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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00   Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
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Contents

Foreword

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1 Scope

The present document specifies the procedures and the Nq and Nq' Application Protocol (Nq-AP) messages used on the Nq/Nq' interfaces between the RAN Congestion Awareness Function (RCAF) and the Mobility Management Entity (MME) or the Serving GPRS Support Node (SGSN). The related stage 2 requirements are specified in 3GPP TS 23.401 [2] and 3GPP TS 23.060 [3].

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 23.401: "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".

[3]   3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".

[4]   3GPP TS 29.303: "Domain Name System Procedures; Stage 3"

[5]   3GPP TS 23.003: "Numbering, addressing and identification".

[6]   IETF RFC 791 (September 1981): "Internet Protocol".

[7]   IETF RFC 2460 (December 1998): "Internet Protocol, Version 6 (IPv6) Specification".

[8]   IETF RFC 4960 (September 2007): "Stream Control Transmission Protocol".

[9]   ITU-T Recommendation E.212: "The international identification plan for mobile terminals and mobile users".

[10]   3GPP TS 36.413: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP)".

[11]   IETF RFC 1035: "Domain Names - Implementation and Specification".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 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 TR 21.905 [1].

RCAF   RAN Congestion Awareness Function

4 General Description

This document describes the procedures, messages and information elements over the Nq and Nq' interfaces between the MME/SGSN and the RCAF to transfer the IMSI/APN information associated to the eNodeB or E-UTRAN cells or UTRAN Service Area experiencing user plane congestion.

The Nq interface is located between the RCAF and the MME. The Nq' interface is located between the RCAF and the SGSN.

Both the Nq and the Nq' interfaces use the Nq-AP protocol. The Nq-AP protocol described in this document uses a Type, Length and Value (TLV) encoding of messages over an SCTP transport. The SCTP transport is described in clause 6. The Nq-AP messages and the Information Elements are described in clause 8 and 9 respectively.

5 Procedures for Nq-AP

5.1 Introduction

The Nq interface is used between the RCAF and MME for the IMSI and APN information retrieval procedures as specified in sub-clause 5.9.3 of 3GPP TS 23.401 [2].

The Nq' interface is used between the RCAF and SGSN for the APN information retrieval procedure as specified in sub-clause 6.17 of 3GPP TS 23.060 [3].

5.2 IMSI and APN Information Retrieval Procedure

5.2.1 General

The IMSI and APN information retrieval procedure is used between the RCAF and the MME over the Nq interface. The RCAF uses this procedure to retrieve from the MME:

- the IMSIs that are currently in ECM-CONNECTED state and having active E-RABs under a given eNodeB or E-UTRAN cell;

- for each IMSI the list of APNs currently having active PDN connections.

The RCAF selects the MME(s) serving a user plane congested eNodeB or an E-UTRAN cell through the DNS procedure as specified in sub-clause 5.4 of 3GPP TS 29.303 [4].

5.2.2 IMSI and APN Information Retrieval Procedure Initiation

5.2.2.1 Procedures in the RCAF

When the RCAF needs to retrieve the IMSI(s) / APN(s) information for a given user plane congested area, the RCAF shall send the NqAP-IMSI-APN-INFORMATION-REQUEST message towards the MME(s).

The RCAF shall include in the NqAP-IMSI-APN-INFORMATION-REQUEST message:

- the Global eNodeB ID IE(s) if it requests the IMSI(s) and APN(s) for a given user plane congested area at an eNodeB level;

- the ECGI IE(s) if it requests the IMSI(s) and APN(s) for a given user plane congested area at an E-UTRAN cell level.

   NOTE: For a given user plane congested area, the RCAF retrieves the IMSI and APN information from the MME at a eNodeB level or E-UTRAN cell level based on local policy at the RCAF.

5.2.2.2 Procedures in the MME

When the MME receives the NqAP-IMSI-APN-INFORMATION-REQUEST message from the RCAF, the MME shall report in the NqAP-IMSI-APN-INFORMATION-RESPONSE message, for each eNodeB or E-UTRAN cell requested by the RCAF, that has at least one subscriber:

- the Macro eNodeB ID or Home eNodeB ID or the E-UTRAN cell ID in the RAN Entity value field of the RAN Entity Identifier IE for which the MME(s) report the IMSI and the APN information.

  - all the subscribers that are currently in ECM-CONNECTED state and having active E-RABs, except the subscribers involved in an Emergency call, under the given eNodeB or E-UTRAN cell in the Subscriber-Information IE. Multiple instances of the Subscriber-Information IE shall be included if there are multiple subscribers under the given eNodeB or E-UTRAN cell.

    - for each subscriber, the IMSI in the IMSI IE and APNs currently having active PDN connections in the APN IE. Multiple instances of the APN IE shall be included under a Subscriber-Information IE if the subscriber has active PDN connections towards multiple APNs.

The information reported by the MME for each eNodeB or E-UTRAN cell shall be encoded as an instance of the RAN Associated Information IE.

For a single NqAP-IMSI-APN-INFORMATION-REQUEST message from the RCAF, the MME may send multiple NqAP-IMSI-APN-INFORMATION-RESPONSE messages.

There shall be no NqAP-IMSI-APN-INFORMATION-RESPONSE sent, if the MME does not find any subscriber under any of the requested eNodeB or E-UTRAN cell.

5.3 APN Information Retrieval Procedure

5.3.1 General

The APN information retrieval procedure is used between the RCAF and the SGSN over the Nq' interface. The RCAF uses this procedure to retrieve from the SGSN:

- the APNs that are currently having PDP contexts activated for each IMSI provided by the RCAF.

The RCAF selects the SGSN(s) serving a user plane congested SAI through the DNS procedure as specified in sub-clause 5.5 of 3GPP TS 29.303 [4].

5.3.2 APN Information Retrieval Procedure Initiation

5.3.2.1 Procedures in the RCAF

When the RCAF needs to retrieve the APN(s) for the list of IMSI(s) experiencing RAN user plane congestion, the RCAF shall send the NqAP-APN-INFORMATION-REQUEST message towards the SGSN(s).

The RCAF shall include the following information in the NqAP-APN-INFORMATION-REQUEST message

- the list of IMSI(s) in the IMSI IE. Multiple instances of the IMSI IE shall be included if there are multiple subscribers for which APN information needs to be queried from the SGSN.

5.3.2.2 Procedures in the SGSN

When the SGSN receives the NqAP-APN-INFORMATION-REQUEST message from the RCAF, the SGSN shall report in the NqAP-APN-INFORMATION-RESPONSE message, if there is at least one subscriber's information to report:

- list of subscribers for which the APN information is provided by the SGSN, in the Subscriber-Information IE. Multiple instances of the Subscriber-Information IE shall be included if there are multiple subscribers for which the SGSN is reporting the APN information. Each instance of the Subscriber-Information IE contains:

  - the IMSI of the subscriber encoded in the IMSI IE;

  - the APNs currently having active PDP contexts with active RABs, encoded in the APN IE. Multiple instances of the APN IE shall be included under a Subscriber-Information IE if the subscriber has active PDP contexts towards multiple APNs. Emergency call APNs shall be excluded.

  - If the subscriber does not have any PDP context with active RABs, then the SGSN shall not include that subscriber's information in the NqAP-APN-INFORMATION-RESPONSE.

In a pooled SGSN scenario each SGSN may have only a subset of IMSIs registered. An SGSN shall report the APN information only for the IMSIs it knows.

For a single NqAP-APN-INFORMATION-REQUEST message from the RCAF, the SGSN may send multiple NqAP-APN-INFORMATION-RESPONSE messages.

There shall be no NqAP-APN-INFORMATION-RESPONSE sent, if the SGSN does not find any requested subscriber attached.

6 Transport

6.1 General

This subclause specifies the standards for signalling transport to be used across Nq/Nq' interface. Nq/Nq' interface is a logical interface between the RCAF and the MME/SGSN. All the Nq-AP messages described in the present document require an SCTP association between the RCAF and the MME/SGSN.

6.2 IP layer

The RCAF shall support IPv6 (see IETF RFC 2460 [7]) and IPv4 (see IETF RFC 791 [6]).

6.3 Transport layer

SCTP (see IETF RFC 4960 [8]) shall be supported as the transport layer of Nq-AP messages.

Semi-permanent SCTP associations shall be established between the RCAF and MME/SGSN, i.e. the SCTP associations shall remain up under normal circumstances when the RCAF needs to use the Nq-AP procedures towards the MME/SGSN.

The RCAF shall initiate establishment of the SCTP association.

Transport network redundancy can be achieved by SCTP multi-homing between two end-points, of which one or both is assigned with multiple IP addresses. SCTP end-points shall support a multi-homed remote SCTP end-point. For SCTP endpoint redundancy, an SCTP endpoint (in the RCAF or MME/SGSN) may send an INIT, at any time for an already established SCTP association, which the other SCTP endpoint shall handle as defined in IETF RFC 4960 [8].

RCAF and MME/SGSN shall support a configuration with a single SCTP association per RCAF/MME (or RCAF/SGSN) pair. Configurations with multiple SCTP endpoints per RCAF/MME (or RCAF/SGSN) pair may be supported.

Within the SCTP association established between one RCAF and one MME/SGSN, both RCAF and MME/SGSN shall reserve several stream identifiers, based on the INIT message exchange for the sole use of Nq-AP procedures.

The registered port number for Nq-AP is 36424.

The payload protocol identifier to be used for Nq-AP is 0.

7 Error Handling

7.1 General

This subclause specifies procedures for the handling of unknown, unforeseen, and erroneous protocol data by the receiving entity (i.e. the MME or the RCAF). These procedures are called "error handling procedures". If a protocol error is detected by the receiving NqAP entity, it should log the event including the erroneous message and may include the error in a statistical counter.

7.2 Message too short

When the receiving entity receives a message that is too short to contain a complete message type information element, the receiving entity shall ignore that message.

7.3 Unknown or unforeseen message type

The entity receiving a message with a message type that is not defined or is not implemented, it shall ignore the message.

The entity receiving a message that is not defined to be received by that entity (e.g. the message is sent in the wrong direction) shall treat the message as unknown message and shall ignore the message.

7.4 Missing mandatory information element

When the entity receiving a request message diagnoses a "missing mandatory information element" error, the receiving entity shall ignore the message and shall return a corresponding response message with the cause IE set to "Mandatory IE missing", together with the type of the missing mandatory IE.

When the entity receiving a response message diagnoses a "missing mandatory information element" error, it shall ignore the message.

7.5 Information elements unknown or unforeseen in the message

The receiving entity shall ignore all information elements unknown or unforeseen in a message.

7.6 Out of sequence information elements

The receiving entity shall ignore all information elements that are out of sequence.

7.7 Repeated information elements

If an information element is repeated in a message in which repetition of the information element is not specified, the receiving entity shall only handle the contents of the information element appearing first and shall ignore all subsequent repetitions of the information element. When repetition of information elements is specified, the receiving entity shall only handle the contents of specified repeated information elements. If a limit on the repetition of information elements is specified and the limit is exceeded, the receiving entity shall handle the contents of information elements appearing first up to the limit of repetitions and shall ignore all subsequent repetitions of the information element.

7.8 Syntactically incorrect mandatory information element.

On receipt of a message, which contains a syntactically incorrect mandatory information element, the receiver shall ignore the message and shall return a corresponding response message with the cause IE set to "Mandatory IE incorrect", together with the type of the offending mandatory IE.

7.9 Syntactically incorrect optional information elements

The receiving entity shall treat all optional information elements that are syntactically incorrect in a message as not present in the message.

7.10 Conditional information element errors

When the entity receiving a request message diagnoses a "missing conditional information element" error, the receiving entity shall ignore the message and shall return a corresponding response message with the cause IE set to "Conditional IE missing", together with the type of the missing conditional IE.

When the entity receiving a request message diagnoses an "unexpected conditional information element" error or when it receives a message containing at least one syntactically incorrect conditional information element which is required to be present in the message, the receiving entity shall ignore the message and shall return a corresponding response message with the cause IE set to "Conditional IE incorrect", together with the type of the offending conditional IE.

When the entity receiving a response message diagnoses a "missing conditional information element" error, "unexpected conditional information element" error or when it receives a response message containing at least one

syntactically incorrect conditional information element which is required to be present in the message, it shall ignore the message.

When the entity receives a message containing a syntactically incorrect conditional information element, which is not required to be present in the message, nor required to be absent in the message, then the receiving entity shall ignore that information element.

7.11 Information elements with semantically incorrect contents

When an information element with semantically incorrect contents is received, the foreseen reactions of the procedural part of the present specification are performed.

If however no such reactions are specified, the receiving entity shall ignore that information element and treat the rest of the message. If the semantically incorrect information element in a request message is a mandatory information element, then the receiving entity shall return a corresponding response message with the cause IE set to "Mandatory IE incorrect", together with the type of the offending mandatory IE. If the semantically incorrect information element in a response message is a mandatory information element, then the receiving entity shall ignore the message.

7.12 NqAP Message of Invalid Length

If an NqAP entity receives a Request message within an IP/SCTP packet of a length that is inconsistent with the value specified in the Length field of the NqAP message header, then the receiving NqAP entity should log the error and shall send the Response message with the Cause IE value set to "Invalid Length".

If an NqAP entity receives a Response message within an IP/SCTP packet of a length that is inconsistent with the value specified in the Length field of the NqAP message header, then the receiving NqAP entity should log the error and shall silently discard the message.

8 Messages Description

8.1 NqAP-IMSI-APN-INFORMATION-REQUEST Message

8.1.1 Message definition

This message is sent by the RCAF to the MME to request the list of IMSIs and APNs activated for each IMSI under a given RAN Identifier (E-UTRAN cell Id or the eNodeB Id). Table 8.1.1 shows the content of the NqAP-IMSI-APN-INFORMATION-REQUEST message. Multiple instances of the RAN Entity Identifier IE shall be included if the RCAF is requesting the IMSI and APN information from MME for multiple eNodeB(s) or E-UTRAN Cell Ids.

Table 8.1.1: NqAP-IMSI-APN-INFORMATION-REQUEST message content

Information element	Type/Reference	Presence	Format	Length
Message type	Message type 9.2	M	V	1
RAN Entity Identifier	RAN Entity Identifier 9.4.3	M	TLV	11-13

8.2 NqAP-IMSI-APN-INFORMATION-RESPONSE Message

8.2.1 Message definition

This message is sent by the MME to the RCAF in response to the NqAP-IMSI-APN-INFORMATION-REQUEST message. Table 8.2.1 shows the content of the NqAP-IMSI-APN-INFORMATION-RESPONSE message. The RAN-Associated-Information IE shall be encoded if the cause value in Cause IE is "Request Accepted". Multiple instances of the RAN-Associated-Information IE shall be included if the RCAF had requested IMSI and APN information for multiple eNodeB Id(s) or EUTRAN Cell Id(s) and if the particular instance of the NqAP-IMSI-APN-INFORMATION-RESPONSE message could find subscribers under some or all of these requested eNodeB Id(s) or EUTRAN Cell Id(s).

The MME Name IE shall be included if the cause value in Cause IE is anything other than "Request Accepted".

Table 8.2.1: NqAP-IMSI-APN-INFORMATION-RESPONSE message content

Information element	Type/Reference	Presence	Format	Length
Message type	Message type 9.2	M	V	1
Cause	Cause 9.4.6	M	TLV	4
RAN Associated Information	RAN-Associated-Information 9.4.5	C	TLV	Variable
MME Name	Fully Qualified Domain Name (FQDN) 9.4.7	C	TLV	Variable

8.3 NqAP-APN-INFORMATION-REQUEST Message

8.3.1 Message definition

This message shall be sent by the RCAF to the SGSN to request the list of APNs activated for a given set of IMSI(s). Table 8.3.1 shows the content of the NqAP-APN-INFORMATION-REQUEST message. Multiple instances of the IMSI IE shall be included if the RCAF is requesting the APN information from SGSN for multiple IMSIs.

Table 8.3.1: NqAP-APN-INFORMATION-REQUEST message content

Information element	Type/Reference	Presence	Format	Length
Message type	Message type 9.2	M	V	1
IMSI	IMSI 9.4.1	M	TLV	6-11

8.4 NqAP-APN-INFORMATION-RESPONSE Message

8.4.1 Message definition

This message is sent by the SGSN to the RCAF in response to the NqAP-APN-INFORMATION-REQUEST message. Table 8.4.1 shows the content of the NqAP-APN-INFORMATION-RESPONSE message. The Subscriber-Information IE shall be encoded if the cause value in Cause IE is "Request Accepted". Multiple instances of the Subscriber-Information IE shall be included if the RCAF had requested APN information for multiple IMSI(s) and if the particular instance of the NqAP-APN-INFORMATION-RESPONSE message carries more than one subscriber's information.

The SGSN Name IE shall be included if the cause value in Cause IE is anything other than "Request Accepted".

Table 8.4.1: NqAP-APN-INFORMATION-RESPONSE message content

Information element	Type/Reference	Presence	Format	Length
Message type	Message type 9.2	M	V	1
Cause	Cause 9.4.6	M	TLV	4
Subscriber Information	Subscriber-Information 9.4.4	C	TLV	Variable
SGSN Name	Fully Qualified Domain Name (FQDN) 9.4.7	C	TLV	Variable

9 Information Elements

9.1 Overview

This clause specifies the coding of the information elements used in by the Nq-AP protocol.

The spare bits in the coding of an information element shall be set to zero by the sender and shall be ignored by the receiver.

9.1.1 Presence requirements for Information Elements

There are four different presence requirements (Mandatory, Conditional, Conditional-Optional, Optional) for an information element within a given Nq-AP message:

- Mandatory means that the IE shall be included by the sending side, and that the receiver diagnoses a "missing mandatory information element" error, when detecting that the IE is not present.

- Conditional means:

  - that the IE shall be included by sending entity if the conditions specified in the relevant protocol specification are met;

  - the receiver shall check the conditions as specified in the corresponding message type description, based on the parameter combination in the message and/or on the state of the receiving node, to infer if a conditional IE shall be expected. Only if a receiver has sufficient information the following applies. A conditional IE, which is absolutely necessary for the receiving entity to complete the procedure, is missing, then the receiver shall abort the procedure.

- Conditional-Optional means:

  - that the IE shall be included by an entity complying with this version of the specification, if the conditions specified are met.

  - the receiver need not check the presence of the IE in the message. If the receiver checks the presence of the Conditional-Optional IE, then the IE's absence shall not trigger any of the error handling procedures. The handling of an absence or erroneous such IEs shall be treated as Optional IEs.

- Optional means:

  - that the IE shall be included as a service option. Therefore, the IE may be included or not in a message. The handling of an absent optional IE, or an erroneous optional IE is specified in subclause 7 "Error Handling".

For grouped IEs, the presence requirement of the embedded IE shall follow the rules:

- The grouped IE is Mandatory within a given message: the presence requirements of individual embedded IEs are as stated within the Mandatory grouped IE for the given message.

- The grouped IE is Conditional within a given message: if the embedded IE in the grouped IE is Mandatory or Conditional, this embedded IE is viewed as Conditional IE by the receiver. If the embedded IE in the grouped IE is Optional, this embedded IE is viewed as Optional IE by the receiver.

- The grouped IE is Conditional-Optional within a given message: if the embedded IE in the grouped IE is Mandatory or Conditional, this embedded IE is viewed as Conditional-Optional IE by the receiver. If the embedded IE in the grouped IE is Conditional-Optional, this embedded IE is viewed as Optional IE by the receiver. If the embedded IE in the grouped IE is Optional, this embedded IE is viewed as Optional IE by the receiver.- The grouped IE is Optional within a given message: all embedded IEs in the grouped IE are viewed as Optional IEs by the receiver.

In all of the above cases, appropriate error handling as described in subclause 7 shall be applied for protocol errors of the embedded IEs.

9.1.2 Grouped Information Elements

Information elements can contain other IEs. This type of IE is called "Grouped IEs".

Grouped IEs have a length value in the TLV encoding, which includes the added length of all the embedded IEs. Overall coding of a grouped information element with 3 octets long IE header is defined in subclause 9.3.2 "Information Element Format". Each information element within a grouped IE shall also contain a 3-octet long IE header.

9.2 Message Type

Message type uniquely identifies the message being sent. It is a single octet information element, mandatory in all messages. Table 9.2-1 defines the value part of the Message type information element.

Table 9.2-1: Message type information element

Message Type value	Message type	Reference
0	Reserved	
1	NqAP-IMSI-APN-INFORMATION-REQUEST	8.1
2	NqAP-IMSI-APN-INFORMATION-RESPONSE	8.2
3	NqAP-APN-INFORMATION-REQUEST	8.3
4	NqAP-APN-INFORMATION-RESPONSE	8.4
5-255	Spare. For future use.	

9.3 Information Element Coding

9.3.1 Information Element Types

A Nq-AP message may contain several information elements. Except the Message type IE defined in subclause 9.2, all the other Information Elements shall be TLV (Type, Length, Value) coded. Nq-AP information element type values are specified in the Table 9.3.1-1.

Table 9.3.1-1: Information Element types for Nq-AP

IE Type value (Decimal)	Information elements	Reference
0	Reserved	
1	International Mobile Subscriber Identity (IMSI)	9.4.1
2	Access Point Name (APN)	9.4.2
3	RAN Entity Identifier	9.4.3
4	Subscriber-Information	9.4.4
5	RAN Associated Information	9.4.5
6	Cause	9.4.6
7	Fully Qualified Domain Name (FQDN)	9.4.7
8-255	Spare. For future use.	

9.3.2 Information Element Format

Figure 9.3.2-1 depicts the format of an information element.

Octets	Bits 8 7 6 5 4 3 2 1
1	Type = xxx (decimal)
2 to 3	Length = n
4 to (n+3)	IE specific data or content of a grouped IE
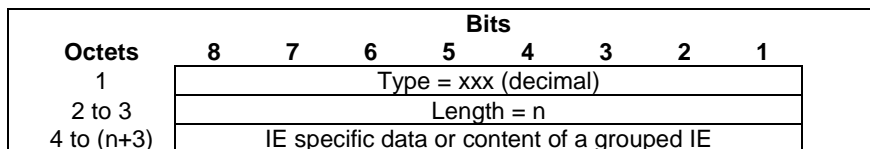
Figure 9.3.2-1: Information Element Format

An IE has the following mandatory fields:

- Type field: This field indicates the type of Information Element. The valid values of the IE type are defined in clause 9.3.1.

- Length: This field contains the length of the information element excluding the first three octets, which are common for all information elements (Type and Length) and is denoted "n" in Figure 9.3.2-1. For all the length fields, bit 8 of the lowest numbered octet is the most significant bit and bit 1 of the highest numbered octet is the least significant bit.

9.4 Information elements

9.4.1 International Mobile Subscriber Identity (IMSI)

The International Mobile Subscriber Identity (IMSI) IE represents the IMSI of the subscriber. The sending entity copies the value part of the IMSI into octets 4 to (n+3) of the IMSI IE. IMSI is defined in 3GPP TS 23.003 [5].

	Bits							
Octets	8	7	6	5	4	3	2	1
1	IE Type = 1(decimal)							
2 to 3	Length = n							
4	Number digit 2				Number digit 1			
5	Number digit 4				Number digit 3			
…	…				…			
n+3	Number digit m				Number digit m-1			

Figure 9.4.1-1: IMSI

Octets 4 to (n+3) represent the IMSI value as described in ITU-T Rec E.212 [9], encoded as TBCD digits, i.e. digits from 0 through 9 are encoded "0000" to "1001". When there is an odd number of digits, bits 8 to 5 of the last octet are encoded with the filler "1111". The maximum number of digits is 15.

9.4.2 Access Point Name (APN)

The Access Point Name information element specifies the APN towards which a subscriber has active PDN connection and is coded as shown in figure 9.4.2-1. The encoding the APN field follows 3GPP TS 23.003 [5] subclause 9.1. The content of the APN field shall be the full APN with both the APN Network Identifier and APN Operator Identifier being present as specified in 3GPP TS 23.003 [5] subclauses 9.1.1 and 9.1.2, 3GPP TS 23.060 [3] Annex A and 3GPP TS 23.401 [2] subclause 4.3.8.1.

NOTE: The APN field is not encoded as a dotted string as commonly used in documentation.

	Bits							
Octets	8	7	6	5	4	3	2	1
1	IE Type = 2(decimal)							
2 to 3	Length = n							
4 to (n+3)	Access Point Name (APN)							

Figure 9.4.2-1: APN

9.4.3 RAN Entity Identifier

The RAN Entity Identifier IE represents the location granularity for which subscriber information is provided. The RAN Entity Identifier shall either be a Macro eNodeB ID or a Home eNodeB ID or a E-UTRAN Cell Global Identity. The RAN Entity Identifier is coded as shown in figure 9.4.3-1.

	Bits							
Octets	8	7	6	5	4	3	2	1
1	IE Type = 3 (decimal)							
2 to 3	Length = n							
4	RAN Entity Type							
5 to (n+4)	RAN Entity Value							

Figure 9.4.3-1: RAN Entity Identifier

The RAN Entity Type values are given below in Table 9.4.3-1

Table 9.4.3-1: RAN Entity Type values and their meanings

RAN Entity Type	RAN Entity Value (Decimal)
Macro eNodeB ID	0
Home eNodeB ID	1
E-UTRAN Cell Global Identity	2
<Spare>	3 to 255

If the RAN Entity Type is Macro eNodeB ID then the RAN Entity value shall represent a Macro eNodeB ID. The Macro eNodeB ID is encoded as shown below in Figure 9.4.3-2.

	Bits							
Octets	8	7	6	5	4	3	2	1
5	MCC digit 2				MCC digit 1			
6	MNC digit 3				MCC digit 3			
7	MNC digit 2				MNC digit 1			
8	Spare				Macro eNodeB ID			
9 to 10	Macro eNodeB ID							
11 to 12	Tracking Area Code (TAC)							

Figure 9.4.3-2: Encoding of Macro eNodeB as the RAN Entity Value

The Macro eNodeB ID consists of 20 bits. Bit 4 of Octet 8 is the most significant bit and bit 1 of Octet 10 is the least significant bit. The coding of the Macro eNodeB ID is the responsibility of each administration. Coding using full hexadecimal representation shall be used.

If the RAN Entity Type is Home eNodeB ID then the Home eNodeB ID shall be encoded as the RAN Entity value as shown below in Figure 9.4.3-3.

	Bits							
Octets	8	7	6	5	4	3	2	1
5	MCC digit 2				MCC digit 1			
6	MNC digit 3				MCC digit 3			
7	MNC digit 2				MNC digit 1			
8	Spare				Home eNodeB ID			
9 to 11	Home eNodeB ID							
12 to 13	Tracking Area Code (TAC)							

Figure 9.4.3-3: Encoding of Home eNodeB as the RAN Entity Value

The Home eNodeB ID consists of 28 bits. See 3GPP TS 36.413 [10]. Bit 4 of Octet 9 is the most significant bit and bit 1 of Octet 12 is the least significant bit. The coding of the Home eNodeB ID is the responsibility of each administration. Coding using full hexadecimal representation shall be used.

If the RAN Entity Type is E-UTRAN Cell Global Identity (ECGI) then the ECGI shall be encoded as the RAN Entity value as shown below in Figure 9.4.3-4.

	Bits							
Octets	8	7	6	5	4	3	2	1
5	MCC digit 2				MCC digit 1			
6	MNC digit 3				MCC digit 3			
7	MNC digit 2				MNC digit 1			
8	Spare				ECI			
9 to 11	ECI (E-UTRAN Cell Identifier)							

Figure 9.4.3-4: Encoding of ECGI as the RAN Entity Value

The E-UTRAN Cell Identifier (ECI) consists of 28 bits. The ECI field shall start with Bit 4 of octet 8, which is the most significant bit. Bit 1 of Octet 11 is the least significant bit. The coding of the E-UTRAN cell identifier is the responsibility of each administration. Coding using full hexadecimal representation shall be used.

9.4.4 Subscriber-Information

The Subscriber-Information IE is a grouped IE and it carries the information related to a subscriber (IMSI and APN).

Octet 1		IE Type = 4 (decimal)	
Octets 2 and 3		Length = n	
Information elements	**P**	**Condition / Comment**	**IE Type**
IMSI	M		IMSI
APN	M	If there are more than one APN for which PDN connections are activated for a subscriber, then each APN shall be encoded as a separate instance of the APN IE	APN

Figure 9.4.4-1: Subscriber Information

9.4.5 RAN Associated Information

The RAN Associated Information IE is a grouped IE and it carries the information related to list of subscribers for a given RAN Entity Identifier.

Octet 1		IE Type = 5 (decimal)	
Octets 2 and 3		Length = n	
Information elements	**P**	**Condition / Comment**	**IE Type**
RAN Entity Identifier	M		RAN Entity Identifier
Subscriber Information	M	If there are more than one subscriber under the given RAN Entity Identifier, then each subscriber's information shall be encoded as a separate instance of the Subscriber Information IE	Subscriber-Information

Figure 9.4.5-1: RAN Associated Information

9.4.6 Cause

The Cause IE shall be used to indicate the RCAF

-    Success / reason for failure of processing a request message;

The Cause IE shall be encoded as specified in figure 9.4.6-1 below.

.	**Bits**							
Octets	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1	IE Type = 6 (decimal)							
2 to 3	Length = n							
4	Cause value							
5	Type of the offending IE							

Figure 9.4.6-1: Cause

Cause is a variable length IE, which may have either of the following two lengths values:

-    If n = 1, then the Cause IE shall be 4 octets long. Therefore, octet 5 will not be present.

-    If n = 2, then the Cause IE shall be 5 octets long.

The Cause value shall be included in a response message. In a response message, the Cause value indicates the acceptance or the rejection of the corresponding request message. The Cause value indicates the explicit reason for the rejection.

If the rejection is due to a mandatory IE or a verifiable conditional IE is faulty or missing, the offending IE shall be included in Octet 5.
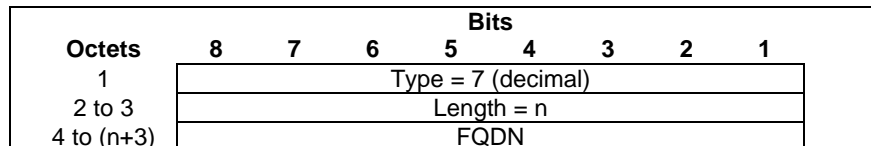
The following table provides the various cause values

Table 9.4.6-1: Cause values

Cause Type	Cause value (decimal)	Meaning
	0	Reserved. Shall not be sent and if received the Cause shall be treated as an invalid IE
Acceptance Cause	1	Request Accepted
	2 to 15	Spare. This value range shall be used for acceptance cause values.
Protocol Errors	16	Mandatory IE incorrect
	17	Mandatory IE missing
	18	Conditional IE incorrect
	19	Conditional IE missing
	20	Invalid length
	21 to 63	Spare. This value range shall be used by Cause values representing protocol errors.
Cause Codes Representing Status	64	MME/SGSN Congested
	65 to 255	Spare. For Future Use.

9.4.7   Fully Qualified Domain Name (FQDN)

Fully Qualified Domain Name (FQDN) is coded as depicted in Figure 9.4.7-1.

	Bits							
Octets	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1	Type = 7 (decimal)							
2 to 3	Length = n							
4 to (n+3)	FQDN							

Figure 9.4.7-1: Fully Qualified Domain Name (FQDN)

The FQDN field encoding shall be identical to the encoding of a FQDN within a DNS message of section 3.1 of IETF RFC 1035 [11] but excluding the trailing zero byte.

NOTE: The FQDN field in the IE is not encoded as a dotted string as commonly used in DNS master zone files.

Annex A (informative):
Change history

<table>
<tr><th colspan="8">Change history</th></tr>
<tr><th>Date</th><th>TSG #</th><th>TSG Doc.</th><th>CR</th><th>Rev</th><th>Subject/Comment</th><th>Old</th><th>New</th></tr>
<tr><td>2014-10</td><td>CT4#66bis</td><td>C4-142063</td><td></td><td></td><td>TS skeleton</td><td></td><td>0.1.0</td></tr>
<tr><td>2014-10</td><td>CT4#66bis</td><td>C4-142064</td><td></td><td></td><td>Implementation of C4-142065</td><td></td><td>0.1.0</td></tr>
<tr><td>2014-11</td><td>CT4#67</td><td>C4-142451</td><td></td><td></td><td>Implementation of C4-142444, C4-142445, C4-142446, C4-142450, C4-142479</td><td>0.1.0</td><td>0.2.0</td></tr>
<tr><td>2015-02</td><td>CT4#68</td><td>C4-150347</td><td></td><td></td><td>Implementation of C4-150251, C4-150254, C4-150376, C4-150256, C4-150258, C4-150259</td><td>0.2.0</td><td>0.3.0</td></tr>
<tr><td>2015-04</td><td>CT4#68bis</td><td>C4-150680</td><td></td><td></td><td>Implementation of C4-150713, C4-150649</td><td>0.3.0</td><td>0.4.0</td></tr>
<tr><td>2015-05</td><td>CT4#69</td><td>C4-150982</td><td></td><td></td><td>Implementation of C4-150830, C4-150873, C4-150981</td><td>0.4.0</td><td>0.5.0</td></tr>
<tr><td>2015-06</td><td>CT#68</td><td>CP-150278</td><td></td><td></td><td>Presented for information and approval</td><td>0.5.0</td><td>1.0.0</td></tr>
<tr><td>2015-06</td><td></td><td></td><td></td><td></td><td>Approved in CT#68</td><td>1.0.0</td><td>13.0.0</td></tr>
<tr><td>2015-12</td><td>CT#70</td><td>CP-150777</td><td>0001</td><td>-</td><td>Registered port number for Nq-AP</td><td>13.0.0</td><td>13.1.0</td></tr>
<tr><td>2017-03</td><td>CT#75</td><td>-</td><td>-</td><td>-</td><td>Update to Rel-14 version (MCC)</td><td>13.1.0</td><td>14.0.0</td></tr>
<tr><td>2018-06</td><td>CT#80</td><td>-</td><td>-</td><td>-</td><td>Update to Rel-15 version (MCC)</td><td>14.0.0</td><td>15.0.0</td></tr>
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History

Document history		
V15.0.0	July 2018	Publication