

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 199 (decimal)							
3 to 4	Length = n							
5 to 6	Secondary PDR ID							

IE Type: 200

IE Name: PFCP_IE_EXTENDED_APPLY_ACTIONS

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 200 (decimal)							
3 to 4	Length = n							
5 to 5	EXTENDED_APPLY_ACTIONS							

IE Type: 201

IE Name: PFCP_IE_UPDATE_ADDNL_FORW_PARAMS

IE Format and Encoding Information

Octet 1 and 2	Update Additional Forwarding Parameters IE Type = 201 (decimal)					
Octets 3 and 4	Length = n					
Information elements	P	Condition / Comment	Appl.			IE Type
			Sxa	Sxb	Sxc	
Destination Interface	C	This IE will be provided only if it is changed. When present, it indicates the destination interface of the outgoing packet.	X	X	X	Destination Interface
Outer header removal	C	This IE will be provided only if it is changed.	X	X	-	
Outer Header Creation	C	This IE will be provided only if it is changed.	X	X	-	Outer Header Creation

Outer header marking	C	This IE will be provided only if it is changed.			-	
Forwarding Policy	C	This IE will be provided only if it is changed.	-	X	X	Forwarding Policy

Sx Message(s) Using the IE: Update FAR IE within Sx Session Modification Request.

IE Type: 202

IE Name: PFCP_IE_CONFIG_ACTION

IE Format and Encoding Information

Octet 1 and 2	Sub Part Number IE Type = 202 (decimal)			
Octets 3 and 4	Length = 1 byte			
Information elements	**P**	**Condition / Comment**	**IE Length**	**IE ID**
Config Action	M	Add or delete the config	1 Byte	202

Note **PFCP_IE_CONFIG_ACTION**: This IE is Optional. The Sub Part Index parameter is Mandatory if this IE is present.

If this IE is not present then only Type and Length are available.

IE Type: 203

IE Name: PFCP_IE_CORRELATION_ID

IE Format and Encoding Information

Octet 1 and 2	Correlation ID IE Type = 203 (decimal)			
Octets 3 and 4	Length = 2 bytes			
Information elements	**P**	**Condition / Comment**	**IE Length**	**IE ID**

Co-Relation ID	M	Unique number which will represent transaction ID. During Split buffer message, correlation ID will be the same so that receiver can combine buffer.	2 Bytes	203

Sx Message(s) Using the IE: Sx Prime PFD MGMT Request for configuring the UP with various configurations.

Sx Prime PFD MGMT Response

IE Type: 204

IE Name: PFCP_IE_SUB_PART_NUMBER

IE Format and Encoding Information

Octet 1 and 2	Sub Part Number IE Type = 204 (decimal)			
Octets 3 and 4	Length = 1 byte			
Information elements	**P**	**Condition / Comment**	**IE Length**	**IE ID**
Number of Sub Parts	O	N – Indicates total number of sub parts for this config	1 Byte	204

Sx Message(s) Using the IE: Sx Prime PFD MGMT Request for configuring the UP with various configurations.

Note **PFCP_IE_SUB_PART_NUMBER**: This IE is Optional. The Sub Part Number Index parameter is Mandatory if this IE is present.

If this IE is not present then only Type and Length are available.

IE Type: 205

IE Name: PFCP_IE_SUB_PART_INDEX

IE Format and Encoding Information

Octet 1 and 2	Sub Part Index IE Type = 205 (decimal)			
Octets 3 and 4	Length = 1 byte			
Information elements	**P**	**Condition / Comment**	**IE Length**	**IE ID**

Sub Part index	O	Indicates the sub part number going into this config message.	1 Byte	205

Sx Message(s) Using the IE: Sx Prime PFD MGMT Request for configuring the UP with various configurations.

Sx Prime PFD MGMT Response.

Note **PFCP_IE_SUB_PART_INDEX**: This IE is Optional. The Sub Part Index parameter is Mandatory if this IE is present.

If this IE is not present then only Type and Length are available.

IE Type: 206

IE Name: PFCP_IE_CONTENT_TLV

IE Format and Encoding Information

Octet 1 and 2	Content TLV IE Type = 206 (decimal)			
Octets 3 and 4	Length = 3003 bytes			
Information elements	**P**	**Condition / Comment**	**IE Length**	**IE ID**
Content TLV	M	Type – Indicates Ruledef, Charging Action,Action priority line, Rule and Route config, Group of Ruledef	3003 bytes	206
		Rule in GoR - 1 Byte		
		Length – Length of Content - 2 Byte		
		Value – Actual Buffer content - Max size 3000 Bytes		

Sx Message(s) Using the IE: Sx Prime PFD MGMT Request for configuring the UP with various configurations.

IE Type: 207

IE Name: PFCP_IE_RBASE_NAME

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 207 (decimal)							
3 to 4	Length = n							
5 to n	Rulebase Name							

Note

- Octets 1-2—Indicates Rulebase IE. Type 202 Reserved
- Octets 3-4—Indicates the length of rulebase name
- Octets 5-n—Rulebase name

This IE contains the active Rulebase Name for a subscriber to be communicated to User Plane.

IE Type: 208

IE Name: PFCP_IE_NSH_INFO

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 208 (decimal)							
3 to 4	Length = n							
5 to 5	BitOctet							
6 to 6	MSISDN Length							
7 to 22	MSISDN							
23 to 23	IMSI Length							
24 to 40	IMSI							

IE Type: 209

IE Name: PFCP_IE_STATS_REQUEST

IE Format and Encoding Information

Information Elements	P	Condition / Comment	IE Type	IE ID
Query Params	M	Query Params describes the type of the query and optionally the name of the entity being queried.	Query Params	210
Classifier Params	O	These are used along with query params for narrowing down the search.	Classifier Params	211

This IE is of grouped type and consists of two IEs: Query Params IE and the Classifier Params IE. Multiple instances of Classifier Params IE can be present.

IE Type: 210

IE Name: PFCP_IE_QUERY_PARAMS

IE Format and Encoding Information

Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 210 (decimal)							
3 to 4	Length = n							
7	ENTITY TYPE							
8	Spare						QUERY TYPE	QUERY ALL
9 to 10	Entity Name Length							
10 to n	Entity Name							

Query Params is encoded as follows:

Octet 7: ENTITY TYPE – Numeric Identifier. Indicates the type of entity being queried:

1: Network Instance (APN name) – [PFCP IE ID: 22] 2: Rulebase etc. (Future use) – [PFCP IE ID: 207]

Octet 8 encodes the following flags:

- QUERY ALL—Indicates whether you are querying one instance of the specified entity or all of them.
- QUERY TYPE—Indicates whether you are querying individual ENTITY of the given type or we are expecting aggregated node level statistics. It takes values as follows:

- 0: Bit when unset, indicates individual statistics.
- 1: Bit when set indicates aggregated statistics.

Valid combinations of the preceding flags are used to realize the use cases.

IE Type: 211

IE Name: PFCP_IE_CLASSIFIER_PARAMS

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 211 (decimal)							
3 to 4	Length = n							
5 to 6	Classifier Type							
7	Spare:6						NC: 1	SC: 1
8	Variable length							

Classifier Params IE is encoded as follows:

Octet 5 to Octet 6: Encodes the type of the classifier. It is defined by the context set by entity type.

So, same numeric identifiers may mean different for two different entity types.

Octet 7 onwards is used to encode the Bit Octet 1, which is set either bit 1 or bit 2. Bit 1 represents String Classifier (SC) and Bit 2 is Num classifier (NC) .

Octet 8 onwards is used to encode the classifier content. This content is encoded as an octet string. In case of numeric classifiers, the numbers are appropriately converted into string format and are delivered as is to the application. This process removes the length limitation on type of encoded numeric identifiers.

Octet 8 onwards is used to encode variable length. The Variable length includes 4 bytes--Number of classifiers OR variable length “String Classifier”.

IE Type: 212

IE Name: PFCP_IE_STATS_RESPONSE

IE Format and Encoding Information

	Bits

Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 212 (decimal)							
3 to 4	Length = n							
5	ENTITY TYPE							
6	Part Number							
7	Total Number of Parts							
8 to n	Blob of data							

ENTITY TYPE is the same as the one that is received in request. Else, Control Plane rejects the response from the User Plane.

The response from User plane can span across multiple messages depending upon the amount of data that needs to be sent to Control Plane.

- Message ID identifies one subpart of the response.
- Total number of messages this response consists of.

Blob of data consists of compressed context specific data. Contents of the same are uncompressed at Control Plane and interpreted as per the identifiers received (ENTITY TYPE). Blob of data is set of (data-len, data), where Length at Octets 3 to 4 includes data-len. In the **IE Format and Encoding Information** structure it is used to keep track of “data” that gets encoded as “Blob of data”.

IE Type: 213

IE Name: PFCP_IE_STATS_ACK

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 213 (decimal)							
3 to 4	Length = n							
5	RESPONSE TYPE							
6 to n	Missing message parts							

RESPONSE TYPE is: 0: ACK (success) if all parts of the response are correctly received at CP 1: NACK (failure) - CP responds with the message parts that were not received within the specified time.

Octets 6 specifies missing part numbers at CP in case CP sends out a NAck. When the UP pushes the **PfcpStatsResponseAck** to CP, Octet 6 assigns a number for each Part numbers. If a specific **PfcpStatsResponseAck** is missing when the CP sends out a NACK ,then it fills those Part numbers.

Use of NAck mechanism is not envisaged as of now. These will be incorporated in call flows, if required in future.

IE Type: 214

IE Name: PFCP_IE_PACKET_MEASUREMENT

IE Format and Encoding Information

The Packet Measurement IE contains the measured traffic volume in packets. This IE is encoded as follows:

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 214 (decimal)							
3 to 4	Length = n							
5	Spare					DLVOL	ULVOL	TOVOL
m to (m+7)	Total Packets							
p to (p+7)	Uplink Packets							
q to (q+7)	Downlink Packets							
s to (n+4)	These octet(s) is/are present only if explicitly specified							

The following flags are coded within Octet 5:

- Bit 1 – TOVOL— If this bit is set to "1", then the Total Packets field appears. Else, the Total Packets field does not appear.
- Bit 2 – ULVOL—If this bit is set to "1", then the Uplink Packets field appears. Else, the Uplink Packets field does not appear.
- Bit 3 – DLVOL—If this bit is set to "1", then the Downlink Packets field appears. Else, the Downlink Packets field does not appear.
- Bit 4 to bit 8—These are spare bits for future use, and are set to 0.

At least one bit is set to 1. However, you can set many bits to 1.

The Total Packets, Uplink Packets, and Downlink Packets fields are encoded as an Unsigned64 binary integer value. The fields contain the total, uplink, or downlink number of packets respectively.

This is not a mandatory IE for any message.

This IE is available in the following messages between Control Plane and User Plane.

- Sx Session Modification over SxA, SxB, SxC, SxAB
- Sx Usage Report Session Deletion Response over SxA, SxB, SxC, SxAB
- Sx Usage Report Session Report Request over SxA, SxB, SxC, SxAB

IE Type: 215

IE Name: PFCP_IE_EXTENDED_MEASUREMENT_METHOD

IE Format and Encoding Information

A new IE (215 - Extended Measurement Method) is encoded as follows. This IE indicates the method for measuring the usage of network resources.

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 215 (decimal)							
3 to 4	Length = n							
5	Spare	Spare	Spare	Spare	Spare	Spare	Spare	Pkt
6 to (n+4)	These octet(s) is/are present only if explicitly specified.							

Figure Extended Measurement Method

Octet 5 is encoded as follows:

- Bit 1 – Pkt (Packet)—When set to 1, this bit indicates a request for measuring the usage of the traffic in packets.
- Bit 2 to 8—These are spare bits for future use, and are set to 0.

Note Only one bit is set to 1.

This is not a mandatory IE for any message.

This IE can be available in the following message between Control Plane and User Plane.

- Sx Session Establishment over SxA, SxB, SxC, SxAB

Similarly, Usage Report from User Plane is enhanced to support the packet information.

IE Type: 216

IE Name: PFCP_IE_RECALCULATE_MEASUREMENT

IE Format and Encoding Information

This private IE has been added to support "Max number of change conditions" trigger for offline charging records, such as Gz and Rf.

	Bits

Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 216 (decimal)							
3 to 4	Length = n							
5	Spare	Spare	Spare	Spare	Spare	Spare	RCVOL	RCDUR
6 to (n+4)	These octet(s) is/are present only if explicitly specified.							

The following flags are coded within Octet 5:

- Bit 1 – RCDUR (Re-calculate Duration Measurement)—When set to 1, this flag indicates a request for resetting the Duration Measurement to ‘0’ by the UP function.
- Bit 2 – RCVOL (Re-calculate Volume Measurement)—When set to 1, this flag indicates a request for resetting the Volume Measurement to ‘0’ by the UP function. Then, the UP function proceeds to repopulate the Volume Measurement. The repopulation is done by aggregating the Volume Measurement of all the URRs that contain Linked URR ID as the URR ID sent in Update URR IE.
- Bit 3 to 8—Spare bits for future use, and are set to 0.

1. PFCP Session Modification Request
2. PFCP Session Report Response

IE Type: 217

IE Name: PFCP_IE_SUB_INFO

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 217 (decimal)							
3 to 4	Length = n							
5 to 5	BitOctet							
6 to 6	MSISDN Length							
7 to 22	MSISDN							
23 to 23	IMSI Length							
24 to 40	IMSI							
41 to 41	IMEI Length							
42 to 57	IMEI							
58 to 61	Call ID							

Octets 5-5: BitOctet. Indicates the available fields.

- Bit 1—IMSI

- Bit 2—MSISDN
- Bit 3—IMEI
- Bit 4—Call ID

IE Type: 218

IE Name: PFCP_IE_INTR_INFO

IE Format and Encoding Information

The IE is part of Create Dupl Params and Update Duplicate Params IE.

Create Duplicate Params IE can be part of Sx Establishment Request and Sx Session Modify Request.

Update Duplicate Params IE can be part of Sx Session Modify Request.

	Bits								
Octets	8	7	6	5	4	3	2	1	
1 to 2	Type = 218 (decimal)								
3 to 4	Length = n								
5 to 5	BitOctet								
6 to 9	Intercept ID								
10 to 13	Charging ID								
14 to 14	Bearer ID								
15 to 18	Context name Length								
19 to 22	Context name								
23	Length of intercept key				1 byte				
24 to 29	Intercept Key				max 25 bytes, variable length mentioned in above octet				
30 to 33	CP IPv4 Address				4 bytes				
34 to 50	CP IPv6 address				16 bytes				
51 to 51	S8HRBearer ID				1 byte				
52 to 55	S8HR GTPC TEID				4 bytes				
56 to 56	S8HR IMS media flag				1 byte				

Octets 5-5: BitOctet. Indicates the available fields.

- Bit 1—Intercept ID
- Bit 2—Charging ID
- Bit 3—Bearer ID
- Bit 4—Context name

- Bit 5—Intercept Key
- Bit 6—CP IPv4 address
- Bit 7—CP IPv6 address
- Bit 8—S8HR Bearer ID, GTPC TEID, and IMS media flag

Note The offset might change based on presence of an IE or not". For example, if Intercept ID bit 1 is not SET (==0), then Charging ID will be present in bit 6 to 9.

IE Type: 219

IE Name: PFCP_IE_NODE_CAPABILITY

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 219 (decimal)							
3 to 4	Length = n							
5 to 8	Max Sessions Supported							
9 to (n+4)	These octet(s) is/are present only if explicitly specified.							

The Max Sessions Supported value are encoded as an Unsigned32 binary integer value.

Max Sessions supported value is the maximum number of sessions that are supported by User Plane for this association with Control Plane.

IE Type: 220

IE Name: PFCP_IE_INNER_PACKET_MARKING

IE Format and Encoding Information

The Inner Packet Marking IE type is encoded as follows. It indicates the DSCP to be used for UL/DL Inner packet marking.

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 220 (decimal)							
3 to 4	Length = n							
5 to 6	ToS/Traffic Class							

The ToS/Traffic Class is encoded on two octets as an OctetString. The first octet contains the DSCP value in the IPv4 Type-of-Service or the IPv6 Traffic-Class field and the second octet contains the ToS/Traffic Class mask field, which is set to "0xFC".

IE Type: 221

IE Name: PFCP_IE_TRANSPORT_LEVEL_MARKING_OPTIONS

IE Format and Encoding Information

TRANSPORT LEVEL MARKING OPTIONS is encoded as follows. It indicates the copy-inner/outer flags for encaps-header marking.

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 221 (decimal)							
3 to 4	Length = n							
5 to 5	Copy-Inner/Outer Flag							

Copy-Inner/Outer flags are encoded on 1 Octet.

IE Type: 222

IE Name: PFCP_IE_PDHIR_OUTER_HEADER_CREATION

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 222 (decimal)							
3 to 4	Length = n							
5 to 6	Description							
7 to 10	IPv4 address - based on description							
11 to 27	IPv6 address - based on description							
28 to 29	Port number							

Octet 5 to 6: Specifies if the IPv4 or IPv6 address or both are present. IPv4 address is present only if 5th bit (1 << 4) is set to 1. IPv6 address is present only if 4th bit (1 << 3) is set to 1.

Both IPv4 and IPv6 addreses are present when description is 768. For example, i.e. (3 << 8 i.e. 0x300).

Port number is present only if IPv4 or IPv6 address is present.

IE Type: 223

IE Name: PFCP_IE_CHARGING_PARAMS

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 223 (decimal)							
3 to 4	Length = n							
5 to 6	Charging Chars							
7	GTPP Group Name Length							
8	GTPP Group Name							
9 to 12	GTPP Context ID							
13	Accounting Policy Name Length							
14	Accounting Policy Name							
15 to 18	Accounting Policy Service Type							
19 to 22	Diameter Interim Interval							
23	AAA Group Name Length							
24	AAA Group Name							
25 to 28	AAA Group Context ID							
29 to 32	RADIUS Interim Interval							
33	Gy Offline Charging							
34	GTPP Dictionary							
35	CC Group Name Length							
36	CC Group Name							

Note The GTPP Group Name, Accounting Policy Name, Accounting Group Name, and CC Group Name parameters in this table denote the single byte format for representation purposes. Based on the length field set for these parameters, the byte position may vary as it is not fixed.

IE Type: 224

IE Name: PFCP_IE_GY_OFFLINE_CHARGE

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 224 (decimal)							
3 to 4	Length = n							
5 to 5	Gy Offline Charging Status							

IE Type: 225

IE Name: PFCP_IE_BEARER_INFO

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 225 (decimal)							
3 to 4	Length = n							
5 to 5	QCI							
6 to 6	ARP							
7 to 8	Charging ID							

IE Type: 226

IE Name: PFCP_IE_SUB_PARAMS

IE Format and Encoding Information

	Bits

Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 226 (decimal)							
3 to 4	Length = n							
5 to 8	BitOctet							
9 to 10	Charging Characteristics							
11 to 11	RAT Type							
12 to 12	MCC MNC Length							
Variable Length	MCC MNC Value							
4 bytes/16 bytes	SGSN Address IPv4/IPv6							
1 byte	ULI Length							
Variable Length	ULI Value							
4 bytes	Congestion Level Value							
1 byte	Customer ID Length							
Variable Length	Customer ID value							
4 bytes/16 bytes	GGSN Address IPv4/IPv6							
1 byte	User Name Length							
Variable Length	User Name Value							
1 byte	RADIUS String Length							
Variable Length	RADIUS String Value							
1 byte	Session ID Length							
Variable Length	Session ID Value							
1 byte	MS Timezone Length							
Variable Length	MS Timezone Value							
1 byte	User Agent Length							
Variable Length	User Agent Value							
1 byte	Hash Value Length							

Variable Length	Hash Value	
1 byte	Called Station ID Length	
Variable Length	Called Station ID Value	
4 bytes	Content Filtering Policy ID	
1 byte	Charging Disabled Flag	
1 byte	TS Profile Length	
Variable Length	TS Profile	
1 byte	TS Subscription Scheme Length	
Variable Length	TS Subscription Scheme	
1 byte	Traffic Optimization Policy ID	
4 bytes	Consolidated CF Policy ID	

Octets 1: BitOctet. Indicates the available fields.

- Bit 1—Charging Characters
- Bit 2—RAT Type
- Bit 3—MCC/MNC
- Bit 4—SGSN Address IPv4
- Bit 5—SGSN Address IPv6
- Bit 6—ULI
- Bit 7—Congestion Level
- Bit 8—Customer ID
- Bit 9—GGSN Address IPv4
- Bit 10—GGSN Address IPv6
- Bit 11—UserName
- Bit 12—Radius String
- Bit 13—Session ID
- Bit 14—MS Timezone valid
- Bit 15—User Agent
- Bit 16—Hash value
- Bit 17—Call Station Id
- Bit 18—Unused

- Bit 19—Content Filtering Policy Id
- Bit 20—Charging Disabled Value
- Bit 21—TS profile
- Bit 22—TS subscription
- Bit 23—Traffic Optmization Policy ID
- Bit 24—Consolidate CF policy ID

Note The offset might change based on presence of an IE or not". For example, if Intercept ID bit 1 is not SET (==0), then Charging ID will be present in bit 6 to 9.

IE Type: 227

IE Name: PFCP_IE_RULE_NAME

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 227 (decimal)							
3 to 4	Length = n							
5 to 68	Rule Name							

IE Type: 228

IE Name: PFCP_IE_LAYER2_MARKING

IE Format and Encoding Information

To pass the L2 Marking information to the UP for the bearer, a new custom-IE is defined and the FAR is modified to include it as follows. It identifies the Layer 2 Marking to be applied for the packets matching this FAR.

The length of the IE could be either 0 or 1.

	Bits

Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 228 (decimal)							
3 to 4	Length = n							
5 to 5	TYPE (2 Bits) PRIORITY (6 Bits) **Type :** (1-DSCP, 2-QCI, 3-None) - beginning 2 Bits **Priority-Value:** the last 6 bits • Internal-Priority in case of QCI/None type • DCSP value in case of DSCP type							

IE Type: 229

IE Name: PFCP_IE_MONITOR_SUBSCRIBER_INFO

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 229 (decimal)							
3 to 4	Length = n							
5	Spare		C		D		Action	
d to (d+7)	Data tracing parameters							
p to (p+15)	Protocol tracing parameters							
s to (n+4)	These octet(s) is/are present only if explicitly specified.							

Action: STOP / START monitor subscriber tracing. STOP =1, START =2.

D = DATA events tracing is ON if D=1. The 8 octets (d to d+7) contain data events tracing (fastpath) information should be present only when D=1.

C = CONTROL events tracing is ON if C=1.

Data Tracing (fastpath) Information (8 octets): It will contain the data filter parameters like Packet capture, Packet capture size, and MEH header.

Octet 5:

- Bit 1 to 2 – Action [action(2 bit), control(1 bit),data(1 bit)]
- Bit 3 – Display Data Info
- Bit 4 – Display Control Info
- Bit 5 - C Bit

- Bit 6 - D Bit
- Bit 7 - Unused
- Bit 8 - Unused

Octet 6:

- Bit 1 – VPP enable/disable
- Bit 2 – PCAP - Packet capture
- Bit 3 – MEH
- Bit 4 to 6 - Priority

Octet 2 to 3: Packet size

Octet 4 – 8: Reserved for future use. Currently, all set to 0.

Protocol Tracing Information (16 octets/128 bits): The 16 octets (p to p+15) contain protocol tracing information and should be present only when either control flag (C) or data flag (D) is enable. Each bit represents a unique protocol to monitor. For example, if 49th bit is 1, PFCP events tracing is ON. Protocol Tracing ‘Rulematch Events (Option 34)’, ‘L3 Data (Option 19)’, ‘EDR (Option 77)’ and ‘Subscriber Summary After Call Disconnect’ are controlled by control event flag.

Note The offset might change based on presence of an IE or not". For example, if Intercept ID bit 1 is not SET (==0), then Charging ID will be present in bit 6 to 9.

IE Type: 230

IE Name: PFCP_IE_MON_SUB_REPORT_SESS_REP_REQ

IE Format and Encoding Information

Bits

Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 230 (decimal)							
3 to 4	Length = n							
5	Status code							
6 to 9	CLI Instance ID							
10	Congestion Short Term							
11	Congestion Longer Term							
12	Flag Throttled							
13 to 16	Accepted Packet Count							
17 to 20	Rejected Packet Count							
21 to 24	PCAP File Transfer Rate							

Status code: It indicates the acceptance or the rejection of the subscriber trace at UP. Status code = 0 will mean a success. Values 1-255 will uniquely specify the specific error code or notification.

IE Type: 231

IE Name: PFCP_IE_CREATE_BLI

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 231 (decimal)							
3 to 4	Length = n							
5 to 6	numCreateBli							
7 to n. Max(1280)	Create BLI [PFCP_MAX_CREATE_BLI]							

IE Type: 232

IE Name: PFCP_IE_BLI_ID

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 232 (decimal)							
3 to 4	Length = n							
5 to 6	BLI ID							

IE Type: 233

IE Name: PFCP_IE_QCI

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 233 (decimal)							
3 to 4	Length = n							
5 to 6	QCI							

IE Type: 234

IE Name: PFCP_IE_5QI

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 234 (decimal)							
3 to 4	Length = n							
5 to 6	5QI							

IE Type: 235

IE Name: PFCP_IE_ARP

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 235 (decimal)							
3 to 4	Length = n							
5 to 6	ARP							

IE Type: 236

IE Name: PFCP_IE_CHARGING_ID

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 236 (decimal)							
3 to 4	Length = n							
5 to 9	Charging ID							

IE Type: 237

IE Name: PFCP_IE_RATING_GRP

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 237 (decimal)							
3 to 4	Length = 2 bytes							
5 to 8	Rating Group							

IE Type: 238

IE Name: PFCP_IE_NEXTHOP

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 238 (decimal)							
3 to 4	Length = n							
5 to 10	Next hop ID							
11 to 14	Next hop IP address							

IE Type: 239

IE Name: PFCP_IE_NEXTHOP_ID

IE Format and Encoding Information

	Bits						
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 239 (decimal)							
3 to 4	Length = 5							
5	Next hop ID							

IE Type: 240

IE Name: PFCP_IE_NEXTHOP_IP

IE Format and Encoding Information

	Bits						
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 240 (decimal)							
3 to 4	Length = n							
5	Spare			V4			V6	
m to (m+3)	IPv4 Address							
p to (p+15)	IPv6 Address							

IE Type: 241

IE Name: PFCP_IE_QGR_INFO

IE Format and Encoding Information

	Bits

Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 241 (decimal)							
3 to 4	Length = n							
5 to 6	Number of QGR							
7 to 7	QGR 1 information stats - Bit Octet							
8 to 8	QGR Operation(Add/Modify/Remove)							
9 to 12	QGR Priority							
13 to 13	QGR Name Length							
14 to n	QGR Name							
n+1 to n+4	FAR ID							
n+5 to n+8	QER ID							
n+8 to n+11	URR ID							
Same as 7 to n+11	Next QGR (if any) information stats							

IE Type: 242

IE Name: PFCP_IE_UE_IP_VRF

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 242 (decimal)							
3 to 4	Length = n							
5	Spare		Identical VRF flag		IPv6 VRF Valid		IPv4 VRF Valid	
m to (m+1)	VRF-1 Name Length = p							
Variable Length	VRF-1 Name							
n to n+1	VRF-2 Name Length = q							
Variable Length	VRF-2 Name							

IE Type: 243

IE Name: PFCP_IE_SERVICE_ID

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 243 (decimal)							
3 to 4	Length = n							
5 to 9	Service ID							

IE Type: 244

IE Name: PFCP_IE_USER_PLANE_ID

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 244 (decimal)							
3 to 4	Length = n							
5 to 9	User Plane ID							

IE Type: 245

IE Name: PFCP_IE_PEER_VERSION

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 245 (decimal)							
3 to 4	Length = n							
5 to 9	Peer version							
10 to 14	StarOS GR version							
15 to 16	Length							
17 to n. Max(128)	StarOS version [PFCP_STAROS_VERSION_MAX]							

IE Type: 246

IE Name: PFCP_IE_GX_ALIAS

IE Format and Encoding Information

The IE is used to communicate a Gx-Alias GoR(Group-of-Ruledef) name, Start and End PDR IDs and also the operation to perform, from CP to UP during Sx Session Establishment/Modification Request message. There can be multiple instances of same IE in an Sx-message.

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 246 (decimal)							
3 to 4	Length n [Min=7, Max=69 {5+ACSCTRL_GRP_OF_RDEFS_NAMELEN (64)}]							
5	Flags (Add/delete GoR Rules),for example, 1 for Add, 0 Delete rules in GoR							
6 to 7	Start PDR ID							
8 to 9	End PDR ID							
10 to n+4	Gx-alias GoR name (min size=2, max size=64)							

IE Type: 247

IE Name: PFCP_IE_NBR_INFO_SESS_REP_REQ

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 247 (decimal)							
3 to 4	Length = n							
5 to 33	NAT IP address							
34 to 636	Port chunk information list							
637 to 639	Allocation flag							
640 to 644	naptNumUsersPerIP							
645 to 649	Release timer							

IE Type: 248

IE Name: PFCP_IE_NAT_IP

IE Format and Encoding Information

	Bits						
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 248 (decimal)							
3 to 4	Length = n							
5 to 29	IPv4 address							

IE Type: 249

IE Name: PFCP_IE_PORT_CHUNK_INFO

IE Format and Encoding Information

	Bits						
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 249 (decimal)							
3 to 4	Length = n							
5 to 6	numPortChunkInfo							
7 to n Max (600)	Port chunk information [PFCP_MAX_PORT_CHUNK_INFO]							

IE Type: 250

IE Name: PFCP_IE_ALLOCATION_FLAG

IE Format and Encoding Information

	Bits						
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 250 (decimal)							
3 to 4	Length = n							
5 to 9	Allocation flag							

IE Type: 251

IE Name: PFCP_IE_NAPT_NUM_USERS_PER_USER

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 251 (decimal)							
3 to 4	Length = n							
5 to 7	NAPT_NUM_USERS_PER_USER							

IE Type: 252

IE Name: PFCP_IE_RELEASE_TIMER

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 252 (decimal)							
3 to 4	Length = n							
5 to 7	Release timer							

IE Type: 253

IE Name: PFCP_IE_QUERY_INTERFACE

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 253 (decimal)							
3 to 4	Length = n							
5 to 6	Spare:3							
7 to 8	offline_urr:1							
9 to 10	online_urr:1							
11 to 12	radius_urr:1							
13 to 14	bearer_urr:1							
15 to 16	sess_urr:1							

IE Type: 254

IE Name: PFCP_IE_BUSY_OUT_INACTIVITY_TIMEOUT

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 254 (decimal)							
3 to 4	Length = n							
5 to 9	Inactivity timeout							

IE Type: 256

IE Name: PFCP_IE_TRIGGER_ACTION_REPORT

IE Format and Encoding Information

	Bits							
Octets	8	7	6	5	4	3	2	1
1 to 2	Type = 256 (decimal)							
3 to 4	Length = n							
5 to 7	Number of trigger actions							
8 to n Max (1400)	Trigger action [PFCP_MAX_TRIGGER_ACTION]							