

Non-IP Data Over SCEF

This chapter describes the transfer of Non-IP data over SCEF using Cellular Internet of Things (CIoT) technology. This feature is discussed in the following sections:

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Feature Summary and Revision History

Summary Data

Applicable Product(s) or Functional Area	MME
Applicable Platform(s)	• UGP • ASR 5500 • VPC-DI • VPC-SI
Feature Default	Disabled - Configuration Required
Related Changes in This Release	Not applicable
Related Documentation	• *Command Line Interface Reference* • *Statistics and Counters Reference* • *Ultra IoT C-SGN Administration Guide*

Revision History

Revision Details	Release
This release supports: • Connection Management by SCEF Procedure to release a T6a connection between MME and SCEF. • PDN disconnect and detach procedure towards the UE when it receives a MO Data Answer message with Permanent Failure from SCEF.	21.19
The feature is tested and qualified on the ASR 5500 platform. This release supports temporary buffering of single MT Data Request received from SCEF while UE is in idle mode.	21.3
First introduced.	N5.1 (21.1.V0)

Feature Description

The Service Capability Exposure Function (SCEF) is the key entity within the 3GPP architecture for service capability exposure that provides a means to securely expose the services and capabilities provided by 3GPP network interfaces. SCEF resides either on the edge of an IoT domain or completely within the IoT domain, interfacing with an external API Management Platform at the edge.

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CIoT brings in newer set of applications and requirements to be supported at various network elements. One such requirement is the support of Non-IP data over SCEF. Non-IP Data Delivery (NIDD) is one of the prime features of SCEF that helps transfer data between the SCEF and the Application Server (AS) using APIs. The support of Non-IP Data Delivery is part of the CIoT EPS optimizations.

Non-IP data over SCEF requires “Data over NAS” support and the implementation of T6a - Diameter interface at MME. A PDN Type "Non-IP" is used for NIDD over SCEF.

The Diameter T6a interface interacts between the MME and SCEF to support:

- Non IP PDN connection establishment
- MO Non IP data
- MT Non IP data
- Monitoring Event configuration at MME
- Monitoring Event configuration by MME to SCEF



Important Cisco SCEF runs on the CPS platform and is available for trial purposes only. Contact your Cisco account representative for more information.

Non-IP Data Delivery over SCEF supports the following functionalities:

- Non-IP Data Delivery
- Connection Management
- Idle to Active transition and vice-versa with CIoT Optimization for subscribers having SCEF PDN
- Recovery of subscribers with Control Plane CIoT optimizations on Session Manager restart
- Control Plane CIoT Optimizations

SCEF Initiated T6a Connection Release Enhancement: MME allows Service Capability Exposure Function (SCEF) to initiate T6a connections release procedure in compliance with the 3GPP specifications 23.682 Release 15 of Section 5.13.5.3 and 29.128 Release 15 of Section 5.8.

Buffering Non-IP Data from SCEF

MME supports temporary buffering of single MT Data Request received from SCEF while UE is in idle mode. The request is buffered till UE is paged and an MT Data Answer is sent upon paging success/failure.

The following functionality for temporary buffering is applicable on a UE basis.

- MT Data Request is buffered while UE is being paged till the corresponding MT Data Answer is sent.
- A single MT Data Request will be buffered per SCEF PDN.
- The subsequent MT Data Request for the PDN will not be buffered and immediately rejected with experimental result code DIAMETER_ERROR_UNABLE_TO_COMPLY (5012).
- Sends buffered non-IP payload to UE and MT Data Answer with success result code (2001) to SCEF, upon paging success.
- Sends MT Data Answer with experimental result code DIAMETER_ERROR_USER_TEMPORARILY_UNREACHABLE (5653) upon paging failure. MME also sends MT Data Answer with this result code due to expiry of SCEF wait time prior to paging completion.
- Sends Connection Management Request (CMR) with Connection-Action AVP set to Connection Update and CMR-Flags AVP set to 1, once UE comes to connected mode. MT Data Answer was previously sent with experimental result code DIAMETER_ERROR_USER_TEMPORARILY_UNREACHABLE (5653), so that SCEF can send buffered data to MME once UE is reachable.
- MT Data Request is not buffered if UE cannot be paged due to PSM/eDRX.

  MT Data Answer with cause code DIAMETER_ERROR_USER_TEMPORARILY_UNREACHABLE (5653) will be sent followed by CMR when UE comes to connected mode.
- Statistics are supported for MT Data Request buffered, MT Data Answer sent for buffered requests and MT Data Answer dropped for buffered requests.

The Buffering Non-IP Data from SCEF feature is enabled by default.

Packet Data Network Disconnect or Detach Procedure

Before the implementation of Packet Data Network (PDN) Disconnect or Detach procedure in a network, MME followed the below process after receiving the permanent failure code:

1. The User Equipment (UE) connects to the network with Non-IP Data Delivery (NIDD) option and establishes T6a connection.
2. UE tries Mobile Originated (MO) NIDD whenever a Session DB on the SCEF gets cleared.
3. UE sends Non-Access Stratum (NAS) “MO REQUEST” with the data and receives NAS_SERVICE_ACCEPT.
4. The MME sends Diameter “MO-Data-Request” over T6A and receives “DIAMETER_ERROR_INVALID_EPS_BEARER (5651)” or “DIAMETER_ERROR_USER_UNKNOWN”.

However, there was data loss. This data loss was because of the lack of PDN Disconnect or Detach procedure initiation from MME towards the UE. UE may assume that it is T6a connected and retry MO NIDD indefinitely.

In StarOS 21.19 and later releases, the MME supports PDN Disconnect or Detach procedure towards the UE when it receives a MO Data Answer message with Permanent Failure Result-Code/Experimental-Result from SCEF. If the permanent failure is different from DIAMETER_ERROR_ INVALID_EPS_BEARER and from DIAMETER_ERROR_USER_UNKNOWN, then MME also initiates the "Connection Management by MME/SGSN" procedure to release the T6a connection between the MME and the SCEF.

How It Works

Several IoT applications are implemented where Non-IP data is transferred between Applications/Service Capability Servers and CIoT devices.

The Non-IP data delivery to SCS/AS is accomplished by one of two mechanisms:

- Delivery using SCEF
- Delivery using a Point-to-Point (PtP) SGi tunnel.

This section only covers Non-IP data delivery over SCEF.

Interaction between MME and SCEF

The UE indicates in the ESM connection request (for example: in the Attach or PDN Connectivity Request) that a Non-IP PDN type is used. The subscription information has a default APN for PDN Type Non-IP, which the MME uses for the first received Non-IP connectivity request unless the UE has included an APN in the request. The MME then initiates a T6a connection towards the SCEF corresponding to the SCEF ID indicator for that APN.

At each PDN connectivity request, the MME decides which delivery mechanism (SCEF based delivery or SGi based delivery) is used for delivering the Non-IP data between RAN and AS. An indication associated with the used APN determines if SCEF based delivery or SGi based delivery shall be used.

When the MME decides to use SCEF based delivery mechanism for Non-IP data, a PDN connection is established towards the selected SCEF. Such a PDN Connection is also known as an "SCEF Connection".

Connection Management

The Application Server (AS) and UE information are registered with the SCEF using two different call flows:

- AS registration with SCEF
- UE registration with SCEF

AS Registration

The AS registration is also called as the Non-IP Data Delivery configuration procedure. The call-flow procedure is as given below:

1. AS registers itself for a particular UE.
2. SCEF performs authentication and authorization. SCEF may downgrade the load information, if the specified load exceeds the local limits maintained in the SCEF's configuration.
3. SCEF sends a Non-IP Data Delivery Information Request to HSS.
4. HSS sends a Non-IP Data Delivery Information Answer. The answer includes the UE's 3GPP identifier, since the request may have used an external-id. The answer may also include load-control information, although such is not defined in the current NIA specification.

UE Registration

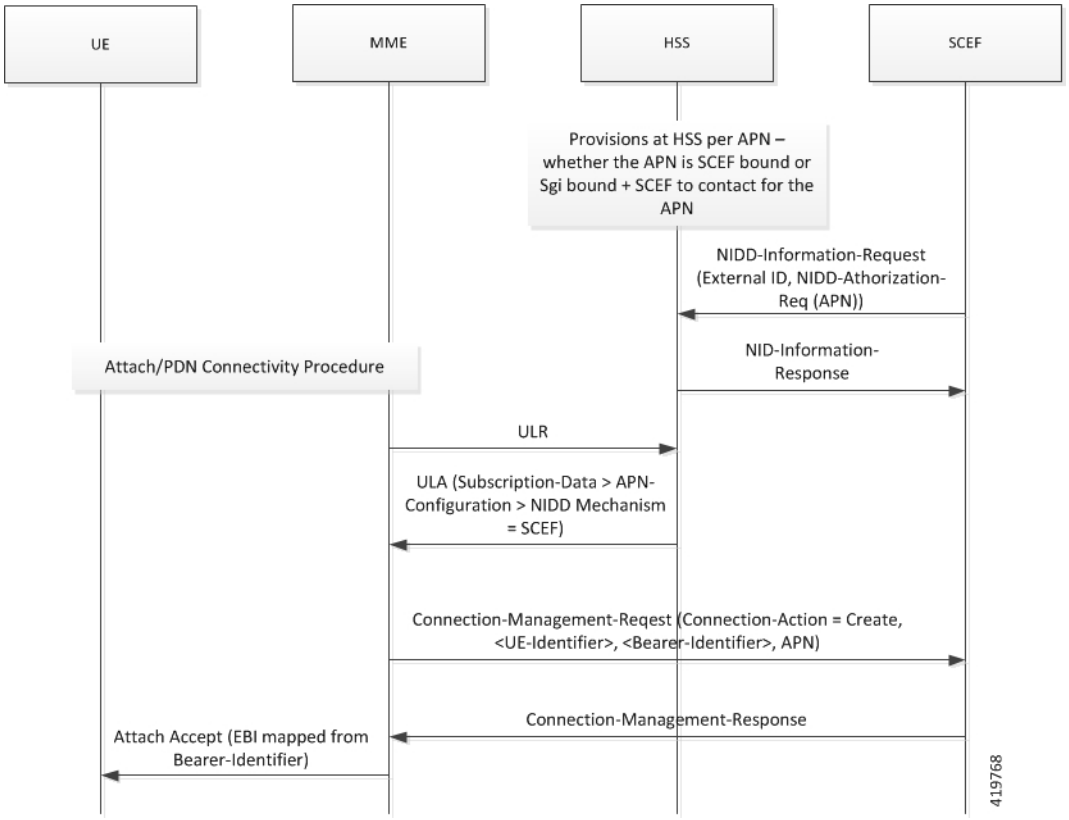
The UE registration is called the T6a Connection establishment procedure. The call-flow procedure is as given below:

1. The UE attaches, indicating a desired connection for non-IP data. This registers the UE with the MME.
2. MME sends a Connection Management Request to SCEF.
3. If an AS has not already registered with the SCEF for that UE, SCEF may either reject the Connection Management Request, or SCEF may initiate the Non-IP Data Delivery Configuration Procedure for an AS.
4. SCEF sends a Connection Management Answer.

The following call-flow is used between MME and SCEF/Inter-working SCEF (IWK-SCEF), and is invoked by the MME to:

- Establish a T6a connection between MME and SCEF
- Release a T6a connection between the MME and the SCEF

Figure 1: SCEF PDN Connection Creation



This procedure is mapped to the commands: Connection-Management-Request and Connection-Management-Answer (CMR/CMA) in the Diameter application along with IEs, described below:

Note Not all IEs included are supported by MME.

Connection Management Request

Information Element Name	Mapping to Diameter AVP	Category	Description
User Identity	User-Identifier	M	This information element contains the identity of the UE. This is a grouped AVP which contains the IMSI.
EPS Bearer Identity	Bearer-Identifier	M	This information element contains the identity of the EPS bearer, identifying the T6a connection to the applicable request.

Information Element Name	Mapping to Diameter AVP	Category	Description
T6a Connection Action	Connection-Action	M	This information element contains T6a connection management action indicating a T6a connection establishment, a T6a connection release or a T6a connection update.
APN	Service-Selection	C	This information element contain the APN that the user wants to connect with. This information element is applicable if the request is for a T6a connection establishment.
Serving PLMN Rate Control	Serving-PLMN-Rate-Control	O	This information element contains the Serving PLMN rate control set by the MME.
CMR Flags	CMR-Flags	O	This information element contains a Bit mask.
Maximum UE Availability Time	Maximum-UE-Availability-Time	O	This information element may be included, if available, if the Connection-Action AVP indicates a T6a connection update and the UE-Reachable-Indicator is set in the CMR-Flags AVP. When present, it indicates the timestamp (in UTC) until which a UE using a power saving mechanism (such as extended idle mode DRX) is expected to be reachable for MT Non-IP Data Delivery. This information may be used by the SCEF to prioritize the retransmission of MT Non-IP Data to UEs using a power saving mechanism.
Extended PCO	Extended-PCO	C	This information element is present, if the MME receives Extended PCO information from the UE.
3GPP Charging Characteristics	3GPP-Charging-Characteristics	C	This information element contains PDN Connection Charging Characteristics data for an APN Configuration with SCEF-based NIDD mechanism. It will be present, if the request is for a T6a connection establishment or for a T6a connection update.

Information Element Name	Mapping to Diameter AVP	Category	Description
RAT-Type	RAT-Type	C	This Information element contains the used RAT Type. It will be present, if the request is for a T6a connection establishment.
Supported Features	Supported-Features	O	This information element contains the list of features supported by the origin host.
Terminal Information	Terminal-Information	C	This information element contains the identity of the UE
Visited PLMN ID	Visited-PLMN-Id	C	This information element shall contain the identity (MCC and MNC) of serving PLMN. It will be present if the request is for a T6a connection establishment or for a T6a connection update.

Connection Management Answer

Information Element Name	Mapping to Diameter AVP	Category	Description
Result	Result-Code / Experimental-Result	M	This information element provides the result of the request. Result-Code AVP shall be used for errors defined in the Diameter Base Protocol. Experimental-Result AVP is used for T6a/b errors. This is a grouped AVP, which contains the 3GPP Vendor ID in the Vendor-Id AVP, and the error code in the Experimental-Result-Code AVP.
NIDD Charging Identifier	PDN-Connection-Charging-Id	C	This Information element is defined in 3GPP TS 32.253 [23] and will be present if the answer is for a T6a connection establishment.
Extended PCO	Extended-PCO	C	This Information Element shall be present, if the SCEF needs to send Extended PCO information to the UE.
Supported Features	Supported-Features	O	This information element contains the list of features supported by the origin host.

Connection Release

MME allows Service Capability Exposure Function (SCEF) to initiate T6a connections release procedure in compliance with the 3GPP specifications 23.682 Release 15, Section 5.13.5.3 and 29.128 Release 15, Section 5.8.

Using one of the following procedures, the MME releases the T6a connection towards the SCEF(s) corresponding to the SCEF ID indicator for an APN:

- User Equipment (UE)-initiated Detach procedure for E-UTRAN
- MME-initiated Detach procedure
- HSS-initiated Detach procedure
- UE or MME requested PDN disconnection procedure.

In one of the following scenarios, the SCEF releases the T6a connection towards the MME corresponding to PDN connections:

- When an NIDD Authorization Update request from the HSS indicates that the user is no longer authorized for NIDD.
- Failure of SCEF or failure of SCS/AS connection
- Based on a request from the SCS/AS
- Based on removal of the APN associated with the T6a connection from the SCEF

SCEF Initiated T6a Connection Release Procedure

SCEF invokes Connection Management by SCEF procedure to release a T6a connection between MME and SCEF. This procedure is mapped to the commands Connection-Management-Request/Answer (CMR/CMA) in the Diameter application along with IEs.

The following table describes Connection Request management IE from SCEF.

Table 1: Connection Management SCEF Request

Information Element Name	Mapping to Diameter AVP	Category	Description
User Identity	User-Identifier	M	This information element contains the identity of the UE. This is a grouped AVP which contains the IMSI.
EPS Bearer Identity	Bearer-Identifier	M	This information element contains the identity of the EPS bearer, identifying the T6a connection to the applicable request.

Information Element Name	Mapping to Diameter AVP	Category	Description
T6a/b Connection Action	Connection Action	M	This information element contains T6a connection management action indicating a T6a connection establishment, a T6a connection release, or a T6a connection update.
Extended PCO	Extended- PCO	C	This information element contains Extended-Protocol Configuration Options (PCO), indicating that the SCEF needs to send updated extended PCO information (for example, APN Rate Control information) to the UE.
Supported Features	Supported-Features	O	Lists the features supported by the origin host.

SCEF sets the Connection-Action to CONNECTION_RELEASE (1) for a T6a Connection Release.

The following table describes SCEF Answer management from MME.

Table 2: Connection Management SCEF Answer

Information Element Name	Mapping to Diameter AVP	Category	Description
Result	Result-Code/Experimental-Result	M	This information element provides the result of the request. Result-Code AVP is used for errors defined in the Diameter Base Protocol. Experimental-Result AVP is used for T6a/b errors. This is a grouped AVP, which contains the 3GPP Vendor ID in the Vendor-Id AVP, and the error code in the Experimental-Result-Code AVP.

Information Element Name	Mapping to Diameter AVP	Category	Description
Supported Features	Supported-Features	O	This information element contains the list of features supported by the origin host.

After MME receives the Connection Management Request with Connection-Action set to 1 in t6a interface, MME does the following.

Table 3: T6a Connection Release Procedure by SCEF

Step	Description
1	Checks if the User Identity exists in the MME. If the User Identity does not exist, sets the Experimental-Result to **DIAMETER_ERROR_USER_UNKNOWN** in the Connection Management SCEF Answer.
2	Checks whether the T6a connection action indicates a T6a connection update or T6a connection release. If the T6a connection acttion is not update or release, then sets the Experimental-Result to **DIAMETER_ERROR_OPERATION_NOT_ALLOWED** in the Connection Management SCEF Answer.
3	Checks whether a T6a connection context exists for a user and the received EPS Bearer Identity. If T6a conection context does not exist, then sets the Experimental-Result to **DIAMETER_ERROR_ INVALID_EPS_BEARER** in the Connection Management SCEF Answer.
4	If the T6a connection action indicates T6a connection release, delete the T6a connection context at the MME. If successful, sets the Result code to DIAMETER_SUCCESS in the Connection Management SCEF Answer.
5	The MME performs the MME initiated Detach procedure.

Initiating Packet Data Network Disconnect or Detach Procedure

MME triggers the PDN disconnect or detach procedure based on the following conditions:

- MME checks whether to trigger PDN Disconnect procedure or Detach procedure based on the PDN Count.
- If the last PDN and Attach without PDN connectivity is supported by UE, then MME triggers the PDN Disconnect procedure.
- If UE has more than one PDN, and UE sends MO Data Request procedure towards SCEF-specific PDN, and if MME receives MO Data answer with any permanent failure cause, MME triggers PDN disconnect procedure towards UE. MME initiates Connection release procedure towards SCEF except when the error is other than “DIAMETER_ERROR_USER_UNKNOW” and “DIAMETER_ERROR_INVALID_EPS_BEARER”
- If UE has only one PDN and Attach without PDN is not supported, then MME triggers Detach procedure. If permanent failure is different than Diameter_Error_User_Unknown and Invalid EPS Bearer ID, MME initiates a Connection Management procedure to release the T6a connection.

- If UE has one PDN or more than one PDN and UE sends MO Data Request procedure towards SCEF-specific PDN, and if MME receives MO Data answer with failure cause as User-Unknown, MME triggers Detach procedure.

The following table provides an easy reference point when MME initiates Detach/PDN disconnect towards UE and release of T6a connection towards SCEF in certain error cases.

Table 4: Detach/PDN disconnect Errors

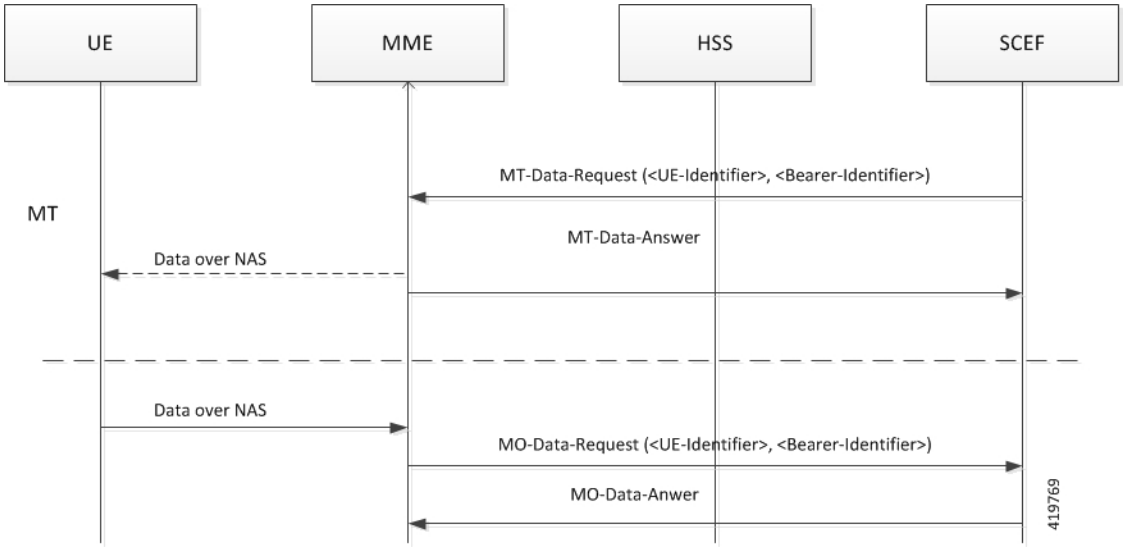
DIAMETER_ERROR/No of PDNs	1 PDN & Attach without PDN Support by UE	>1 PDN	1 PDN & Attach without PDN not Support by UE
USER_UNKNOWN	Detach towards UE and no T6a Connection release towards SCEF	Detach towards UE and no T6a Connection release towards SCEF	Detach towards UE and no T6a Connection release towards SCEF
INVALID_EPS_BEARER	PDN Disconnect towards UE and no T6a Connection release towards SCEF	PDN Disconnect towards UE and no T6a Connection release towards SCEF	Detach towards UE and no T6a Connection release towards SCEF
OPERATION_NOT_ALLOWED	PDN Disconnect towards UE and T6a Connection release towards SCEF	PDN Disconnect towards UE and T6a Connection release towards SCEF	Detach towards UE and T6a Connection release towards SCEF
NIDD_CONFIGURATION_NOT_AVAILABLE	PDN Disconnect towards UE and T6a Connection release towards SCEF	PDN Disconnect towards UE and T6a Connection release towards SCEF	Detach towards UE and T6a Connection release towards SCEF
SCEF_REFERENCE_ID_UNKNOWN	PDN Disconnect towards UE and T6a Connection release towards SCEF	PDN Disconnect towards UE and T6a Connection release towards SCEF	Detach towards UE and T6a Connection release towards SCEF

Non-IP Data Delivery

Non-IP data delivery over the SCEF have the following data delivery modes:

- Mobile Originated (MO) Data Delivery
- Mobile Terminated (MT) Data Delivery

Figure 2: SCEF PDN MO and MT Data Delivery



MO Data Procedure

The Mobile Originated procedure is used between the MME and the SCEF/IWK-SCEF that is invoked by the MME to forward mobile originated Non-IP data of a UE from the MME to the SCEF.

This procedure is mapped to the commands MO-Data-Request and MO-Data-Answer (ODR/ODA) in the Diameter application with IEs described below:

Information Element Name	Mapping to Diameter AVP	Category	Description
User Identity	User-Identifier	M	This information element contains the identity of the UE. This is a grouped AVP which also contains the IMSI.
EPS Bearer Identity	Bearer-Identifier	M	This information element contains the identity of the EPS-bearer identifying the T6a connection for the Non-IP data delivery.
Non-IP Data	Non-IP-Data	C	This information element contains the Non-IP data to be delivered to the SCEF. This Information Element will present when the request conveys Non-IP data.
Supported Features	Supported-Features	O	If present, this information element shall contain the list of features supported by the origin host.

Information Element Name	Mapping to Diameter AVP	Category	Description
MO Exception Data Counter	RRC-Cause-Counter	C	The MME includes this Information Element when the MME needs to send a non-zero counter value for the MO Exception Data Counter. The timestamp in the counter is set with the time at which the counter value increased from 0 to 1.

MO Data Answer

Information Element Name	Mapping to Diameter AVP	Category	Description
Result	Result-Code / Experimental-Result	M	This information element contains the result of the request. The Result-Code AVP is used to indicate success or errors as defined in the Diameter Base Protocol. The Experimental-Result AVP is used for T6a/b errors. This is a grouped AVP, which contains the 3GPP Vendor ID in the Vendor-Id AVP, and the error code in the Experimental-Result-Code AVP.
Requested Retransmission Time	Requested-Retransmission-Time	O	This information element may be present if the Experimental-Result-Code is set to DIAMETER_ERROR_USER_TEMPORARILY_UNREACHABLE and the Maximum Retransmission Time information element is present in the MT Data Request. It may be included if the UE is using a power saving mechanism (such as extended idle mode DRX) and the UE is currently not reachable. When present, this indicate the retransmission time (in UTC) at which the SCEF is requested to retransmit the MT Non-IP Data. The Requested Retransmission Time shall not exceed the Maximum Retransmission Time received from the SCEF.
Supported Features	Supported-Features	O	If present, this information element shall contain the list of features supported by the origin host.

Limitations

The Non-IP Data Delivery over SCEF feature has the following limitations:

- In release 21.1.V0 (N5.1): MME does not support buffering of data.

In 21.3 and later releases: MME supports temporary buffering of single MT Data Request received from SCEF while UE is in idle mode. Buffering of multiple MT Data Request messages per SCEF PDN for a UE is not supported.

- Non-IP data in-sequence delivery cannot be guaranteed and data PDUs may be lost requiring higher protocol layers to ensure guaranteed delivery when needed.
- Currently, only Connection Establishment, Connection Release, MO data transfer, MT data transfer with connected mode and paging on MT data request from SCEF for the UE in IDLE mode, is supported.
- For Control Plane IoT Optimized UEs, both Inter-MME and Intra-MME handovers are not supported.

Supported Standards

The Non-IP Data Delivery over SCEF feature complies with the following standards:

- 3GPP TS 24.301 Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3.
- 3GPP TS 23.401 General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access.
- 3GPP TS 23.682 Architecture enhancements to facilitate communications with packet data networks and applications.
- 3GPP TS 29.128 Mobility Management Entity (MME) and Serving GPRS Support Node (SGSN) interfaces for interworking with packet data networks and applications.
- 3GPP TS 29.274 3GPP Evolved Packet System (EPS); Evolved General Packet Radio Service (GPRS) Tunnelling Protocol for Control plane (GTPv2-C); Stage 3.
- 3GPP TS 29.272 Evolved Packet System (EPS); Mobility Management Entity (MME) and Serving GPRS Support Node (SGSN) related interfaces based on Diameter protocol.

Configuring Non-IP Data over SCEF

This section documents the configuration procedures for the transfer of Non-IP data over SCEF.

This feature is configured in the following stages:

- Configuring SCEF-service
- Association of SCEF-service to MME-service
- Association of SCEF-service to Call-Control-Profile
- Configuring PDN Type Identifier in APN Profile

Configuring SCEF-service

The following CLI command configures SCEF-service:

```
configure
  context context_name
```

```
scef-service service_name
   [ no ] diameter endpoint endpoint_name
   [ default ] diameter dictionary standard
   end
```

Notes:

- The prefix **no** disables the configuration.
- The prefix **default** assigns or restores the default vale for the selected parameters.
- The **scef-service** command is used to create and configure an SCEF Peer Service to communicate with SCEF peers.
- The *service_name* variable identifies the scef-service. The service name is a string with range 1 to 63 characters.
- The **diameter** command configures the Diameter interface (T6a-interface).
- The **dictionary standard** command configures the standard dictionary to be used for T6a interface.
- The **endpoint** *endpoint_name* command configures the diameter endpoint.

Note It is recommended to not remove a diameter endpoint when there are active calls on the system. Adhere to the 'Method of Procedure' to remove an endpoint, otherwise the system behavior would be undefined.

Verifying the Configuration

The SCEF-service configuration can be verified using the show commands provided in this section.

To verify all configured SCEF services, use the following command:

show scef-service all

On executing the above command the following new fields are displayed for SCEF service configuration:

- Service Name
- Context
- Status
- Diameter endpoint
- Diameter dictionary

To verify a specified SCEF service, use the following command:

show scef-service name *service_name*

On executing the above command the following output is displayed for SCEF service configuration:

```
Service name                    : scef1
Context                         : hss
Status                          : STARTED
```

```
Diameter endpoint               : t6a-endpoint
Diameter dictionary             : Standard
```

Association of SCEF-service to MME-service

The following CLI configuration associates the SCEF-service to an MME-service:

```
configure
  context context_name
    mme-service service_name
      [ no ] scef-service service_name
      end
```

Notes:

- The **no** command prefix disables/disassociates the scef-service configuration.
- The **scef-service** command associates SCEF with its MME peer.
- The *service_name* identifies the name of the SCEF service that will be used by the MME service. It is a string of range from 1 to 63.

Verifying the Configuration

The association of an SCEF-service to an MME-service can be verified using the show commands provided in this section.

To verify all associated SCEF services, use the following command:

show mme-service all

On executing the above command the following new field(s) are displayed:

- SCEF Service

To verify a specific MME-service, use the following command:

show mme-service name *service_name*

On executing the above command, the following output is displayed:

```
SCEF Service                : scef1
```

Association of SCEF-service to Call-Control-Profile

The following CLI configuration associates SCEF-service to the Call-Control-Profile.

```
configure
  call-control-profile profile_name
    [ remove ] scef-service service_name
    end
```

Notes:

- The **no** command prefix disables/disassociates the scef-service configuration.

- The **scef-service** command associates SCEF with the call-control-profile.
- The *service_name* identifies the name of the SCEF service. It is a string of range from 1 to 63.

Verifying the Configuration

The association of an SCEF-service to the Call Control Profile can be verified using the show commands provided in this section.

To verify all associated SCEF services, use the following command:

show call-conrol-profile full all

On executing the above command the following new field(s) are displayed:

- SCEF Service

To verify a specific MME-service, use the following command:

show call-control-profile name *profile_name*

On executing the above command, the following output is displayed:

```
SCEF Service                          : scef1
```

To verify configured values for specified Call Control Profile with CP CIoT Optimization, use the following command:

show call-control-profile full name *profile_name*

When CP CIoT Optimization is enabled, the output displayed on executing the above command is as follows:

```
CIoT Optimisation:
  CP-Optimisation : Enabled
  Access-Type     : WB-EUTRAN
```

Note In the above output, the field **Access-Type** can have other results such as: NB-IoT, or both WB-EUTRAN and NB-IoT, based on the configuration.

When CP CIoT Optimization is diabled, the output displayed on executing the above command is as follows:

```
CIoT Optimisation
  CP-Optimisation           : Disabled
  Access-Type               : N/A
```

Configuring PDN Type Identifier in APN Profile

The following CLI configures/overrides PDN Type indicator in APN profile.

```
configure
   apn-profile profile_name
     pdn-type { ip | non-ip { sgi | t6a [ scef-id scef_id [ scef-realm
realm_name ] ] } }
     remove pdn-type
     end
```

Notes:

- The **remove** command prefix removes the pdn-type configuration.
- The **pdn-type** command identifies the Cellular IoT PDN type.
- The **ip** keyword identifies the Cellular IoT PDN type as IP PDN.
- The **non-ip** keyword identifies the Cellular IoT PDN type as Non-IP PDN.
- The **t6a** keyword identifies the Cellular IoT Non-IP PDN delivery path type as T6a
- The **scef-id** *scef-id-string* is an optional keyword, which specifies the SCEF identifier at the T6a interface. The SCEF identifier is a string of length 1 up to 63 characters.
- The **scef-realm** *realm-name* is an optional keyword, which specifies the SCEF Diameter realm. The realm_name is string of length 1 up to 127 characters.

Verifying the Configuration

The PDN Type Identifier for a specified APN Profile can be verified using the following show command(s):

show apn-profile full name *profile_name*

On executing the above command, the following new fields are displayed:

- PDN Type
- NON-IP Delivery Mechanism Type
- SCEF-Id (for T6a interface)
- SCEF-Realm (for T6a interface)

When PDN Type is configured, the output displayed on executing the above command is as follows:

```
PDN Type                              : NON-IP
  NON-IP Delivery Mechanism Type      : SGi/T6A
    SCEF-Id                           : scef1
    SCEF-Realm                        : xyz.com
```

When PDN Type is configured, the output displayed on executing the above command is as follows:

```
PDN Type                              : Not Configured
```

Configuring SCEF Wait Time in APN Profile

Use the following configuration in the APN Profile Configuration mode to configure the SCEF wait time value in APN Profile.

```
configure
  apn-profile profile_name
    [ remove ] ciot scef wait-time wait_time
    end
```

Notes:

- **ciot**: Configures the parameters related to Cellular IoT features.

- **scef**: Configures the SCEF specific parameters.
- **wait-time** *wait_time*: Specifies the wait time in seconds, before which MME is expected to send MT Data Answer (TDA) to SCEF in response to the MT Data Request (TDR) message. *wait_time* is an integer ranging from 1 to 100.
- The SCEF wait time configuration at MME overrides the value of SCEF wait time received in MT Data Request. MME will respond with MT Data Answer within the configured SCEF wait time value irrespective of the presence or absence of SCEF Wait Time AVP in MT Data Request sent by SCEF.
- This command is disabled by default.

Verifying the Configuration

The SCEF wait time in APN Profile can be verified using the following show command.

show apn-profile full name *profile_name*

The following fields display the configured SCEF wait time for a specified APN profile on executing the above command:

```
CIoT:
   SCEF:
      Wait-Time  :  10 secs
```

Monitoring and Troubleshooting

This section provides information on how to monitor and troubleshoot using show commands and bulk statistics available to support of this feature.

Show Commands and/or Outputs

This section provides information regarding show commands and/or their outputs in support of this feature.

show mme-service db record imsi *mobile_station_identifier*

```
DB RECORD
=========
  Sessmgr Instance : 1
  Imsimgr Instance : 2
.
.
APN Config Data
------------------
.
.
PDN-GW Name                    : test
PDN-GW Realm                   : test.com
Non-IP-PDN-Type-Indicator      : FALSE
Non-IP-Data-Delivery-Mechanism : N/A
SCEF-ID                        : N/A
SCEF-Realm                     : N/A
```

show mme-service session all

The above show command displays the MME Session information. For this feature, a new field is added as displayed in the following output:

- PDN information
  - PDN Type: IPv4/IPv6/IPv4v6/Non-IP
  - PDN Data Delivery Interface: S1-U/S11-U/T6a
  - PDN Non-IP Data Delivery Charging Identifier



Note This information is applicable when CIoT Optimization is enabled.

show mme-service session counters imsi *mobile_station_identifier*

On executing the above command the following output is displayed for this feature:

```
Username: n/a                          Callid: 00004e22
    MSID:         123456789012346
...
...
...
ESM Events:
  PDN Connections:
   Attempted:          0   Success:         0
   Failures:           0
  NON-IP PDN Connections With SCEF:
   Attempted:          0   Success:         0
   Failures:           0
...
...
...
  PDN Disconnections With SCEF:
   Attempted:          0   Success:         0
   Failures:           0
...
...
Control Plane User Data Statistics:
  Cumulative Data Over T6A (SCEF) Statistics:
    Rx Packets:         0   Rx Bytes:            0
    Tx Packets:         0   Tx Bytes:            0
    Rx Drop Packets:    0   Rx Drop Bytes:       0
    Tx Drop Packets:    0   Tx Drop Bytes:       0
Per PDN Statistics:
 APN Name: starent.com
  Data Over T6A (SCEF) Statistics:
    Rx Packets:         0   Rx Bytes:            0
    Tx Packets:         0   Tx Bytes:            0
    Rx Drop Packets:    0   Rx Drop Bytes:       0
    Tx Drop Packets:    0   Tx Drop Bytes:       0
```

show mme-service statistics

The ESM procedure statistics counters are added for the following:

- Non-IP PDN Connections over SCEF (T6a)

- Non-IP PDN Disconnects over SCEF (T6a)

The statistics added are as follows:

```
ESM Statistics:
.
.
PDN Connections With PDN Type Override to ipv6:
   Attempted:          0   Success:         0
   Failures:           0
NON-IP PDN Connections With SCEF:
   Attempted:          0   Success:         0
   Failures:           0
NON-IP PDN Connections With SGI:
   Attempted:          0   Success:         0
   Failures:           0
PDN Disconnections With SCEF:
   Attempted:          0   Success:         0
   Failures:           0
```

For PDN statistics, the following is displayed:

```
.
.
PDN Statistics:
  All PDNs:            0   Connected PDNs:      0
  Idle PDNs:           0
NON-IP PDN Statistics:
...
...
Data Over T6A (SCEF) Statistics:
   Rx Packets:         0   Rx Bytes:            0
   Tx Packets:         4   Tx Bytes:            0
   Rx Drop Packets:    0   Rx Drop Bytes:       0
   Tx Drop Packets:    0   Tx Drop Bytes:       0
```

show scef-service statistics all

On executing the above command, the following output is displayed. The below fields are newly added to show the SCEF service statistics:

```
SCEF statistics for Service: scef1
Session Stats:
  Total Current Sessions: 0
  Sessions Failovers:     0   Total Starts:           2
  Total Session Updates:  4   Total Terminated:       2
Message Stats:
  Total Messages Rcvd:    5   Total Messages Sent:    5
  OD Request:             0   OD Answer:              0
  ODR Retries:            0   ODA Timeouts:           0
  ODA Dropped:            0
  TD Request:             1   TD Answer:              1
  TDR Retries:            0   TDA Timeouts:           0
  TDA Dropped:            0
  TD Request Buffered :   0   TD Answer Buffered:     0
  TDA Dropped Buffered:   0
  CI Request:             0   CI Answer:              0
  CIR Retries:            0   CIA Timeouts:           0
  CIA Dropped:            0
  RI Request:             0   RI Answer:              0
  RIR Retries:            0   RIA Timeouts:           0
  RIA Dropped:            0
  CM-E Request:           2   CM-E Answer:            2
```

```
  CMR-E Retries:          0   CMA-E Timeouts:          0
  CMA-E Dropped:          0
  CM-R Request:           2   CM-R Answer:             2
  CMR-R Retries:          0   CMA-R Timeouts:          0
  CMA-R Dropped:          0
  CM-U Request:           0   CM-U Answer:             0
  CMR-U Retries:          0   CMA-U Timeouts:          0
  CMA-U Dropped: 0

Message Error Stats:
  Unable To Comply:       0   User Unknown:            0
  Other Errors:           0   RAT Not Allowed:         0

Bad Answer Stats:
  Auth-Applicaiotn-Id:    0   Session-Id:              0
  Origin-Host:            0   Origin Realm:            0
  Parse-Message-Errors:   0   Parse-Misc-Errors:       0
  Miscellaneous:          0
```

show scef-service statistics summary

On executing the above command, the following statistics are displayed for SCEF service:

```
Session Stats:
Total Current Sessions:        0
Sessions Failovers:            0  Total Starts:           2
Total Session Updates:         4  Total Terminated:
```

show subscribers all

The above show command displays the subscriber information. For this feature, a new Network Type is added as displayed in the following output:

```
Network (I) - IP (M) - Mobile-IP (L) - L2TP
Type: (P) - Proxy-Mobile-IP (i) - IP-in-IP (G) - GRE
(V) - IPv6-in-IPv4 (S) - IPSEC (C) - GTP
(A) - R4 (IP-GRE) (T) - IPv6 (u) - Unknown
(W) - PMIPv6(IPv4) (Y) - PMIPv6(IPv4+IPv6) (R) - IPv4+IPv6
(v) - PMIPv6(IPv6) (/) - GTPv1(For SAMOG) (+) - GTPv2(For SAMOG)
(N) - NON-IP
```

Bulk Statistics

Counters	Description
The following bulk statistics are included in the MME Schema to track T6a data:	
t6a-data-pkts-rx	Proprietary counter provides the total number of NON-IP packets received over T6A Interface
t6a-data-pkts-tx	Proprietary counter provides the total number of NON-IP packets transmitted over T6A Interface
t6a-data-bytes-rx	Proprietary counter provides the total number of NON-IP data in bytes received over T6A Interface
t6a-data-bytes-tx	Proprietary counter provides the total number of NON-IP data in bytes transmitted over T6A Interface

Counters	Description
t6a-data-pkts-rx-drop	Proprietary counter provides the total number of NON-IP packets received over T6A Interface, but dropped by MME
t6a-data-pkts-tx-drop	Proprietary counter provides the total number of NON-IP packets transmitted over T6A Interface, but transmission failed
t6a-data-bytes-rx-drop	Proprietary counter provides the total number of NON-IP data in bytes received over T6A Interface, but dropped by MME
t6a-data-bytes-tx-drop	Proprietary counter provides the total number of NON-IP data in bytes transmitted over T6A Interface, but transmission failed
The following bulk statistics are included in the SCEF Schema to track the SCEF service data:	
vpnname	The name of the VPN associated with the interface.
vpnid	The identification number of the context configured on the system that is currently facilitating the LCS service. This is an internal reference number. The identification number is generated during system startup
servname	The name of the LCS service for which these statistics are being displayed.
servid	The identification number of the LCS service for which these statistics are being displayed. This is an internal reference number. The identification number is generated during system startup
tot-active-sess	The current total number of active sessions per SCEF service.
tot-sess-failover	The total number of session failovers.
tot-sess-starts	The total number of session starts.
tot-sess-updates	The total number of session updates.
tot-sess-term	The total number of session terminations.
tot-msg-rcvd	The total number of messages received per SCEF service.
tot-msg-sent	The total number of messages sent by MME per SCEF service.
mo-data-req	The total number of MO data request sent by the MME.
mo-data-answer	The total number of MO data answers received by MME.
mo-data-retries	The total number of MO data request retries.
mo-data-timeout	The total number of MO data request timeout happened because of SCEF not responding.
mo-data-dropped	The total number of MO data requests dropped at MME.
mt-data-req	The total number of MT data requests received.
mt-data-answer	The total number of MT data answer sent by MME to SCEF.

Counters	Description
mt-data-retries	The total number of MT data retries received at MME.
mt-data-timeout	The total number of MT data time outs happened.
mt-data-dropped	The total number of MT data requests dropped at MME.
mt-data-req-buffered	The total number of MT Data Requests buffered temporarily.
mt-data-answer-buffered	The total number of MT Data Answers sent for buffered requests.
mt-data-buffered-dropped	The total number of buffered MT Data Answers dropped at MME.
config-info-req	The total number of Configuration Information Requests received at MME.
config-info-answer	The total number of Configuration Information Answer sent by MME.
config-info-retries	The total number of duplicate Configuration Information Requests received at MME.
config-info-timeout	The total number of Configuration Information Request timeout happened.
config-info-dropped	The total number of Configuration Information Requests dropped.
report-info-req	The total number of Report Information Requests sent by MME to SCEF.
report-info-answer	The total number of Report Information Answer recieved by MME.
report-info-retries	The total number of Report Information Requests retries sent by MME.
report-info-timeout	The total number of Report Information Requests timed out.
report-info-dropped	The total number of Report Information Requests dropped.
conn-mgmt-est-req	The total number of Connection-Management-Requests sent by MME for the connection action establishment.
conn-mgmt-est-answer	The total number of Connection-Management-Answers received for the connection action establishment.
conn-mgmt-est-retries	The total number of Connection-Management-Request retry happened for the connection action establishment.
conn-mgmt-est-answer-timeout	The total number of Connection-Management-Answer timeouts for the connection action establishment.
conn-mgmt-est-answer-dropped	The total number of Connection-Management-Answers dropped for the connection action establishment.
conn-mgmt-rel-req	The total number of Connection-Management-Requests sent by MME for the connection action release.
conn-mgmt-rel-answer	The total number of Connection-Management-Answers received for the connection action release.

Counters	Description
conn-mgmt-rel-retries	The total number of Connection-Management-Request retry happened for the connection action release.
conn-mgmt-rel-answer-timeout	The total number of Connection-Management-Answer timeouts for the connection action release.
conn-mgmt-rel-answer-dropped	The total number of Connection-Management-Answers dropped for the connection action release.
conn-mgmt-update-req	The total number of Connection-Management-Requests sent by MME for the connection action update.
conn-mgmt-update-answer	The total number of Connection-Management-Answers received for the connection action update.
conn-mgmt-update-retries	The total number of Connection-Management-Request retry happened for the connection action update.
conn-mgmt-update-answer-timeout	The total number of Connection-Management-Answer timeouts for the connection action release.
conn-mgmt-update-answer-dropped	The total number of Connection-Management-Answers dropped for the connection action release.
msg-error-other	The total number of other result error codes received from SCEF .
msg-error-unable-to-comply	The total number of result code diameter-unable-to-comply received from SCEF.
msg-error-user-unknown	The total number of result code user-unknown received from SCEF.
msg-error-rat-not-allowed	The total number of result code rat-not-allowed received from SCEF.
bad-answer-auth-app-id	The total number of bad answers received because of error in auth-app-id.
bad-answer-session-id	The total number of bad answers received because of invalid session id.
bad-answer-origin-host	The total number of bad answers received because of invalid origin host.
bad-answer-origin-realm	The total number of bad answers received because of invalid origin realm.
bad-answer-parse-msg-err	The total number of bad answers received because of message parse error.
bad-answer-parse-misc-err	The total number of bad answers received because of miscellaneous msg parse error.
bad-answer-answer-misc	The total number of bad answers received because of miscellaneous errors.