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and Serving GPRS Support Node (SGSN)
interfaces for interworking with packet data networks
and applications
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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

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1 Scope

The present document describes the Diameter-based interfaces between the SCEF/IWK-SCEF and other network entities such as MME/SGSN for the Architecture enhancements to facilitate communications with packet data networks and applications.

In particular, this document specifies the T6a interface between the MME and the SCEF, the T6ai interface between the MME and the IWK-SCEF, the T6b interface between the SGSN and the SCEF, the T6bi interface between the SGSN and the SCEF and the T7 interface between the SCEF and the IWK-SCEF. The procedures over those interfaces are defined in 3GPP TS 23.682 [2].

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 23.682: "Architecture enhancements to facilitate communications with packet data networks and applications ".

[3] IETF RFC 3588: "Diameter Base Protocol".

[4] 3GPP TS 29.229: "Cx and Dx interfaces based on the Diameter protocol; protocol details ".

[5] 3GPP TS 29.336: "Home Subscriber Server (HSS) diameter interfaces for interworking with packet data networks and applications".

[6] 3GPP TS 29.228: "IP multimedia (IM) Subsystem Cx Interface; Signalling flows and Message Elements".

[7] IETF RFC 4960: "Stream Control Transport Protocol".

[8] IETF RFC 5234: "Augmented BNF for Syntax Specifications: ABNF".

[9] IETF RFC 7683: "Diameter Overload Indication Conveyance".

[10] 3GPP TS 29.212: "Policy and Charging Control (PCC); Reference points".

[11] 3GPP TS 25.413: "UTRAN Iu interface Radio Access Network Application Part (RANAP) signalling".

[12] 3GPP TS 24.008: "Mobile Radio Interface Layer 3 specification; Core Network Protocols; Stage 3".

[13] 3GPP TS 36.413: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP)".

[14] 3GPP TS 48.018: "General Packet Radio Service (GPRS); Base Station System (BSS) - Serving GPRS Support Node (SGSN); BSS GPRS protocol (BSSGP)".

[15] IETF RFC 7944: "Diameter Routing Message Priority".

[16] 3GPP TS 29.272: "Mobility Management Entity (MME) and Serving GPRS Support Node (SGSN) related interfaces based on Diameter protocol".

[17] 3GPP TS 29.329: "Sh Interface based on the Diameter protocol; Protocol details".

[18] Void.

[19] 3GPP TS 23.007: "Restoration procedures".

[20] 3GPP TS 32.299: "Telecommunication management; Charging management; Diameter charging applications".

[21] IETF RFC 5778: "Diameter Mobile IPv6: Support for Home Agent to Diameter Server Interaction".

[22] 3GPP TS 32.299: "Telecommunication management; Charging management; Diameter charging applications".

[23] 3GPP TS 32.253: "Telecommunication management; Charging management; Control Plane (CP) data transfer domain charging".

[24] 3GPP TS 23.003: "Numbering, addressing and identification".

[25] 3GPP TS 23.401: "GPRS enhancements for E-UTRAN access".

[26] 3GPP TS 29.172: "Location Services (LCS); Evolved Packet Core (EPC) LCS Protocol (ELP) between the Gateway Mobile Location Centre (GMLC) and the Mobile Management Entity (MME); SLg interface".

[27] 3GPP TS 29.338: "Diameter based protocols to support SMS capable MMEs".

[28] 3GPP TS 24.301: "Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3".

[29] 3GPP TS 29.061: "Interworking between the Public Land Mobile Network (PLMN) supporting packet based services and Packet Data Networks (PDN)".

[30] 3GPP TS 32.298: "Telecommunication Management; Charging Management; Charging Data Record (CDR) parameter description".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

DRMP	Diameter Routing Message Priority
SCEF	Service Capability Exposure Function
IWK-SCEF	Interworking - SCEF

4 General Description

4.1 Introduction

The T6a/b reference point between the MME/SGSN and the SCEF, the T6ai/bi reference point between the MME/SGSN in the VPLMN and the IWK-SCEF and the T7 reference point between the IWK-SCEF and the SCEF are defined in the 3GPP TS 23.682 [2].

This document describes the Diameter-based T6a/b, T6ai/bi and T7 related procedures, message parameters and protocol specification.

An excerpt of the 3GPP Architecture for the enhancements to facilitate communications with packet data networks and applications, as defined in 3GPP TS 23.682 [2] is shown in Figure 4.1-1, where the relevant interfaces towards the SCEF/IWK-SCEF are highlighted.

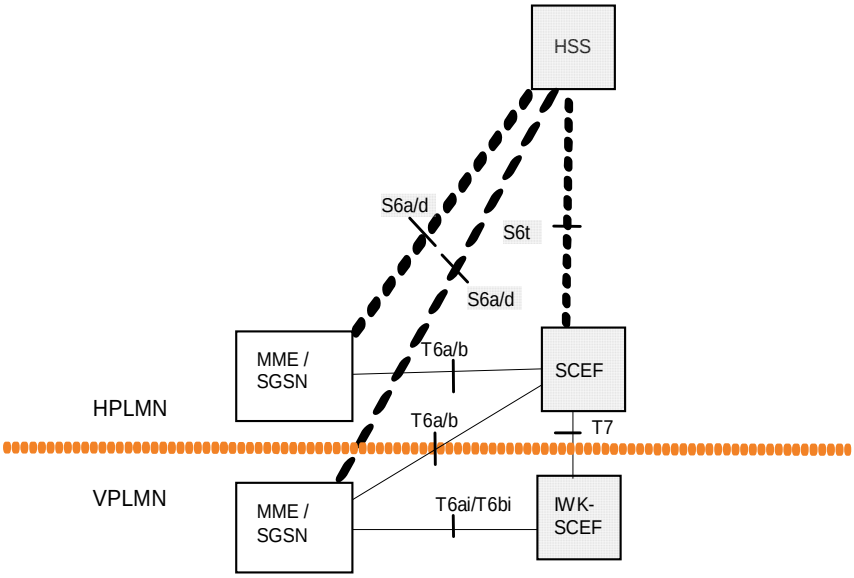

Figure 4.1-1: 3GPP Architecture for the enhancements to facilitate communications with packet data networks and applications

In this architecture, the T6a/b reference point connects the MME/SGSN with the SCEF.

The T6a/b interface shall allow the SCEF:

- to receive reports of the monitoring events from the MME/SGSN configured via an HSS;
- to configure the monitoring events at an MME/SGSN which are not UE related in the non roaming cases;
- to manage a connection between the MME and the SCEF on T6a;
- to send MT data on T6a;
- to receive MO data on T6a.

The T6ai/bi reference point connects the MME/SGSN with the IWK-SCEF in the visited network, if the IWK-SCEF is deployed.

The T6ai/bi interface shall allow the IWK-SCEF to:

- to receive configuration of the monitoring events from the MME or the SGSN and perform a filtering of the services which are allowed for this subscriber in this visited network based on roaming policies;
- to receive reports of the monitoring events from the MME/SGSN that are configured via an HSS, perform a filtering and forward them to the SCEF (in the home network which has configured the event) via the T7 reference point;
- to receive MO data on T6ai and forward them to the SCEF;
- to receive MT data and forward them to the MME on T6ai;
- to manage a connection between MME and IWK-SCEF on T6ai and forward connection management commands to the SCEF.

The T7 reference point connects the IWK-SCEF in the visited network with the SCEF in the home network.

The T7 interface shall allow the IWK-SCEF to:

- to forward reports received on T6ai/bi to the SCEF indicated in the event report received on T6ai/T6bi;
- to receive MO data on T6ai and forward them to the SCEF on T7;
- to receive MT data on T7 and forward them to the MME;
- to manage connection between the SCEF and the IWK-SCEF on T7 and forward connection management commands to the MME.

5 Procedures Description

5.1 Introduction

This section describes the Diameter-based T6a, T6b, T6ai, T6bi and T7 interface related procedures and the Information elements exchanged between the functional entities.

In the tables that describe the Information Elements transported by each Diameter command, each Information Element is marked as (M) Mandatory, (C) Conditional or (O) Optional in the "Cat." column. For the correct handling of the Information Element according to the category type, see the description detailed in section 6 of the 3GPP TS 29.228 [6].

5.2 Report Procedures

5.2.1 General

This procedure is used between the MME/SGSN and the SCEF, between the MME/SGSN and the IWK-SCEF and between the IWK-SCEF and the SCEF.

When the procedure is invoked by the MME or the SGSN, it is used for reporting:

- the UE Loss of Connectivity;
- the UE Reachability;
- location of the UE and change in location of the UE;
- Communication Failure.

When the procedure is invoked by the IWK-SCEF, it is used for conveying the monitoring event reported by the MME or the SGSN to the SCEF, after applying the roaming policies configured at the IWK-SCEF.

This procedure is mapped to the commands Reporting-Information-Request/Answer in the Diameter application specified in clause 6. The tables 5.2.1-1 and 5.2.1-2 detail the involved information elements.

Table 5.2.1-1: Reporting Information Request

Information Element Name	Mapping to Diameter AVP	Cat.	Description
Monitoring Event Report (see 3GPP TS 29.336 [5] subclause 8.4.3)	Monitoring-Event-Report	C	If the Reporting-Information-Request is sent for reporting the monitoring events, the MME/SGSN and the IWK-SCEF shall include the monitoring event(s) reported towards the SCEF.
Supported Features (See 3GPP TS 29.229 [4])	Supported-Features	O	If present, this information element shall contain the list of features supported by the origin host.

Table 5.2.1-2: Reporting Information Answer

Information Element Name	Mapping to Diameter AVP	Cat.	Description
Result (See 6.3)	Result-Code / Experimental-Result	M	Result of the request. Result-Code AVP shall be used for errors defined in the Diameter Base Protocol. Experimental-Result AVP shall be 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.
Supported Features (See 3GPP TS 29.229 [4])	Supported-Features	O	If present, this information element shall contain the list of features supported by the origin host.

5.2.2 Detailed Behaviour of the MME/SGSN

5.2.2.0 General

The MME/SGSN shall fill the Monitoring-Event-Report AVP according to the event reported as specified below. For all monitoring events, the SCEF-ID and the SCEF-Reference-ID AVPs shall be included. In addition, the event specific AVPs as listed below shall be included based on the type of event reported.

If the MME/SGSN receives an Experimental-Result-Code set to DIAMETER_ERROR_SCEF_REFERENCE_ID_UNKNOWN within an RIA command, it shall delete the event stored for the indicated SCEF-ID and SCEF-Reference-ID (see 3GPP TS 23.007 [19]).

5.2.2.1 UE Loss of Connectivity

The following AVPs shall be present within the Monitoring-Event-Report AVP when the UE Loss of Connectivity event is reported:

- Monitoring-Type set to LOSS_OF_CONNECTIVITY (0)

5.2.2.2 UE Reachability

The following AVPs shall be present within the Monitoring-Event-Report AVP when the UE Reachability event is reported:

- Monitoring-Type set to UE_REACHABILITY (1)
- Reachability-Information set to REACHABLE_FOR_DATA(1)

5.2.2.3 Location Reporting

The following AVPs shall be present within the Monitoring-Event-Report AVP when the location event is reported:

- Monitoring-Type set to LOCATION_REPORTING (2)
- EPS-Location-Information

5.2.2.4 Communication Failure

The following AVPs shall be present within the Monitoring-Event-Report AVP when the Communication Failure event is reported

- Monitoring-Type set to COMMUNICATION_FAILURE (5)
- Communication-Failure-Information (see subclause 6.4.3)

5.2.2.5 Availability after DDN failure

The following AVPs shall be present within the Monitoring-Event-Report AVP when the Availablability after DDN failure event is reported:

- Monitoring-Type set to AVAILABILITY_AFTER_DDN_FAILURE (6)

5.2.3 Detailed Behaviour of the SCEF

When the SCEF receives a Monitoring Event Report AVP from the MME/SGSN or the IWK-SCEF with a SCEF-Reference-ID not known by the SCEF, it shall reply with Experimental-Result-Code set to DIAMETER_ERROR_SCEF_REFERENCE_ID_UNKNOWN (see 3GPP TS 23.007 [19]).

Otherwise when the SCEF receives a Reporting-Information-Request command from the MME/SGSN or the IWK-SCEF, the SCEF shall set Result-Code to DIAMETER_SUCCESS in the Reporting-Information-Answer and shall handle it according to the procedures defined in 3GPP TS 23.682 [2].

5.2.4 Detailed Behaviour of the IWK-SCEF

When the IWK-SCEF receives a Reporting-Information-Request command from the MME/SGSN it shall deliver the request to the SCEF after applying the roaming policies configured at the IWK-SCEF, as specified in 3GPP TS 23.682 [2].

5.3 Event Configuration Procedure

5.3.1 General

This procedure is used between the SCEF and the MME and between the SCEF and the SGSN to configure the monitoring events directly at the MME/SGSN through the T6a/b interface.

When the procedure is invoked by the SCEF, it is used for configuring the event(s):

- the number of UEs at a given geographic location.

This procedure is mapped to the commands Configuration-Information-Request/Answer in the Diameter application specified in clause 6. The tables 5.3.1-1 and 5.3.1-2 detail the involved information elements.

Table 5.3.1-1: Configuration Information Request

Information Element Name	Mapping to Diameter AVP	Cat.	Description
Monitoring Event Configuration (see 3GPP TS 29.336 [5] subclause 8.4.2)	Monitoring-Event-Configuration	C	If present, this Information Element shall contain the details of the Monitoring event(s) configured.
Supported Features (See 3GPP TS 29.229 [4])	Supported-Features	O	If present, this Information Element shall contain the list of features supported by the origin host.

Table 5.3.1-2: Configuration Information Answer

Information Element Name	Mapping to Diameter AVP	Cat	Description
Result (See 6.3)	Result-Code / Experimental-Result	M	Result of the request. Result-Code AVP shall be used for errors defined in the Diameter Base Protocol. Experimental-Result AVP shall be used for T6a/T6b 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.
Supported Features (See 3GPP TS 29.229 [4])	Supported-Features	O	If present, this information element shall contain the list of features supported by the origin host.
Monitoring Event Report (see 3GPP TS 29.336 [5] subclause 8.4.3)	Monitoring-Event-Report	C	If an immediate report is available this information element shall contain the requested data available in the MME/SGSN.
Monitoring Event-Configuration Status (see 3GPP TS 29.336 [5] subclause 8.4.24)	Monitoring-Event-Config-Status	O	If present it shall contain the status of each monitoring event configuration identified by an SCEF-Reference-ID

5.3.2 Detailed Behaviour of the MME/SGSN

Monitoring Events configuration and deletion directly at the MME/SGSN for roaming scenarios is not supported. For the non roaming cases, when the Configuration-Information-Request is received from the SCEF, the MME/SGSN shall, in the following order:

1. Check whether the requesting SCEF is authorized to request the specified service (e.g: number of UEs at a given geographic location). If not, Experimental-Result-Code shall be set to DIAMETER_ERROR_UNAUTHORIZED_REQUESTING_ENTITY (5510) in the Configuration-Information-Answer.

2. If the TA / RA / ECGI location requested by the SCEF is not served by the MME/SGSN, then the MME/SGSN shall set the Experimental-Result AVP to DIAMETER_ERROR_REQUESTED_LOCATION_NOT_SERVED (5650) in the Configuration-Information-Answer.

If there is an error in any of the above steps then the MME/SGSN shall stop processing and shall return the error code specified in the respective step.

If the MME/SGSN cannot fulfil the received request for reasons not stated above, it shall stop processing the request and set Result-Code to DIAMETER_UNABLE_TO_COMPLY.

If CIR message includes multiple SCEF-Reference-ID and for a SCEF-Reference-ID the monitoring events cannot be handled, the MME/SGSN shall report the failed SCEF-Reference-ID to the SCEF with an appropriate status in the Monitoring-Event-Config-Status AVP.

For the number of UEs in a geographic location monitoring event, for each SCEF-Reference-ID that the MME/SGSN is able to successfully process, the MME/SGSN shall include in the Configuration-Information-Answer, the exact count of

the number of UEs at the requested location. If the requested location type is current location, then the MME/SGSN may activate the paging and RAN location reporting procedures (if required) before providing the response in the Configuration-Information-Answer.

5.3.3 Detailed Behaviour of the IWK-SCEF

Monitoring Events configuration and deletion directly at the MME/SGSN for roaming scenarios is not supported. Consequently the IWK-SCEF is not impacted for Monitoring Events configuration and deletion directly at the MME/SGSN from the SCEF.5.3.4 Detailed Behaviour of the SCEF

When the SCEF receives Monitoring Event Report AVP from the MME/SGSN or the IWK-SCEF in the CIA command, it shall handle it according to the procedures defined in 3GPP TS 23.682 [2].

When the SCEF receives a Monitoring Event Report AVP from the MME/SGSN with a SCEF-Reference-ID not known by the SCEF, it should discard the Monitoring Event Report received in CIA command.

5.4 Event Configuration Procedure for Roaming

5.4.1 General

The MME/SGSN shall send the monitoring event configuration information to the IWK-SCEF in roaming scenarios, when the MME/SGSN receives the monitoring event configuration from the HSS. The monitoring event configuration information shall be locally consumed at the IWK-SCEF and the IWK-SCEF shall not route such requests beyond it.

This procedure is mapped to the commands Configuration-Information-Request/Answer in the Diameter application specified in clause 6. The tables 5.4.1-1 and 5.4.1-2 detail the involved information elements.

Table 5.4.1-1: Configuration-Information-Request

Information Element Name	Mapping to Diameter AVP	Cat.	Description
Monitoring Event Configuration (see 8.4.2)	Monitoring-Event-Configuration	C	If present, this Information Element shall contain the details of Monitoring event(s).
Monitoring Event Report (see 8.4.3)	Monitoring-Event-Report	C	If an immediate report is available this information element shall contain the event reported by the MME/SGSN. The IWK-SCEF may normalize the event report and return it in the Configuration-Information-Answer.
Supported Features (See 3GPP TS 29.229 [7])	Supported-Features	O	If present, this Information Element shall contain the list of features supported by the origin host.

Table 5.4.1-2: Configuration-Information-Answer

Information Element Name	Mapping to Diameter AVP	Cat	Description
Result (See 6.3)	Result-Code / Experimental-Result	M	Result of the request. Result-Code AVP shall be used for errors defined in the Diameter Base Protocol. Experimental-Result AVP shall be used for S6t 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.
Supported Features (See 3GPP TS 29.229 [7])	Supported-Features	O	If present, this information element shall contain the list of features supported by the origin host.
Monitoring Event-Configuration Status (see 3GPP TS 29.336 [5] subclause 8.4.24)	Monitoring-Event-Config-Status	O	If present it shall contain the status of each monitoring event configuration identified by an SCEF-Reference-ID

5.4.2 Detailed Behaviour of the IWK-SCEF

When the Configuration-Information-Request is received from the MME/SGSN, the IWK-SCEF shall, in the following order:

1. Check whether the requesting SCEF, identified by the SCEF-ID is authorized to request the specified service at the VPLMN. If not, Experimental-Result shall be set to DIAMETER_ERROR_UNAUTHORIZED_REQUESTING_ENTITY (5510) in the Configuration-Information-Answer.

2. Check whether the chargeable party for the monitoring event is authorized to be charged at the VPLMN. If not, Experimental-Result shall be set to DIAMETER_ERROR_UNAUTHORIZED_REQUESTING_ENTITY (5510) in the Configuration-Information-Answer.

If the monitoring event configuration also carries the monitoring event report, the IWK-SCEF checks if the immediate events reported by the MME/SGSN needs to be normalized. If yes, the IWK-SCEF shall normalize the event report as per local policies. The IWK-SCEF shall then send the normalized monitoring event report towards the SCEF as a separate Reporting-Information-Request message.

If the monitoring event configuration is for a continuous monitoring (i.e Monitoring-Duration and/or Maximum-Number-Of-Reports are set), then the IWK-SCEF shall temporarily store the monitoring event configuration until the deletion criteria for the monitoring event configuration is met. The stored monitoring event configuration information shall be used during subsequent monitoring event report procedure, to generate the charging records towards the right chargeable party.

If the received SCEF Reference ID for Deletion does not exist, the IWK-SCEF shall set the Experimental-Result-Code to DIAMETER_ERROR_CONFIGURATION_EVENT_NON_EXISTANT (5514).

If the SCEF-Reference-ID exists and the old configuration data could not be replaced by new Configuration event data, the HSS shall set the Experimental-Result-Code to DIAMETER_ERROR_CONFIGURATION_EVENT_STORAGE_NOT_SUCCESSFUL (5513).

If the IWK-SCEF cannot fulfil the received request for reasons not stated in the above, it shall stop processing the request and set Result-Code to DIAMETER_UNABLE_TO_COMPLY.

5.4.3 Detailed Behaviour of the MME/SGSN

When the MME/SGSN receives the Configuration-Information-Answer from the IWK-SCEF, it shall handle it as follows: For the monitoring event configurations for which the configuration status have changed since last informed to the HSS, the MME/SGSN shall report the status to the HSS through a Notify-Request command as specified in subclause 5.2.5 of 3GPP TS 29.272 [16].

5.5 MO-Data Procedure

5.5.1 General

This procedure shall be used between the MME and the SCEF, between the MME and the IWK-SCEF and between the IWK-SCEF and the SCEF.

When the procedure is invoked by the MME, it is used to forward mobile originated Non-IP data of a mobile user from the MME to the SCEF. The procedure is also invoked on reception of RRC cause "MO Exception data".

This procedure is used according to 3GPP TS 23.682 [2] subclause 5.13.4.

The IWK-SCEF may be in the path between the MME and the SCEF for roaming cases when the IWK-SCEF is deployed by the operator of the visited PLMN.

When the procedure is invoked by the IWK-SCEF, it is used to forward mobile originated Non-IP data received from the MME to the SCEF.

This procedure is mapped to the commands MO-Data-Request/Answer (ODR/ODA) in the Diameter application specified in clause 6.

The tables 5.5.1-1 and 5.5.1-2 detail the involved information elements.

Table 5.5.1-1: MO Data Request

Information Element Name	Mapping to Diameter AVP	Cat.	Description
User Identity (See 6.4.16)	User-Identifier	M	This Information Element shall be present and shall contain the identity of the UE. This is a grouped AVP which shall contain the IMSI.
EPS Bearer Identity (See 6.4.17)	Bearer-Identifier	M	This information element shall be present and shall contain the identity of the EPS-bearer identifying the T6a connection for the Non-IP data delivery.
Non IP data (See 6.4.19)	Non-IP-Data	C	This information element shall contain the Non-IP data to be delivered to the SCEF. This Information Element shall be present when the request conveys Non-IP data.
Supported Features (See 3GPP TS 29.229 [4])	Supported-Features	O	If present, this information element shall contain the list of features supported by the origin host.
MO Exception Data Counter (see 6.4.27)	RRC-Cause-Counter	C	The MME shall include this Information Element when MME needs to send a non-zero counter value for the MO Exception Data Counter. The timestamp in the counter shall be set with the time at which the counter value increased from 0 to 1.

Table 5.5.1-2: MO Data Answer

Information Element Name	Mapping to Diameter AVP	Cat.	Description
Result (See 6.3)	Result-Code / Experimental-Result	M	Result of the request. Result-Code AVP shall be used for errors defined in the Diameter Base Protocol. Experimental-Result AVP shall be 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.
Supported Features (See 3GPP TS 29.229 [4])	Supported-Features	O	If present, this information element shall contain the list of features supported by the origin host.

5.5.2 Detailed Behaviour of the MME

The MME shall make use of this procedure over a T6a connection identified by its EPS bearer identity and previously established with the SCEF to forward the Non-IP data received from the UE to the SCEF or to an IWK-SCEF when deployed for a roaming case.

The MME shall increment the "MO Exception data counter" by one each time the MME has received the RRC cause "MO Exception data". The MME may defer sending a MO Data command message to report a non-zero value for the MO Exception Data Counter based on local configuration.

If the MME has sent the RRC-Cause-Counter for RRC Cause "MO Exception data" in the MO Data Request command the MME shall reset the RRC-Cause-Counter when receiving MO Data Answer command.

When receiving a Permanent Failure Result-Code/Experimental-Result, the MME shall initiate a PDN disconnection procedure or Detach procedure towards the UE and if the permanent failure is different from DIAMETER_ERROR_ INVALID_EPS_BEARER and different from DIAMETER_ERROR_USER_UNKNOWN, the MME shall make use of the "Connection Management by MME" Procedure (see clause 5.7) to release the T6a connection between the MME and the SCEF.

5.5.3 Detailed Behaviour of the SCEF

When the SCEF receives a MO Data Request from the MME or the IWK-SCEF, the SCEF shall, in the following order:

- Check that the User Identity exists in the SCEF. If not, Experimental-Result shall be set to DIAMETER_ERROR_USER_UNKNOWN in the MO Data Answer;
- Check, if, for this user, an EPS bearer context exists. If not, Experimental-Result shall be set to DIAMETER_ERROR_ INVALID_EPS_BEARER in the MO Data Answer;
- Process the delivery of the data (if available) to the SCS/AS and/or process the RRC Cause Counter (if available). If the processing of either of them is not successful, return an appropriate Diameter error code, otherwise return a Result code set to DIAMETER_SUCCESS to the MME or IWK-SCEF. If the data delivery to the SCS/AS has failed due to there being no NIDD configuration context with an SCS/AS, set the Experimental-Result to DIAMETER_ERROR_NIDD_CONFIGURATION_NOT_AVAILABLE in the MO Data Answer.

NOTE: The Diameter Result-Code / Experimental-Result returned by the SCEF can depend on the error returned by the SCS/AS to the SCEF. The interface between the SCEF and the SCS/AS is out of scope of 3GPP.

5.5.4 Detailed Behaviour of the IWK-SCEF

When the IWK-SCEF receives a MO Data Request from the MME, it shall forward the request to the SCEF.

When the IWK-SCEF receives a MO Data Answer from the SCEF, it shall forward the answer to the MME.

5.6 MT Data Procedure

5.6.1 General

This procedure shall be used between the SCEF and the MME, between the SCEF and the IWK-SCEF and between the IWK-SCEF and the MME.

When the procedure is invoked by the SCEF, it is used to forward mobile terminated Non-IP data of a mobile user from the SCEF to the MME.

This procedure is used according to 3GPP TS 23.682 [2] subclause 5.13.3.

The IWK-SCEF may be in the path between the SCEF and the MME for roaming cases when the IWK-SCEF is deployed by the operator of the visited PLMN.

When the procedure is invoked by the IWK-SCEF, it is used to forward mobile terminated Non-IP data received from the SCEF to the MME.

This procedure is mapped to the commands MT-Data-Request/Answer (TDR/TDA) in the Diameter application specified in clause 6.

The tables 5.6.1-1 and 5.6.1-2 detail the involved information elements.

NOTE: The corresponding message name in 3GPP TS 23.682 [2] is "NIDD Submit Request".

Table 5.6.1-1: MT Data Request

Information Element Name	Mapping to Diameter AVP	Cat.	Description
User Identity (See 6.4.16)	User-Identifier	M	This Information Element shall be present and shall contain the identity of the UE. This is a grouped AVP which shall contain the IMSI.
EPS Bearer Identity (See 6.4.17)	Bearer-Identifier	M	This information element shall be present and shall contain the identity of the EPS-bearer identifying the T6a connection for the Non-IP data delivery.
Non-IP Data (See 6.4.19)	Non-IP-Data	C	This information element shall contain the Non-IP data to be delivered to the MME. This Information Element shall be present when the request conveys Non-IP data.
SCEF Wait Time (See 6.4.24)	SCEF-Wait-Time	O	This information element, when present, shall indicate the timestamp (in UTC) until which the SCEF expects a response.
Maximum Retransmission Time (See 3GPP TS 29.338 [27])	Maximum-Retransmission-Time	O	This information element, when present, shall indicate the maximum retransmission time (in UTC) until which the SCEF is capable to retransmit the MT Non-IP Data.
Supported Features (See 3GPP TS 29.229 [4])	Supported-Features	O	If present, this information element shall contain the list of features supported by the origin host.

Table 5.6.1-2: MT Data Answer

Information Element Name	Mapping to Diameter AVP	Cat.	Description
Result (See 6.3)	Result-Code / Experimental-Result	M	This information element shall contain the Result of the request. The Result-Code AVP shall be used to indicate success or errors as defined in the Diameter Base Protocol. The Experimental-Result AVP shall be 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 (See 3GPP TS 29.338 [27])	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 shall 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 (See 3GPP TS 29.229 [4])	Supported-Features	O	If present, this information element shall contain the list of features supported by the origin host.

5.6.2 Detailed Behaviour of the SCEF

The SCEF shall make use of this procedure over a T6a connection identified by its EPS bearer identity and previously established with the MME to forward the Non-IP data received from the SCS/AS to the MME or to an IWK-SCEF when deployed for a roaming case.

The SCEF shall check if an EPS bearer context exists for the user before sending the request.

The SCEF may include the Maximum-Retransmission-Time AVP in the MT Data Request to indicate the maximum retransmission time for when it is capable to retransmit the Non-IP Data.

If the MT Data Answer includes the Requested-Retransmission-Time AVP, the SCEF shall retransmit the MT Non-IP Data at the requested retransmission time.

5.6.3 Detailed Behaviour of the MME

When the MME receives a MT Data Request from the SCEF or the IWK-SCEF, the MME shall, in the following order:

- Check that the User Identity exists in the MME. If not, Experimental-Result shall be set to DIAMETER_ERROR_USER_UNKNOWN in the MT Data Answer;
- Check whether, for this user, an EPS bearer context exists. If not, Experimental-Result shall be set to DIAMETER_ERROR_ INVALID_EPS_BEARER in the MT Data Answer.
- Process the data delivery to the UE and:
  - if it is successful, return a Result code set to DIAMETER_SUCCESS to the SCEF or IWK-SCEF;
  - return an Experimental-Result set to DIAMETER_ERROR_USER_TEMPORARILY_UNREACHABLE, if the UE is using a power saving function (e.g. extended idle mode DRX or UE Power Saving Mode as defined in 3GPP TS 23.682 [27]) and the UE is expected to not be reachable shortly or, based on MME implementation, within the time indicated by the SCEF-Wait-Time;

    The MME shall set the Not Reachable for NIDD flag and store the SCEF Host and Realm for which this flag is set;

    If the MT Data Request includes the Maximum-Retransmission-Time AVP, the MME may additionally include the Requested-Retransmission-Time AVP requesting the SCEF to retransmit the Non-IP Data at a later time prior to the Maximum Retransmission Time;

    The MME shall then update the SCEF, as specified in subclause 5.7, when it detects that the UE is reachable or about to become reachable and the Not Reachable for NIDD flag is set. If the MME included the Requested-Retransmission-Time AVP in the MT Data Answer, the MME shall do so only if the UE becomes reachable before the Requested Retransmission Time, i.e. the MME shall reset the Not Reachable for NIDD flag when the Requested-Retransmission-Time expires if the UE has not become reachable beforehand;

  - return an Experimental-Result set to DIAMETER_ERROR_UNREACHABLE_USER, if the UE is not reachable;
  - otherwise return an appropriate Diameter error code.

5.6.4 Detailed Behaviour of the IWK-SCEF

When the IWK-SCEF receives a MT Data Request from the SCEF, it shall forward the request to the MME.

When the IWK-SCEF receives a MT Data Answer from the MME, it shall forward the answer to the SCEF.

5.7 Connection Management by MME Procedure.

5.7.1 General

This procedure shall be used between the MME and the SCEF, between the MME and the IWK-SCEF and between the IWK-SCEF and the SCEF.

When the procedure is invoked by the MME, it is used:

- to establish a T6a connection between the MME and the SCEF;
- to update the parameters or the status of a T6a connection between the MME and the SCEF, e.g. to indicate to the SCEF that the UE has become or is about to become reachable when MT non-IP data is pending at the SCEF for a UE using a power saving function;
- to release a T6a connection between the MME and the SCEF.

This procedure is used according to 3GPP TS 23.682 [2] subclause 5.13.1 and 5.13.5 and 5.13.6. The IWK-SCEF may be in the path between the MME and the SCEF for roaming cases when the IWK-SCEF is deployed by the operator of the visited PLMN.

When the procedure is invoked by the IWK-SCEF, it is used to forward the Connection Management Request received from the MME to the SCEF.

This procedure is mapped to the commands Connection-Management-Request/Answer (CMR/CMA) in the Diameter application specified in clause 6.

The tables 5.7.1-1 and 5.7.1-2 detail the involved information elements.

Table 5.7.1-1: Connection Management Request

Information Element Name	Mapping to Diameter AVP	Cat.	Description
User Identity (See 6.4.16)	User-Identifier	M	This Information Element shall be present and shall contain the identity of the UE. This is a grouped AVP which shall contain the IMSI.
EPS Bearer Identity (See 6.4.17)	Bearer-Identifier	M	This Information Element shall be present and shall contain the identity of the EPS bearer identifying the T6a connection to which the request applies.
T6a Connection Action (See 6.4.18)	Connection-Action	M	This Information element shall be present and shall contain a T6a connection management action indicating a T6a connection establishment or a T6a connection release or a T6a connection update.
APN (See 6.4.20)	Service-Selection	C	This Information element shall contain the APN the user wants to connect to. It shall be present if the request is for a T6a connection establishment.
Serving PLMN Rate Control (See 6.4.21)	Serving-PLMN-Rate-Control	O	If present, this information element shall contain the Serving PLMN rate control set by the MME.
CMR Flags (See 6.4.25)	CMR-Flags	O	This Information Element contains a bit mask. See subclause 6.4.25 for the meaning of the bits and the condition for each bit to be set or not.
Maximum UE Availability Time (See 3GPP TS 29.338 [27])	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 shall indicate 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 shall be present, if the MME receives Extended PCO information from the UE.
3GPP Charging Characteristics (See 3GPP TS 32.298 [30]	3GPP-Charging-Characteristics	C	This Information element shall contain the PDN Connection Charging Characteristics data for an APN Configuration with SCEF-based NIDD mechanism. It shall be present if the request is for a T6a connection establishment and may be present if the request is for a T6a connection update.
RAT-Type (See 3GPP TS 29.212 [10])	RAT-Type	C	This Information Element shall contain the used RAT Type. It shall be present if the request is for a T6a connection establishment.
Supported Features (See 3GPP TS 29.229 [4])	Supported-Features	O	If present, this information element shall contain the list of features supported by the origin host.
Terminal Information (See 3GPP TS 29.272 [16])	Terminal-Information	C	This Information Element shall contain the identity of the UE. It shall be present if available.
Visited PLMN ID (See 3GPP TS 29.272 [16])	Visited-PLMN-Id	C	This Information Element shall contain the identity (MCC and MNC) of serving PLMN. It shall be present if the request is for a T6a connection establishment or for a T6a connection update.

Table 5.7.1-2: Connection Management Answer

Information Element Name	Mapping to Diameter AVP	Cat.	Description
Result (See 6.3)	Result-Code / Experimental-Result	M	Result of the request. Result-Code AVP shall be used for errors defined in the Diameter Base Protocol. Experimental-Result AVP shall be 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 (See 3GPP TS 32.299 [22])	PDN-Connection-Charging-Id	C	This Information element is defined in 3GPP TS 32.253 [23] and shall 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 (See 3GPP TS 29.229 [4])	Supported-Features	O	If present, this information element shall contain the list of features supported by the origin host.

5.7.2 Detailed Behaviour of the MME

The MME shall make use of this procedure to request one of the following T6a connection management actions:

- for aT6a connection establishment, the MME shall:
  - include the user's IMSI.
  - fill the EPS-Bearer-Identity information element with the identity of the EPS bearer that MME allocated to the Non-IP PDN connection as described in 3GPP TS 23.682 [2];
  - if Serving PLMN Rate Control is configured the MME shall include the Serving PLMN Rate Control information as described in 3GPP TS 23.401 [25];
- for a T6a connection release, the MME shall:
  - fill the EPS Bearer Identity information element with the identity of the EPS bearer of the T6a connection which is released as described in 3GPP TS 23.682 [2];
  - upon getting the Connection Management Answer from the SCEF, delete the T6a connection context;
- for a T6a connection update, the MME shall:
  - fill the EPS Bearer Identity information element with the identity of the EPS bearer of the T6a connection that needs to be updated;
  - set the UE-Reachable-Indicator in the CMR-Flags AVP if the UE has become or is about to become reachable. The MME may additionally include the Maximum UE Availability Time AVP, if available, to indicate 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;
  - upon getting the Connection Management Answer from the SCEF, reset the Not Reachable for NIDD flag if this flag was set and if the UE-Reachable-Indicator was set in the CMR-Flags AVP in the Connection Management Request;
  - if Serving PLMN Rate Control needs to be added or updated the MME shall include Serving PLMN Rate Control information as described in 3GPP TS 23.401 [25].

NOTE: If the UE has several T6a connections to the same SCEF, for which Non-IP data is pending, the MME initiates a T6a connection update for only one of the T6a connections towards this SCEF.

If the MME receives the Extended-PCO AVP in the Connection Management Answer from the SCEF, the MME shall forward the Extended-PCO to the UE transparently, as specified in 3GPP TS 24.301 [28].

5.7.3 Detailed Behaviour of the SCEF

When the SCEF receives a Connection Management Request from the MME the SCEF shall, in the following order:

- check that the User Identity exists in the SCEF. If not, Experimental-Result shall be set to DIAMETER_ERROR_USER_UNKNOWN in the Connection Management Answer;
- check that the T6a connection action indicates a T6a connection establishment, a T6a connection release or a T6a connection update. If not, the Experimental-Result shall be set to DIAMETER_ERROR_OPERATION_NOT_ALLOWED in the Connection Management Answer;
- if the T6a connection action indicates a T6a connection establishment:
  - check whether a valid NIDD configuration exists for the UE at the SCEF;

    If not, the SCEF shall:

    - reject the Connection Management Request, with Experimental-Result set to DIAMETER_ERROR_NIDD_CONFIGURATION_NOT_AVAILABLE in the Connection Management Answer or
    - accept the Connection Management Request, and initiate a NIDD Configuration procedure with a default SCS/AS configured in the SCEF and the MSISDN or an external ID obtained from the HSS, as specified in 3GPP TS 29.336 [5] sub-clause 7.2.3.2. If such NIDD Configuration procedure fails, the SCEF shall reject the Connection Management Request, with Experimental-Result set to DIAMETER_ERROR_NIDD_CONFIGURATION_NOT_AVAILABLE in the Connection Management Answer;
  - create an EPS bearer context;
  - store the MME Identity identified by the Origin-Host AVP of the T6a Connection Management Request, and the MME realm identified by the Origin-Realm AVP of the T6a Connection Management Request in the EPS bearer context;
  - include the Extended-PCO AVP in the Connection Management Answer, if the Extended PCO information (e.g. APN Rate Control information) needs to be provided to the UE;
  - if Serving PLMN Rate Control is provided by the MME, restrict the number of messages for the downlink to not exceed the values provided in Serving PLMN Rate Control. If it is not provided and Serving PLMN Rate Control is active, then continue using the previously provided values;
  - If successful, Result shall be set to DIAMETER_SUCCESS in the Connection Management Answer;
- if the T6a connection action indicates a T6a connection release:
  - check whether, for this user and the received EPS bearer ID, a T6a connection context exists. If not, Experimental-Result shall be set to DIAMETER_ERROR_INVALID_EPS_BEARER in the Connection Management Answer;
  - include the Extended-PCO AVP in the Connection Management Answer, if the Extended PCO information needs to be provided to the UE;
  - Delete the T6a connection context at the SCEF. If successful, Result code shall be set to DIAMETER_SUCCESS in the Connection Management Answer;
- if the T6a connection action indicates a T6a connection update:
  - check whether, for this user and the received EPS bearer ID, a T6a connection context exists. If not, Experimental-Result shall be set to DIAMETER_ERROR_INVALID_EPS_BEARER in the Connection Management Answer;
  - if successful:

- if Serving PLMN Rate Control is provided by the MME, restrict the number of messages for the downlink to not exceed the values provided in Serving PLMN Rate Control. If it is not provided and Serving PLMN Rate Control is active, then continue using the previously provided values;

- include the Extended-PCO AVP in the Connection Management Answer, if the Extended PCO information (e.g. APN Rate Control information) needs to be provided to the UE;

- store the MME Identity identified by the Origin-Host AVP of the T6a Connection Management Request and the MME realm identified by the Origin-Realm AVP of the T6a Connection Management Request, if the MME identity has changed, in the EPS bearer context, and the Result shall be set to DIAMETER_SUCCESS in the Connection Management Answer;

- if the UE-Reachable-Indicator was set in the CMR-Flags AVP, forward any MT Non-IP data pending for any T6a connection for this UE, to the MME.

If the Serving-PLMN-Rate-Control AVP is included in the Connection Management Request message from the MME, the SCEF shall enforce the Serving PLMN Rate Control as specified in 3GPP TS 23.401 [12] subclause 4.7.7.2.

5.7.4 Detailed Behaviour of the IWK-SCEF

When the IWK-SCEF receives a Connection Management Request from the MME, it shall forward the request to the SCEF.

When the IWK-SCEF receives a Connection Management Answer from the SCEF, it shall forward the answer to the MME.

5.8 Connection Management by SCEF Procedure

5.8.1 General

This procedure shall be used between the SCEF and the MME, between the SCEF and the MME via the IWK-SCEF acting as a Diameter proxy agent for roaming cases.

When the procedure is invoked by the SCEF, it is used

- to update the parameters (e.g. Extended PCO information) associated to a T6a connection between the MME and the SCEF.

This procedure is used according to 3GPP TS 23.682 [2]. The IWK-SCEF may be in the path between the MME and the SCEF for roaming cases when the IWK-SCEF is deployed by the operator of the visited PLMN.

This procedure is mapped to the commands Connection-Management-Request/Answer (CMR/CMA) in the Diameter application specified in clause 6.

The tables 5.8.1-1 and 5.8.1-2 detail the involved information elements.

Table 5.8.1-1: Connection Management SCEF Request

Information Element Name	Mapping to Diameter AVP	Cat.	Description
User Identity (See 6.4.16)	User-Identifier	M	This Information Element shall be present and shall contain the identity of the UE. This is a grouped AVP containing the IMSI.
EPS Bearer Identity (See 6.4.17)	Bearer-Identifier	M	This Information Element shall be present and shall contain the identity of the EPS bearer identifying the T6a connection to which the request applies.
T6a Connection Action (See 6.4.18)	Connection-Action	M	This Information element shall be present and shall contain a T6a connection management action indicating a T6a connection update.
Extended PCO (see 6.4.26)	Extended-PCO	C	This Information Element shall be present if the SCEF needs to send updated Extended PCO information (e.g. APN Rate Control information) to the UE.
Supported Features (See 3GPP TS 29.229 [4])	Supported-Features	O	If present, this information element shall contain the list of features supported by the origin host.

Table 5.8.1-2: Connection Management SCEF Answer

Information Element Name	Mapping to Diameter AVP	Cat.	Description
Result (See 6.3)	Result-Code / Experimental-Result	M	Result of the request. Result-Code AVP shall be used for errors defined in the Diameter Base Protocol. Experimental-Result AVP shall be 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.
Supported Features (See 3GPP TS 29.229 [4])	Supported-Features	O	If present, this information element shall contain the list of features supported by the origin host.

5.8.2 Detailed Behaviour of the SCEF

The SCEF shall make use of this procedure to send the updated Extended PCO information (e.g. APN Rate Control information) to the UE during T6a connection update, if needed. If APN Rate Control Control information is included in the Extended-PCO AVP within the Connection Management SCEF Request message from the SCEF, the SCEF shall enforce the APN Rate Control as specified in 3GPP TS 23.401 [12] subclause 4.7.7.3.

5.8.3 Detailed Behaviour of the MME

When the MME receives a Connection Management SCEF Request from the SCEF or the IWK-SCEF, the MME shall, in the following order:

- check that the User Identity exists in the MME. If not, Experimental-Result shall be set to DIAMETER_ERROR_USER_UNKNOWN in the Connection Management SCEF Answer;
- check that the T6a connection action indicates a T6a connection update. If not, the Experimental-Result shall be set to DIAMETER_ERROR_OPERATION_NOT_ALLOWED in the Connection Management SCEF Answer;
- check whether, for this user and the received EPS bearer ID, a T6a connection context exists. If not, Experimental-Result shall be set to DIAMETER_ERROR_ INVALID_EPS_BEARER in the Connection Management SCEF Answer;
- if the T6a connection action indicates a T6a connection update:

- if the Extended-PCO AVP is received, forward the Extended-PCO to the UE, as specified in 3GPP TS 24.301[28]. If successful, the Result code shall be set to DIAMETER_SUCCESS in the Connection Management SCEF Answer.

5.8.4 Detailed Behaviour of the IWK-SCEF

When the IWK-SCEF receives a Connection Management SCEF Request from the SCEF, it shall forward the request to the MME.

When the IWK-SCEF receives a Connection Management SCEF Answer from the MME, it shall forward the answer to the SCEF.

6 Protocol Specification and Implementation

6.1 Introduction

6.1.1 Use of Diameter Base Protocol

The Diameter Base Protocol as specified in IETF RFC 3588 [3] shall apply except as modified by the defined support of the methods and the defined support of the commands and AVPs, result and error codes as specified in this specification. Unless otherwise specified, the procedures (including error handling and unrecognised information handling) shall be used unmodified.

6.1.2 Securing Diameter Messages

For secure transport of Diameter messages, see 3GPP TS 33.210 [4].

6.1.3 Accounting Functionality

Accounting functionality (Accounting Session State Machine, related command codes and AVPs) shall not be used on the T6a/T6b interface, T6ai/T6bi interface and the T7 interface.

6.1.4 Use of Sessions

Diameter sessions shall be implicitly terminated between:

- the MME/SGSN and the SCEF, for the T6a/T6b interface;
- the MME/SGSN and the IWK-SCEF, for the T6ai/T6bi interface and
- the IWK-SCEF and the SCEF for the T7 interface.

An implicitly terminated session is one for which the server does not maintain state information. The client shall not send any re-authorization or session termination requests to the server.

The Diameter base protocol includes the Auth-Session-State AVP as the mechanism for the implementation of implicitly terminated sessions.

The client (server) shall include in its requests (responses) the Auth-Session-State AVP set to the value NO_STATE_MAINTAINED (1), as described in IETF RFC 3588 [3]. As a consequence, the server shall not maintain any state information about this session and the client shall not send any session termination request. Neither the Authorization-Lifetime AVP nor the Session-Timeout AVP shall be present in requests or responses.

6.1.5 Transport Protocol

Diameter messages over the T6a/T6b, T6ai/T6bi and T7 interface shall make use of SCTP IETF RFC 4960 [7] as transport protocol.

6.1.6 Routing Considerations

6.1.6.1 Routing Considerations for Monitoring Event related Requests

This subclause specifies the use of the Diameter routing AVPs Destination-Realm and Destination-Host for Monitoring Event related requests.

The MME/SGSN shall use the SCEF-ID and the SCEF realm previously received over S6a/b for a monitoring event configuration as the Destination-Host AVP and the Destination-Realm AVP in the Reporting-Information-Request for the monitoring event reports sent over the T6a/T6b or T6ai/bi interface.

The MME/SGSN shall use the pre-configured IWK-SCEF identify and the pre-configured IWK-SCEF realm as the Destination-Host AVP and the Destination Realm AVP in the Configuration-Information-Request for the monitoring event configuration sent over the T6ai/bi interface.

The IWK-SCEF behaves as a Diameter Proxy agent according to IETF RFC 3588 [3] for the Reporting-Information-Request received from the MME/SGSN over the T6ai/bi interface and shall forward these requests to the SCEF over the T7 interface by keeping unchanged the Destination Realm and Destination Host AVPs.

For monitoring events directly configured at the MME/SGSN by the SCEF, if the SCEF knows the address/name of the MME/SGSN, both the Destination-Realm AVP and the Destination-Host AVP shall be present in the request. Otherwise, only the Destination-Realm AVP shall be present and the command shall be routed to the next Diameter node. Consequently, the Destination-Host AVP is declared as optional in the ABNF for all Monitoring Event related requests initiated by the SCEF.

The Destination-Realm AVP is declared as mandatory in the ABNF for all Monitoring Event related requests. The Destination-Host AVP is declared as optional in the ABNF description of the Reporting-Information-Request and of the Configuration Information-Request.

6.1.6.2 Routing Considerations for Non-IP Data Related Requests

This subclause specifies the use of the Diameter routing AVPs Destination-Realm and Destination-Host for Non-IP Data related requests.

The MME shall use the SCEF-ID and the SCEF realm that it received in the subscribed APN associated to the T6a connection at its establishment as the Destination-Host AVP and the Destination realm AVP in the Non-IP data related request commands sent over the T6a and T6ai interfaces.

The Destination-Host AVP is declared as optional and the Destination realm AVP as mandatory in the ABNF description of the Non-IP data related requests initiated by the MME.

NOTE 1: For roaming cases, the routing of MME initiated request commands to the IWK-SCEF relies on the Destination Realm AVP as according to the Diameter base protocol.

NOTE 2: The Diameter implicitly terminated sessions and their Session ID for the Non-IP data related traffic are end to end between the MME and the SCEF.

The IWK-SCEF behaves as a Diameter Proxy agent according to IETF RFC 3588 [3] for the Non-IP related requests received from the MME over the T6ai interface and shall forward these requests to the SCEF over the T7 interface by keeping unchanged the Destination Realm and Destination Host AVPs.

The SCEF obtains the Destination-Host AVP and the Destination-Realm AVP to use in the Non-IP data related requests towards an MME from the Origin-Host AVP and the Origin-Realm AVP received in previous Non-IP Data related requests from the MME. The Origin-Realm AVP in the requests received by the SCEF in roaming cases should contain the domain name of the network to which the MME belongs, encoded as specified in subclause 19.2 of 3GPP TS 23.003 [24].

The Destination-Host AVP is declared as optional and the Destination realm AVP as mandatory in the ABNF for the Non-IP Data related requests initiated by the SCEF.

The IWK-SCEF behaves as a Diameter Proxy agent according to IETF RFC 3588 [3] for the Non-IP related requests received from the SCEF over the T7 interface and shall forward these requests to the MME over the T6ai interface by keeping unchanged the Destination Realm and Destination Host AVPs.

6.1.6.3 Vendor-Specific-Application-ID AVP

If the Vendor-Specific-Application-ID AVP is received in any of the commands, it may be ignored by the receiving node, and it shall not be used for routing purposes.

NOTE: The Vendor-Specific-Application-ID can be included as an optional AVP in all commands in order to ensure interoperability with diameter agents following a strict implementation of IETF RFC 3588 [3], by which messages not including this AVP will be rejected. IETF RFC 3588 [3] indicates that the AVP shall be present in all proxiable commands, such as those defined in this specification, despite the fact that the contents of this AVP are redundant since the Application ID is already present in the command header. This AVP may be removed in subsequent revisions of this specification, once the diameter base protocol is updated accordingly.

6.1.7 Advertising Application Support

The SCEF, MME, SGSN and the IWK-SCEF shall advertise support of the Diameter T6a/T6b Application by including the value of the application identifier in the Auth-Application-Id AVP within the Vendor-Specific-Application-Id grouped AVP of the Capabilities-Exchange-Request and Capabilities-Exchange-Answer commands.

NOTE: Even though the reference point between the MME/SGSN and the IWK-SCEF is called T6ai/T6bi respectively and the reference point between the IWK-SCEF and the SCEF is called T7, all these reference points use the same Diameter Application ID.

The vendor identifier value of 3GPP (10415) shall be included in the Supported-Vendor-Id AVP of the Capabilities-Exchange-Request and Capabilities-Exchange-Answer commands, and in the Vendor-Id AVP within the Vendor-Specific-Application-Id grouped AVP of the Capabilities-Exchange-Request and Capabilities-Exchange-Answer commands.

The Vendor-Id AVP included in Capabilities-Exchange-Request and Capabilities-Exchange-Answer commands that is not included in the Vendor-Specific-Application-Id AVPs as described above shall indicate the manufacturer of the Diameter node as per IETF RFC 3588 [3].

6.1.8 Diameter Application Identifier

The T6a/T6b interface protocol shall be defined as an IETF vendor specific Diameter application, where the vendor is 3GPP. The vendor identifier assigned by IANA to 3GPP (http://www.iana.org/assignments/enterprise-numbers) is 10415.

The Diameter application identifier assigned to the T6a/T6b interface application is 16777346.

The T6ai/T6bi and the T7 interface protocol shall use the same Diameter application identifier as the T6a/T6b interface.

6.1.9 Use of the Supported-Features AVP

When new functionality is introduced on the T6a/T6b application, it should be defined as optional. If backwards incompatible changes cannot be avoided, the new functionality shall be introduced as a new feature and support advertised with the Supported-Features AVP. The usage of the Supported-Features AVP on the T6a/T6b application is consistent with the procedures for the dynamic discovery of supported features as defined in clause 7.2 of 3GPP TS 29.229 [4].

When extending the application by adding new AVPs for a feature, the new AVPs shall have the M bit cleared and the AVP shall not be defined mandatory in the command ABNF.

As defined in 3GPP TS 29.229 [4], the Supported-Features AVP is of type grouped and contains the Vendor-Id, Feature-List-ID and Feature-List AVPs. On the all reference points as specified in this specification, the Supported-Features AVP is used to identify features that have been defined by 3GPP and hence, for features defined in this document, the Vendor-Id AVP shall contain the vendor ID of 3GPP (10415). If there are multiple feature lists defined for the reference point, the Feature-List-ID AVP shall differentiate those lists from one another.

6.2 Commands

6.2.1 Introduction

This section defines the Command code values and related ABNF for each command described in this specification. The ABNF for the commands on T6a/T6b, T6ai/T6bi and T7 are the same if not specified explicitly different.

6.2.2 Command-Code values

This section defines Command-Code values for the T6a/T6b interface application as allocated by IANA.

Every command is defined by means of the ABNF syntax IETF RFC 5234 [8], according to the rules in IETF RFC 3588 [3]. When the definition and use of an AVP is not specified in this document, the guidelines in IETF RFC 3588 [3] shall apply.

The following Command Codes are defined in this specification for T6a/T6b:

Table 6.2.2-1: Command-Code values for T6a/T6b

Command-Name	Abbreviation	Code	Section
Configuration-Information-Request	CIR	8388718	3GPP TS 29.336 [5] subclause 8.2.3 and subclause 6.2.3 below
Configuration-Information-Answer	CIA	8388718	3GPP TS 29.336 [5] subclause 8.2.4 and subclause 6.2.4 below
Reporting-Information-Request	RIR	8388719	3GPP TS 29.336 [5] subclause 8.2.5 and subclause 6.2.5 below
Reporting-Information-Answer	RIA	8388719	3GPP TS 29.336 [5] subclause 8.2.6 and subclause 6.2.6 below
Connection-Management-Request	CMR	8388732	6.2.7
Connection-Management-Answer	CMA	8388732	6.2.8
MO-Data-Request	ODR	8388733	6.2.9
MO-Data-Answer	ODA	8388733	6.2.10
MT-Data-Request	TDR	8388734	6.2.11
MT-Data-Answer	TDA	8388734	6.2.12

For these commands, the Application-ID field shall be set to 16777346 (application identifier of the T6a/T6b interface application, allocated by IANA).

6.2.3 Configuration Information Request (CIR) Command

The Configuration Information Request (CIR) command, indicated by the Command-Code field set to 8388718 and the "R" bit set in the Command Flags field, is sent from:

- the SCEF to the MME/SGSN;
- the SCEF to the IWK-SCEF and
- the MME/SGSN to the IWK-SCEF

This command is originally defined in 3GPP TS 29.336 [5].

For the T6a/T6b interface, the Configuration-Information-Request command format is specified as following:

Message Format:

< Configuration-Information-Request > ::= < Diameter Header: 8388718, REQ, PXY, 16777346 >
< Session-Id >

[DRMP]
{ Auth-Session-State }
{ Origin-Host }
{ Origin-Realm }
[Destination-Host]
{ Destination-Realm }
*[Supported-Features]
*[Monitoring-Event-Configuration]
*[Proxy-Info]
*[Route-Record]
*[AVP]

6.2.4 Configuration-Information-Answer (CIA) Command

The Configuration-Information-Answer (CIA) command, indicated by the Command-Code field set to 8388718 and the "R" bit cleared in the Command Flags field, is sent from:

- the MME/SGSN to the SCEF;
- the IWK-SCEF to the SCEF and
- the IWK-SCEF to the MME/SGSN

This command is originally defined in 3GPP TS 29.336 [5].

For the T6a/T6b interface, the Configuration-Information-Answer command format is specified as following:

Message Format:

< Configuration-Information-Answer > ::= < Diameter Header: 8388718, PXY, 16777346 >
< Session-Id >
[DRMP]
[Result-Code]
[Experimental-Result]
{ Auth-Session-State }
{ Origin-Host }
{ Origin-Realm }
*[Supported-Features]
*[Monitoring-Event-Report]
*[Monitoring-Event-Config-Status]
*[Failed-AVP]
*[Proxy-Info]
*[Route-Record]
*[AVP]

6.2.5 Reporting-Information-Request (RIR) Command

The Reporting-Information-Request (RIR) command, indicated by the Command-Code field set to 8388719 and the "R" bit cleared in the Command Flags field, is sent from:

- the MME/SGSN to the SCEF;
- the MME/SGSN to the IWK-SCEF and
- the IWK-SCEF to the SCEF.

This command is originally defined in 3GPP TS 29.336 [5].

For the T6a/T6b interface, the Reporting-Information-Request command format is specified as following:

Message Format:

```
< Reporting-Information-Request > ::=   < Diameter Header: 8388719, PXY, 16777346 >
                                        < Session-Id >
                                        [ DRMP ]
                                        { Auth-Session-State }
                                        { Origin-Host }
                                        { Origin-Realm }
                                        [ Destination-Host ]
                                        { Destination-Realm }
                                        [ OC-Supported-Features ]
                                        *[ Supported-Features ]
                                        *[ Monitoring-Event-Report ]
                                        *[ Failed-AVP ]
                                        *[ Proxy-Info ]
                                        *[ Route-Record ]
                                        *[AVP]
```

6.2.6 Reporting-Information-Answer (RIA) Command

The Reporting-Information-Answer (RIA) command, indicated by the Command-Code field set to 8388719 and the "R" bit cleared in the Command Flags field, is sent from:

- the SCEF to the MME/SGSN;
- the SCEF to the IWK-SCEF and
- the IWK-SCEF to the MME/SGSN.

This command is originally defined in 3GPP TS 29.336 [5].

For the T6a/T6b interface, the Reporting-Information-Answer command format is specified as following:

Message Format:

```
< Reporting-Information-Answer > ::=< Diameter Header: 8388719, PXY, 16777346 >
                                     < Session-Id >
                                     [ DRMP ]
                                     [ Result-Code ]
                                     [ Experimental-Result ]
                                     { Auth-Session-State }
                                     { Origin-Host }
                                     { Origin-Realm }
                                     [ OC-Supported-Features ]
                                     [ OC-OLR ]
                                     *[ Supported-Features ]
                                     *[ Failed-AVP ]
                                     *[ Proxy-Info ]
                                     *[ Route-Record ]
                                     *[AVP]
```

6.2.7 Connection-Management-Request (CMR) Command

The Connection-Management-Request (CMR) command, indicated by the Command-Code field set to 8388732 and the "R" bit cleared in the Command Flags field, is sent from:

- the MME to the SCEF;
- the MME to the SCEF via the IWK-SCEF for roaming cases;
- the SCEF to the MME;
- the SCEF to the MME via the IWK-SCEF for roaming cases.

For the T6a, T6ai, T7 interfaces, the Connection-Management-Request command format is specified as following:

Message Format:

< Connection-Management-Request > ::= < Diameter Header: 8388732, PXY, 16777346 >
< Session-Id >
< User-Identifier >
< Bearer-Identifier >
[DRMP]
{ Auth-Session-State }
{ Origin-Host }
{ Origin-Realm }
[Destination-Host]
{ Destination-Realm }
[OC-Supported-Features]
[CMR-Flags]
[Maximum-UE-Availability-Time]
*[Supported-Features]
[Connection-Action]
[Service-Selection]
[Serving-PLMN-Rate-Control]
[Extended-PCO]
[3GPP-Charging-Characteristics]
[RAT-Type]
[Terminal-Information]
[Visited-PLMN-Id]
*[Failed-AVP]
*[Proxy-Info]
*[Route-Record]
*[AVP]

6.2.8 Connection-Management-Answer (CMA) Command

The Connection-Management-Answer (CMA) command, indicated by the Command-Code field set to 8388732 and the "R" bit cleared in the Command Flags field, is sent from:

- the SCEF to the MME;
- the SCEF to the MME via the IWK-SCEF for roaming cases; .
- the MME to the SCEF;
- the MME to the SCEF via the IWK-SCEF for roaming cases.

For the T6a, T6ai and T7 interfaces, the Connection-Management-Answer command format is specified as following:

Message Format:

< Connection-Management-Answer > ::= < Diameter Header: 8388732, PXY, 16777346 >
< Session-Id >
[DRMP]
[Result-Code]
[Experimental-Result]
{ Auth-Session-State }
{ Origin-Host }
{ Origin-Realm }
[OC-Supported-Features]
[OC-OLR]
*[Supported-Features]
[PDN-Connection-Charging-Id]
[Extended-PCO]
*[Failed-AVP]
*[Proxy-Info]

*[Route-Record]
*[AVP]

6.2.9 MO-Data-Request (ODR) Command

The MO-Data-Request (ODR) command, indicated by the Command-Code field set to 8388733 and the "R" bit cleared in the Command Flags field, is sent from:

- the MME to the SCEF;
- the MME to the IWK-SCEF and
- the IWK-SCEF to the SCEF.

For the T6a, T6ai, T7 interfaces, the MO-Data-Request command format is specified as following:

Message Format:

```
< MO-Data-Request > ::=  < Diameter Header: 8388733, PXY, 16777346 >
                         < Session-Id >
                         < User-Identifier >
                         < Bearer-Identifier >
                         [ DRMP ]
                         { Auth-Session-State }
                         { Origin-Host }
                         { Origin-Realm }
                         [ Destination-Host ]
                         { Destination-Realm }
                         [ OC-Supported-Features ]
                         *[ Supported-Features ]
                         [ Non-IP-Data ]
                         *[ Failed-AVP ]
                         *[ Proxy-Info ]
                         *[ Route-Record ]
                         [ RRC-Cause-Counter ]
                         *[AVP]
```

6.2.10 MO-Data-Answer (ODA) Command

The MO-Data-Answer (ODA) command, indicated by the Command-Code field set to 8388733 and the "R" bit cleared in the Command Flags field, is sent from:

- the SCEF to the MME;
- the SCEF to the IWK-SCEF and
- the IWK-SCEF to the MME.

For the T6a, T6ai and T7 interfaces, the MO-Data-Answer command format is specified as following:

Message Format:

```
< MO-Data-Answer > ::=  < Diameter Header: 8388733, PXY, 16777346 >
                        < Session-Id >
                        [ DRMP ]
                        [ Result-Code ]
                        [ Experimental-Result ]
                        { Auth-Session-State }
                        { Origin-Host }
                        { Origin-Realm }
                        [ OC-Supported-Features ]
                        [ OC-OLR ]
```

*[Supported-Features]
*[Failed-AVP]
*[Proxy-Info]
*[Route-Record]
*[AVP]

6.2.11 MT-Data-Request (TDR) Command

The MT-Data-Request (TDR) command, indicated by the Command-Code field set to 8388734 and the "R" bit cleared in the Command Flags field, is sent from:

- the SCEF to the MME;
- the SCEF to the IWK-SCEF and
- the IWK-SCEF to the MME.

For the T6a, T6ai, T7 interfaces, the MT-Data-Request command format is specified as following:

Message Format:

< MT-Data-Request > ::= < Diameter Header: 8388734, PXY, 16777346 >
< Session-Id >
< User-Identifier >
< Bearer-Identifier >
[DRMP]
{ Auth-Session-State }
{ Origin-Host }
{ Origin-Realm }
[Destination-Host]
{ Destination-Realm }
[OC-Supported-Features]
*[Supported-Features]
[Non-IP-Data]
[SCEF-Wait-Time]
[Maximum-Retransmission-Time]
*[Failed-AVP]
*[Proxy-Info]
*[Route-Record]
*[AVP]

6.2.12 MT-Data-Answer (TDA) Command

The MT-Data-Answer (OSA) command, indicated by the Command-Code field set to 8388734 and the "R" bit cleared in the Command Flags field, is sent from:

- the MME to the SCEF;
- the MME to the IWK-SCEF and
- the IWK-SCEF to the SCEF.

For the T6a, T6ai and T7 interfaces, the MT-Data-Answer command format is specified as following:

Message Format:

< MT-Data-Answer > ::= < Diameter Header: 8388734, PXY, 16777346 >
< Session-Id >
[DRMP]
[Result-Code]
[Experimental-Result]
{ Auth-Session-State }

{ Origin-Host }
{ Origin-Realm }
[OC-Supported-Features]
[OC-OLR]
[Requested-Retransmission-Time]
*[Supported-Features]
*[Failed-AVP]
*[Proxy-Info]
*[Route-Record]
*[AVP]

6.3 Result-Code AVP and Experimental-Result AVP Values

6.3.1 General

This section defines result code values that shall be supported by all Diameter implementations that conform to this specification.

6.3.2 Success

Result codes that fall within the Success category shall be used to inform a peer that a request has been successfully completed. The Result-Code AVP values defined in Diameter Base Protocol RFC 3588 [3] shall be applied.

6.3.3 Permanent Failures

Errors that fall within the Permanent Failures category shall be used to inform the peer that the request has failed, and should not be attempted again. The Result-Code AVP values defined in Diameter Base Protocol RFC 3588 [3] shall be applied. When one of the result codes defined here is included in a response, it shall be inside an Experimental-Result AVP and the Result-Code AVP shall be absent.

6.3.3.1 DIAMETER_ERROR_UNAUTHORIZED_REQUESTING_ENTITY (5510)

This result code shall be sent by the MME/SGSN or the IWK-SCEF to indicate that the SCEF is not allowed to request Monitoring services. This error code is defined in 3GPP TS 29.336 [5].

6.3.3.2 DIAMETER_ERROR_UNAUTHORIZED_SERVICE (5511)

This result code shall be sent by the MME/SGSN or the IWK-SCEF to indicate that the specific service requested by the SCEF is not allowed as per local policies. This error code is defined in 3GPP TS 29.336 [5].

6.3.3.3 DIAMETER_ERROR_CONFIGURATION_EVENT_STORAGE_NOT_SUCCESSFUL (5513)

This result code shall be sent by the MME/SGSN to indicate that the specific service requested by the SCEF could not be stored. This error code is defined in 3GPP TS 29.336 [5].

6.3.3.4 DIAMETER_ERROR_CONFIGURATION_EVENT_NON_EXISTANT (5514)

This result code shall be sent by the IWK-SCEF to indicate that the requested deletion by the MME/SGSN could not be performed because the event does not exist. This error code is defined in 3GPP TS 29.336 [5].

6.3.3.5 DIAMETER_ERROR_REQUESTED_LOCATION_NOT_SERVED (5650)

This result code shall be sent by the MME/SGSN to indicate that the location for which a related monitoring event is configured (e.g. Number of UEs at a given geographical location) by the SCEF, is not served by the MME/SGSN.

6.3.3.6 DIAMETER_ERROR_USER_UNKNOWN (5001)

This result code shall be sent by the SCEF or the MME to indicate that the user identified by the IMSI is unknown. This error code is defined in 3GPP TS 29.229 [4].

6.3.3.7 DIAMETER_ERROR_OPERATION_NOT_ALLOWED (5101)

This result code shall be sent by the SCEF to indicate that the operation is not allowed when an EPS bearer context exists for the user. This error code is defined in 3GPP TS 29.329 [17].

This result code shall be sent by the SCEF or the MME to indicate that the requested T6a connection action is not allowed.

6.3.3.8 DIAMETER_ERROR_INVALID_EPS_BEARER (5651)

This result code shall be sent by the SCEF or the MME to indicate that there is no existing EPS bearer context for the user.

6.3.3.9 DIAMETER_ERROR_NIDD_CONFIGURATION_NOT_AVAILABLE (5652)

This result code shall be sent by the SCEF to indicate that there is no valid NIDD configuration available.

6.3.3.10 DIAMETER_ERROR_ SCEF_REFERENCE_ID_UNKNOWN (5515)

This result code shall be sent by the SCEF to indicate that the SCEF reference ID is not known by the SCEF.

6.3.3.11 DIAMETER_ERROR_USER_TEMPORARILY_UNREACHABLE (5653)

This result code shall be sent by the MME to indicate that the UE is temporarily not reachable due to a power saving function, and that the MME will update the SCEF when it detects that the UE is reachable or about to become reachable as specified in subclause 5.6.3.

6.3.3.12 DIAMETER_ERROR_UNREACHABLE_USER (4221)

This result code shall be sent by the MME to indicate that the UE is not reachable. This error code is defined in 3GPP TS 29.172 [26].

6.4 AVPs

6.4.1 General

The following table specifies the Diameter AVPs defined for the T6a/T6b interface protocol, their AVP Code values, types, possible flag values and whether or not the AVP may be encrypted. The Vendor-ID header of all AVPs defined in this specification shall be set to 3GPP (10415).

Table 6.4.1-1: T6a/T6b specific Diameter AVPs

				AVP Flag rules				
Attribute Name	**AVP Code**	**Section defined**	**Value Type**	**Must**	**May**	**Should not**	**Must not**	**May Encr.**
Communication-Failure-Information	4300	6.4.4	Grouped	M,V				No
Cause-Type	4301	6.4.5	Unsigned32	M,V				No
S1AP-Cause	4302	6.4.6	Unsigned32	M,V				No
RANAP-Cause	4303	6.4.7	Unsigned32	M,V				No
BSSGP-Cause	4309	6.4.8	Unsigned32	M,V				No
GMM-Cause	4304	6.4.9	Unsigned32	M,V				No
SM-Cause	4305	6.4.10	Unsigned32	M,V				No
Number-Of-UE-Per-Location-Configuration	4306	6.4.11	Grouped	M,V				No
Number-Of-UE-Per-Location-Report	4307	6.4.12	Grouped	M,V				No
UE-Count	4308	6.4.13	Unsigned32	M,V				No
Connection-Action	4314	6.4.18	Unsigned32	M,V				No
Non-IP-Data	4315	6.4.19	Octetstring	M,V				No
Serving-PLMN-Rate-Control	4310	6.4.21	Grouped	M,V				No
Uplink-Rate-Limit	4311	6.4.23	Unsigned32	M,V				No
Downlink-Rate-Limit	4312	6.4.22	Unsigned32	M,V				No
Extended-PCO	4313	6.4.26	OctetString	M,V				No
SCEF-Wait-Time	4316	6.4.24	Time	M,V				No
CMR-Flags	4317	6.4.25	Unsigned32	M,V				No
RRC-Cause-Counter	4318	6.4.27	Grouped	M,V				No
Counter-Value	4319	6.4.28	Unsigned32	M,V				No
RRC-Counter-Timestamp	4320	6.4.29	Time	M,V				No

NOTE 1: The AVP header bit denoted as "M" indicates whether support of the AVP is required. The AVP header bit denoted as "V" indicates whether the optional Vendor-ID field is present in the AVP header. For further details, see IETF RFC 3588 [3].

NOTE 2: If the M-bit is set for an AVP and the receiver does not understand the AVP, it shall return a rejection. If the M-bit is not set for an AVP, the receiver shall not return a rejection, whether or not it understands the AVP. If the receiver understands the AVP but the M-bit value does not match with the definition in this table, the receiver shall ignore the M-bit.

The following table specifies the Diameter AVPs re-used by the T6a/T6b interface protocol from existing Diameter Applications, including a reference to their respective specifications and when needed, a short description of their use within T6a/T6b.

Any other AVPs from existing Diameter Applications, except for the AVPs from Diameter Base Protocol, do not need to be supported. The AVPs from Diameter Base Protocol are not included in table 6.4.1-2, but they may be re-used for the T6a/T6b protocol.

Table 6.4.1-2: T6a/T6b re-used Diameter AVPs

Attribute Name	Reference	Comments
Monitoring-Event-Configuration	3GPP TS 29.336 [5]	This AVP shall contain the monitoring event to be configured at the MME/SGSN or the IWK-SCEF. See 6.4.2.
Monitoring-Event-Report	3GPP TS 29.336 [5]	This AVP shall contain the monitoring event reported by the MME/SGSN or the IWK-SCEF. See 6.4.3.
SCEF-Reference-ID	3GPP TS 29.336 [5]	
SCEF-ID	3GPP TS 29.336 [5]	
SCEF-Reference-ID-for-Deletion	3GPP TS 29.336 [5]	
Supported-Features	3GPP TS 29.229 [4]	
Feature-List-ID	3GPP TS 29.229 [4]	
Feature-List	3GPP TS 29.229 [4]	See 6.4.14
OC-Supported-Features	IETF RFC 7683 [9]	
OC-OLR	IETF RFC 7683 [9]	
Monitoring-Event-Config-Status	3GPP TS 29.336 [5]	This AVP shall contain the status of configuration of each monitoring event identified by an SCEF-ID and SCEF-Reference-ID.
DRMP	IETF RFC 7944 [15]	see 6.4.15
User-Identifier	3GPP TS 29.336 [5]	See 6.4.16
Bearer-Identity	3GPP TS 29.212 [10]	See 6.4.17
Monitoring-Type	3GPP TS 29.336 [5]	
Maximum-Number-of-Reports	3GPP TS 29.336 [5]	
Monitoring-Duration	3GPP TS 29.336 [5]	
Charged-Party	3GPP TS 32.299 [20]	
UE-Reachability-Configuration	3GPP TS 29.336 [5]	
Location-Information-Configuration	3GPP TS 29.336 [5]	
Reachability-Information	3GPP TS 29.336 [5]	
EPS-Location-Information	3GPP TS 29.272 [16]	
Service-Selection	IETF RFC 5778 [21]	See 6.4.20
PDN-Connection-Charging-Id	3GPP TS 32.299 [22]	
Maximum-Retransmission-Time	3GPP TS 29.338 [27]	
Requested-Retransmission-Time	3GPP TS 29.338 [27]	
Maximum-UE-Availability-Time	3GPP TS 29.338 [27]	
3GPP-Charging-Characteristics	3GPP TS 29.061 [29]	
RAT-Type	3GPP TS 29.212 [10]	
Terminal-Information	3GPP TS 29.272 [16]	See 6.4.30
Visited-PLMN-Id	3GPP TS 29.272 [16]	

6.4.2 Monitoring-Event-Configuration

The Monitoring-Event-Configuration AVP is of type Grouped. It shall contain the Monitoring event configuration related data. It is originally defined in 3GPP TS 29.336 [5].

For the T6a/T6b interface, the Monitoring-Event-Configuration AVP format is specified as following:

AVP format:

Monitoring-Event-Configuration ::= <AVP header: 3122 10415>

[SCEF-Reference-ID]

{ SCEF-ID }

{ Monitoring-Type }

*[SCEF-Reference-ID-for-Deletion]

[Maximum-Number-of-Reports]

[Monitoring-Duration]

[Charged-Party]

[UE-Reachability-Configuration]

[Location-Information-Configuration]

*[Number-Of-UE-Per-Location-Configuration]

*[AVP]

6.4.3 Monitoring-Event-Report

The Monitoring-Event-Report AVP is of type Grouped. It shall contain the Monitoring event report data. It is originally defined in 3GPP TS 29.336 [5].

For the T6a/T6b interface, the Monitoring-Event-Report AVP format is specified as following:

AVP format:

Monitoring-Event-Report ::= <AVP header: 3123 10415>

{ SCEF-Reference-ID }

[SCEF-ID]

[Monitoring-Type]

[Reachability-Information]

[EPS-Location-Information]

[Communication-Failure-Information]

*[Number-Of-UE-Per-Location-Report]

*[AVP]

The AVPs applicable for each Monitoring-Type reported by the MME/SGSN are specified under subclause 5.2.2.

6.4.4 Communication-Failure-Information

The Communication-Failure-Information AVP is of type Grouped. It shall contain the reason for communication failure.

AVP format:

Communication-Failure-Information ::= <AVP header: 4300 10415>

[Cause-Type]

[S1AP-Cause]

[RANAP-Cause]

[BSSGP-Cause]

[GMM-Cause]

[SM-Cause]

*[AVP]

6.4.5 Cause-Type

The Cause-Type AVP is of type Unsigned32 and it shall identify the type of the S1AP-Cause. The following values are defined:

RADIO_NETWORK_LAYER (0)

TRANSPORT_LAYER (1)

NAS (2)

PROTOCOL (3)

MISCELLANEOUS (4)

6.4.6 S1AP-Cause

The S1AP-Cause AVP is of type Unsigned32. It shall contain a non-transparent copy of the S1AP cause code as specified subclause 9.2.1.3 of 3GPP TS 36.413 [13]. The RAN cause sub-category of the S1AP-Cause as specified in 3GPP TS 36.413 [13] shall be encoded in the Cause-Type AVP as specified in subclause 6.4.5 above.

6.4.7 RANAP-Cause

The RANAP-Cause AVP is of type Unsigned32. It shall contain the non-transparent copy of the cause value of the RANAP cause code as specified in subclause 9.2.1.4 of 3GPP TS 25.413 [11].

6.4.8 BSSGP-Cause

The BSSGP-Cause AVP is of type Unsigned32. It shall contain the non-transparent copy of the cause value of the BSSGP "Cause" as specified in subclause 11.3.8 in 3GPP TS 48.018 [14].

6.4.9 GMM-Cause

The GMM-Cause AVP is of type Unsigned32. It shall contain the GMM cause code as specified in subclause 10.5.5.14 of 3GPP TS 24.008 [12].

6.4.10 SM-Cause

The SM-Cause AVP is of type Unsigned32. It shall contain the SM cause code as specified in subclause 10.5.6.6 and 10.5.6.6A of 3GPP TS 24.008 [12].

6.4.11 Number-Of-UE-Per-Location-Configuration

The Number-Of-UE-Per-Location-Configuration AVP is of type Grouped. It shall contain the location information for which the number of UEs needs to be reported by the MME/SGSN.

AVP format:

Number-of-UE-Per-Location-Configuration ::= <AVP header: 4306 10415>

{ EPS-Location-Information }

*[AVP]

6.4.12 Number-Of-UE-Per-Location-Report

The Number-Of-UE-Per-Location-Report AVP is of type Grouped. It shall contain the location information along with the number of UEs found at that location by the MME/SGSN.

AVP format:

Number-of-UE-Per-Location-Report ::= <AVP header: 4307 10415>

{ EPS-Location-Information }

{ UE-Count }

*[AVP]

6.4.13 UE-Count

The UE-Count AVP is of type Unsigned32. It shall contain the number of UEs counted against a given criteria (say location information).

6.4.14 Feature-List AVP

6.4.14.1 Feature-List AVP for the T6a/T6b application

The syntax of this AVP is defined in 3GPP TS 29.229 [4].

For the S6t application, the meaning of the bits shall be as defined in table 6.4.14.1-1 for the Feature-List-ID.

Table 6.4.14.1-1: Features of Feature-List-ID used in S6t

Feature bit	Feature	M/O	Description
0	MONTE	O	Configuration and reporting of monitoring events This feature is applicable to from an SCEF with CIR/CIA command pair and the reporting of events to the SCEF with RIR/RIA command pair. If the MME/SGSN does not support this feature, the SCEF shall not send monitoring event configurations to the HSS within CIR.
1	NIDD	O	Support of Non-IP Data service over T6a This feature is applicable to OSR/OSA, ODR/ODA and TDR/TDA command pairs. If the SCEF does not indicate support of this feature in an OSA, the MME may store this information and not send any further OSR commands to that SCEF.
Feature bit: The order number of the bit within the Supported-Features AVP, e.g. "1". Feature: A short name that can be used to refer to the bit and to the feature, e.g. "MONTE". M/O: Defines if the implementation of the feature is mandatory ("M") or optional ("O"). Description: A clear textual description of the feature.			

6.4.15 DRMP

The DRMP AVP is of type Enumerated and it is defined in IETF RFC 7944 [15]. This AVP allows the MME, the SGSN, the SCEF and the IWK-SCEF to indicate the relative priority of Diameter messages.

6.4.16 User-Identifier

The User-Identifier AVP is of type Grouped and it contains the different identifiers used by the UE.

It is originally defined in 3GPP TS 29.336 [5]

AVP format:

User-Identifier ::= <AVP header: 3102 10415>

[User-Name]

*[AVP]

This AVP shall contain the User-Name AVP, i.e. it shall not be empty. The IMSI of the UE shall be included in the User-Name AVP.

6.4.17 Bearer-Identifier

The Bearer-Identifier AVP contains the identity of the EPS bearer used to identify the T6a connection between the MME and the SCEF. It is defined in 3GPP TS 29.212 [10].

6.4.18 Connection-Action

The Connection-Action AVP is of type Unsigned32 and it shall identify the action to be performed on the T6a connection. The following values are defined:

CONNECTION_ESTABLISHMENT (0)

This value shall be used if the T6a Connection-Management-Request applies to a T6a connection establishment.

CONNECTION_RELEASE (1)

This value shall be used if the T6a Connection-Management-Request applies to a T6a connection release.

CONNECTION_UPDATE (2)

This value shall be used if the T6a Connection-Management-Request applies to updating the properties of a T6a connection.

6.4.19 Non-IP-Data

The Non-IP-Data AVP is of type OctetString and it contains the Non-IP data conveyed between the MME and the SCEF.

6.4.20 Service-Selection

The Service-Selection AVP is of type of UTF8String. This AVP shall contain the APN Network Identifier as specified in 3GPP TS 23.003 [3] subclause 9.1.

The contents of the Service-Selection AVP shall be formatted as a character string composed of one or more labels separated by dots (".").

This AVP is originally defined in IETF RFC 5778[21].

6.4.21 Serving-PLMN-Rate-Control

The Serving-PLMN-Rate-Control AVP is of type Grouped and shall contain.

The AVP format shall conform to:

Serving-PLMN-Rate-Control::= <AVP header: 4310 10415>

[Uplink-Rate-Limit]

[Downlink-Rate-Limit]

*[AVP]

A Downlink-Rate-Limit set to 0 shall be interpreted that the Serving PLMN Rate Control for downlink messages is deactivated in the MME. If the Serving PLMN Rate Control is activated, the value of Downlink-Rate-Limit shall not be less than 10, see 3GPP TS 23.401 [25].

An Uplink-Rate-Limit set ot 0 shall be interpreted that the Serving PLMN Rate Control for uplink messages is deactivated in the MME. If Serving PLMN Rate Control is activated, the value of Uplink-Rate-Limit shall not be less than 10, see 3GPP TS 23.401 [25].

6.4.22 Downlink-Rate-Limit

The Downlink-Rate-Limit AVP is of type type Unsigned32 and shall contain the maximum number of NAS Data PDUs per deci hour for this UE for downlink.

6.4.23 Uplink-Rate-Limit

The Uplink-Rate-Limit AVP is of type Unsigned32 and shall contain the maximum number of NAS Data PDUs per deci hour for this UE for uplink.

6.4.24 SCEF-Wait-Time

The SCEF-Wait-Time is of type Time and it shall contain the timestamp (in UTC) until which the SCEF expects a response.

6.4.25 CMR-Flags

The CMR-Flags AVP is of type Unsigned32 and it shall contain a bit mask. The meaning of the bits shall be as defined in table 6.4.25/1:

Table 6.4.25/1: CMR-Flags

Bit	Name	Description
0	UE-Reachable-Indicator	This bit if set indicates that the UE has become or is about to become reachable.
NOTE 1: Bits not defined in this table shall be cleared by the sending entity and discarded by the receiving entity.		

6.4.26 Extended-PCO

The Extended-PCO AVP is of type OctetString. The Extended-PCO AVP shall contain the value part of the ePCO IE, starting from octet 4, as specified in subclause 9.9.4.26 of 3GPP TS 24.301[28].

6.4.27 RRC-Cause-Counter

The RRC-Cause-Counter AVP is of type Grouped and shall contain the number of receptions of "MO Exception data" and the time when the cause " MO Exception Data" is received for the first time.

The AVP format shall conform to:

RRC-Cause-Counter::= <AVP header: 4318 10415>

[Counter-Value]

[RRC-Counter-Timestamp]

*[AVP]

6.4.28 Counter-Value

The Counter-Value AVP is of type type Unsigned32 and shall contain the number of occurrences of reception of RRC cause "MO Exception data".

6.4.29 RRC-Counter-Timestamp

The RRC-Counter-Timestamp AVP is of type Time and shall contain a timestamp.

6.4.30 Terminal-Information

The Terminal-Information AVP is of type Grouped. This AVP shall contain the information about the user's terminal. It is originally defined in 3GPP TS 29.272 [16].

AVP format

Terminal-Information ::= <AVP header: 1401 10415>

[IMEI]

[Software-Version]

*[AVP]

Annex A (normative): Diameter overload control mechanism

A.1 T6a/b and T7 interfaces

A.1.1 General

The Diameter overload control mechanism is an optional feature over the T6a/b and T7 interface, which may be applied to the traffic of requests commands sent to the SCEF and/or to the traffic of request commands sent to the MME.

It is recommended to make use of the IETF RFC 7683 [9] on the T6a/b and T7 interface where:

- when applied to the traffic of request commands sent to the SCEF, the SCEF shall behave as a reporting node while the MME/SGSN, and as an alternative the IWK-SCEF shall behave as a reacting node;
- when applied to the traffic of request commands sent to the MME, the MME shall behave as a reporting node while the SCEF, and as an alternative the IWK-SCEF, shall behave as a reacting node.

A.1.2 SCEF behaviour

The SCEF requests traffic reduction from the MME/SGSN and the IWK-SCEF when it is in an overload situation, by including OC-OLR AVP in answer commands as described in IETF RFC 7683 [9].

The SCEF identifies that it is in an overload situation by implementation specific means. For example, the SCEF may take into account the traffic over the S6t interfaces or other interfaces, the level of usage of internal resources (CPU, memory), the access to external resources etc.

The SCEF determines the specific contents of the OC-OLR AVP in overload reports and the SCEF decides when to send OC-OLR AVPs by implementation specific means.

The SCEF may decide to deactivate Monitoring events to reduce the number of Reporting-Information-Requests sent for reporting monitoring events.

The SCEF shall apply required traffic reduction according to the OC-OLR AVPs received in answer commands from the MME to subsequent applicable requests, as per IETF RFC 7683 [9].

Requested traffic reduction is achieved by the SCEF by implementation specific means. It may in particular implement throttling of MT non-IP data messages.

A.1.3 MME/SGSN behaviour

The MME requests traffic reduction from the SCEF when it is in an overload situation, by including OC-OLR AVP in answer commands as described in IETF RFC 7683 [9].

The MME identifies that it is in an overload situation by implementation specific means.

The MME/SGSN shall apply required traffic reduction according to the OC-OLR AVPs received in answer commands from the SCEF to subsequent applicable requests, as per IETF RFC 7683 [9].

Requested traffic reduction is achieved by the MME/SGSN by implementation specific means. It may in particular implement:

- throttling of monitoring event reports or stop reporting with prioritization (e.g. prioritisation on the type of events, or that one time reporting takes priority over continuous reporting, …);
- throttling of new T6a connection establishment messages;
- throttling of MO non-IP data messages.

A.1.4 IWK-SCEF behaviour

The IWK-SCEF, when acting as a reacting node towards the SCEF shall apply required traffic reduction received in answer commands from the SCEF to subsequent applicable requests received from the MME/SGSN, as per IETF RFC 7683 [9]. In this case the IWK-SCEF does not forward OC-OLR AVPs to the MME/SGSN.

The IWK-SCEF, when acting as a reacting node towards the MME, shall apply required traffic reduction received in answer commands from the MME to subsequent applicable requests received from the SCEF, as per IETF RFC 7683 [9]. In this case the IWK-SCEF does not forward OC-OLR AVPs to the SCEF.

Requested traffic reduction is achieved by the IWK-SCEF by implementation specific means. For example, it may implement throttling of monitoring event report with prioritization, throttling of MO data or MT data messages.

Annex B (normative): Diameter message priority mechanism

B.1 General

IETF RFC 7944 [15] specifies a Diameter routing message priority mechanism that allows Diameter nodes to indicate the relative priority of Diameter messages. With this information, other Diameter nodes may leverage the relative priority of Diameter messages into routing, resource allocation and also abatement decisions when overload control is applied.

B.2 T6a, T6ai, T6b, T6bi, T7 interfaces

The Diameter message priority mechanism is an optional feature which may apply on one or several of the T6a, T6ai, T6b, T6bi, T7 interfaces.

It is recommended to make use of IETF RFC 7944 [15] over the T6a, T6ai, T6b, T6bi, T7 interfaces of an operator network when the overload control defined in Annex A is applied on these interfaces.

A 3GPP functional entity supporting the Diameter message priority mechanism over one or several of the T6a, T6ai, T6b, T6bi, T7 interfaces shall comply with IETF RFC 7944 [15].

A 3GPP functional entity sending a request shall determine the required priority according to its policies. When priority is required, it shall include the DRMP AVP indicating the required priority level in the request it sends, and shall prioritise the request according to the required priority level.

When the 3GPP functional element receives the corresponding response, it shall prioritise the received response according to the priority level received within the DRMP AVP if present in the response, otherwise according to the priority level of the corresponding request.

When a 3GPP functional entity receives a request, it shall handle the request according to the received DRMP AVP priority level. For the response, it may modify the priority level received in the DRMP AVP according to its policies and shall handle the response according to the required priority level. If the required priority level is different from the priority level received in the request, it shall include the DRMP AVP in the response.

The decisions of the 3GPP functional entity for a required priority and for the priority level value are implementation specific.

Diameter requests related to high priority traffic shall contain a DRMP AVP with a high priority of which the level value is operator dependent.

Annex C (informative): Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2015-05					Skeleton of the TS after CT4#69	-	0.0.0
2015-11					TS after CT4#71	0.0.0	0.1.0
2015-12	CT#70	CP-150625			Presented for information	0.1.0	1.0.0
2016-02					TS after CT4#72	1.0.0	1.1.0
2016-03	CT#71	CP-160119			Presented for approval	1.1.0	2.0.0
2016-03	CT#71				Cersion 13.0.0. created after CT#71	2.0.0	13.0.0
2016-06	CT#72	CP-160225	0001	1	Correction on Table 6.4.1-2	13.0.0	13.1.0
2016-06	CT#72	CP-160225	0002	2	Correction on error handling for SCEF reference ID unknown	13.0.0	13.1.0
2016-06	CT#72	CP-160225	0004	1	Removing the direct configuration of MONTE events at MME via IWK-SCEF by the SCEF for roaming case	13.0.0	13.1.0
2016-06	CT#72	CP-160225	0008	3	Overload control update for CIoT	13.0.0	13.1.0
2016-06	CT#72	CP-160225	0011	1	Corrections on styles	13.0.0	13.1.0
2016-06	CT#72	CP-160228	0003	-	Assignment of command codes for CIoT	13.0.0	13.1.0
2016-06	CT#72	CP-160228	0005	4	Signaling the change of MME to the SCEF for a T6a connection used for SCEF PDN	13.0.0	13.1.0
2016-06	CT#72	CP-160228	0006	4	Procedures updates and new AVPs over T6a for CIoT	13.0.0	13.1.0
2016-06	CT#72	CP-160228	0007	5	Connection Action check for CMR	13.0.0	13.1.0
2016-06	CT#72	CP-160228	0009	4	Routing considerations for CIoT	13.0.0	13.1.0
2016-06	CT#72	CP-160228	0012	2	Serving PLMN Rate Control	13.0.0	13.1.0
2016-06	CT#72	CP-160228	0013	2	CIoT support in introduction section	13.0.0	13.1.0
2016-06	CT#72	CP-160228	0014	2	MT Non-IP Data Delivery for UEs using a power saving function	13.0.0	13.1.0
2016-06	CT#72	CP-160228	0015	2	Accept T6 Connection Establishment	13.0.0	13.1.0
2016-06	CT#72	CP-160228	0016	4	Support for APN Rate Control	13.0.0	13.1.0
2016-06	CT#72	CP-160228	0017	1	Charging Characteristics	13.0.0	13.1.0
2016-06	CT#72	CP-160228	0018	2	Corrections in section 5.6.3 of "Detailed Behaviour of the MME"	13.0.0	13.1.0
2016-09	CT#73	CP-160427	0020	-	Adding missing result code	13.1.0	13.2.0
2016-09	CT#73	CP-160423	0021	1	Correction of Reference for ePCO	13.1.0	13.2.0
2016-09	CT#73	CP-160423	0023	-	MT-Data-Request command	13.1.0	13.2.0
2016-09	CT#73	CP-160424	0022	3	Handling of Exception Reports in the Core Network	13.1.0	13.2.0
2016-09	CT#73	CP-160424	0024	1	Sending of ePCO during the T6a connection release procedure	13.1.0	13.2.0
2016-09	CT#73	CP-160424	0025	1	Missing AVP codes and Experimental-Result codes for T6a	13.1.0	13.2.0
2016-09	CT#73	CP-160424	0027	1	SCEF Behaviour of Rate Control Handling	13.1.0	13.2.0
2016-09	CT#73	CP-160573	0028	2	Not Able to Deliver MO Non-IP Data	13.1.0	13.2.0
2016-09	CT#73	CP-160424	0029	1	T6a Connection Release after MO Data Answer with permanent error	13.1.0	13.2.0
2016-09	CT#73	CP-160424	0030	2	Addition of Serving PLMN ID and IMEISV to CMR	13.1.0	13.2.0
2016-12	CT#74	CP-160660	0032	1	AVAILABILITY_AFTER_DDN_FAILURE reporting	13.2.0	13.3.0
2016-12	CT#74	CP-160657	0034	1	Reference Correction	13.2.0	13.3.0
2016-12	CT#74	CP-160657	0037	-	Missing RRC-Cause-Counter AVP in the MO-Data-Request Command	13.2.0	13.3.0
2016-12	CT#74	CP-160664	0040	-	Correction to change IETF drmp draft version to official RFC 7944	13.2.0	13.3.0
2017-09	CT#77	CP-172013	0059	-	Correction of DRMP Procedures	13.3.0	13.4.0

History

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