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Title:	**3GPP TS 29.228 IP Multimedia Subsystem Cx interface;**
	Signalling flows and message contents
Agenda item:	**9.1**
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This document contains **3GPP TS 29.228-v1.0.0 IP Multimedia Subsystem Cx interface; Signalling flows and message contents Rel-5**. It has been agreed by TSG CN WG4, and are forwarded to TSG CN Plenary meeting #14 for information.

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Technical Specification

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Contents

Foreword

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

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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1 Scope

This 3GPP Technical Specification (TS) specifies the interactions between the HSS (Home Subscriber Server) and the CSCF (Call State Control Functions), referred to as the Cx reference point.

The IP Multimedia (IM) Subsystem stage 2 is specified in 3GPP TS 23.228 [5] and the signaling flows for the IP multimedia call control based on SIP and SDP are specified in 3GPP TS 24.228 [6].

This document addresses the Cx reference point related signalling flows .

2 References

[1] 3GPP TR 41.001: "GSM Release specifications".

[2] 3GPP TR 21.905: " Vocabulary for 3GPP Specifications ".

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

[4] 3GPP TS 23.060: "General Packet Radio Service; Service description; Stage 2".

[5] 3GPP TS 23.228: "IP Multimedia (IM) Subsystem – Stage 2".

[6] 3GPP TS 24.228: "Signalling flows for the IP multimedia call control based on SIP and SDP".

[7] 3GPP TS 24.229: "IP multimedia call control protocol based on SIP and SDP ".

[8] 3GPP TS 33.203: "Access security for IP-based services".

[9] draft-ietf-sip-rfc2543bis-05: “SIP: Session Initiation Protocol”, work in progress

[10] 3GPP TS 23.002 "Network architecture".

[11] 3GPP TS 29.229: "Cx Interface based on Diameter – Protocol details"

[12] 3GPP TS 23.218: “IP Multimedia (IM) Session Handling; IP Multimedia (IM) call model”

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply.

IP Multimedia session: IP Multimedia session and IP Multimedia call are treated as equivalent in this specification.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

CSCF	Call Session Control Function
GPRS	General Packet Radio Service
HPLMN	Home PLMN
HSS	Home Subscriber Server
EAP	Extensible Authentication Protocol
IE	Information Element
IF	Information Flow
IP	Internet Protocol
I-CSCF	Interrogating CSCF
IM	IP Multimedia
IMS	IP Multimedia Subsystem
MGCF	Media Gateway Control Function
MO	Mobile Originating
MT	Mobile Terminating
NNI	Network Node Interface
PLMN	Public Land Mobile Network
P-CSCF	Proxy CSCF
SIP	Session Initiation Protocol
S-CSCF	Serving CSCF
VPLMN	Visited PLMN

4 Main Concept

This document presents the Cx interface related functional requirements of the communicating entities.

It gives a functional classification of the procedures and describes the procedures and message parameters.

Error handling flows, protocol version identification, etc. procedures are also included.

5 General Architecture

This clause further specifies the architectural assumptions associated with the Cx reference point, building on 3GPP TS 23.228 [5].

5.1 Functional requirements of network entities

5.1.1 Functional requirements of P-CSCF

There is no requirement for any interaction between the P-CSCF and HSS.

5.1.2 Functional requirements of I-CSCF

The I-CSCF communicates with HSS over the Cx interface.

For functionality of the I-CSCF refer to 3GPP TS 23.002 [10].

5.1.3 Functional requirements of S-CSCF

The S-CSCF communicates with HSS over the Cx interface.

For functionality of the S-CSCF refer to 3GPP TS 23.002 [10].

5.1.4 Functional requirements of HSS

The HSS communicates with I-CSCF and S-CSCF over the Cx interface.

For functionality of the HSS refer to 3GPP TS 23.002 [10].

5.1.5 Functional classification of Cx interface procedures

Operations on the Cx interface are classified in functional groups:

1. Location management procedures
   - The operations regarding registration and deregistration.
   - Location retrieval operation.
2. User data handling procedures
   - The download of user information during registration and to support recovery mechanisms.
   - Operations to support the updating of user data and recovery mechanisms.

Note: Recovery mechanisms have not been specified in SA2 yet.

3. User authentication procedures

Note6 Procedure Descriptions

Note: The mapping of procedures to Diameter commands shall also be described here. These Diameter commands may not necessarily have a 1-to-1 mapping to the Cx messages below.

6.1 Location management procedures

6.1.1 User registration status query

On receiving a registration request, the I-CSCF shall query the HSS to check the registration status of the user.

The HSS checks if the user has already registered. If the user has not registered yet it shall check according to the user subscription and operator limitations/restrictions whether the user is allowed to register e.g. if registering from a visited network.

If the user is authorized to register, the response may contain information about the required S-CSCF capabilities, which enables the I-CSCF to select an S-CSCF. If there are no capabilities included and the user is allowed to register, the I-CSCF can select any S-CSCF for the user. The assignment of an S-CSCF for a user is detailed in [5].

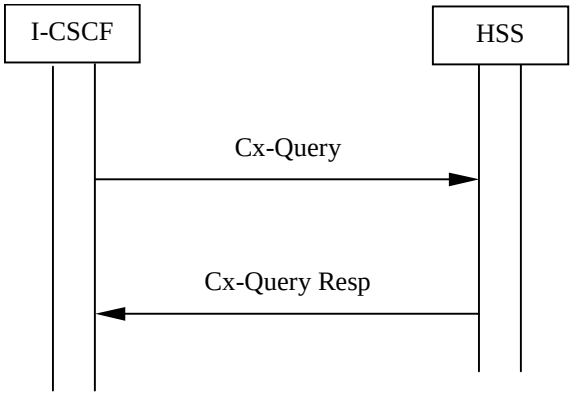


Figure 1: User registration query

If the user has previously registered, the assigned S-CSCF name is included in the response. The response sent to the I-CSCF indicates the result of the registration attempt.

If the user identity is not known to the HSS, the HSS returns an error indication.

6.1.2 S-CSCF registration/deregistration notification

On registering/deregistering a user the S-CSCF shall inform the HSS that the user has been registered/deregistered at this instance. The HSS shall update/clear the assigned S-CSCF to the user in its database according to this information.

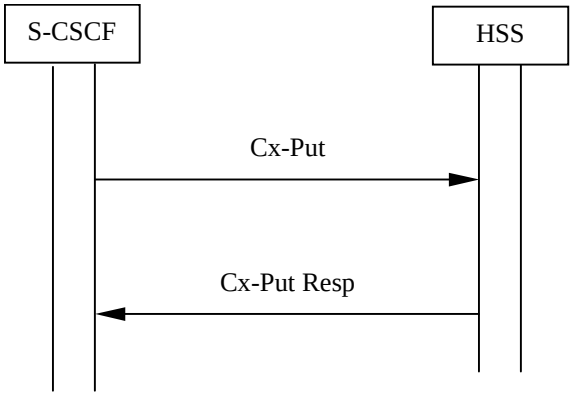


Figure 3: S-CSCF registration/deregistration notification

The response sent to the S-CSCF contains an acknowledgement of the operation and, in case of a positive acknowledgement, the user data and service related information.

6.1.3 Network initiated deregistration

In case of network initiates deregistration of the user the HSS shall send a notification to the S-CSCF indicating that the user shall be deregistered. S-CSCF starts deregistration procedure and sends a notification as described in 6.1.3. For details on network initiated deregistration refer to [5].

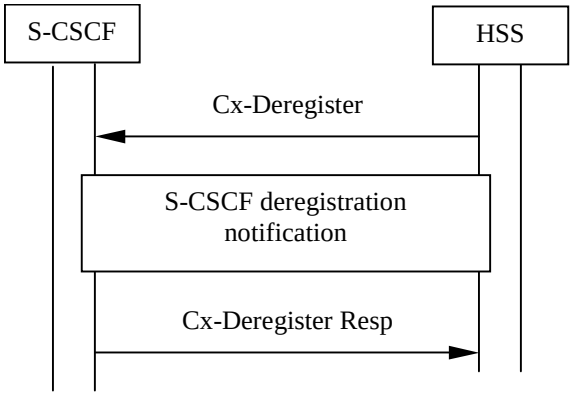


Figure 4: Network initiated deregistration

The response sent to the HSS contains an acknowledgement of the operation.

6.1.4 User location query

In case of a mobile terminated call the I-CSCF sends a query to the HSS to find out the S-CSCF of the called user.

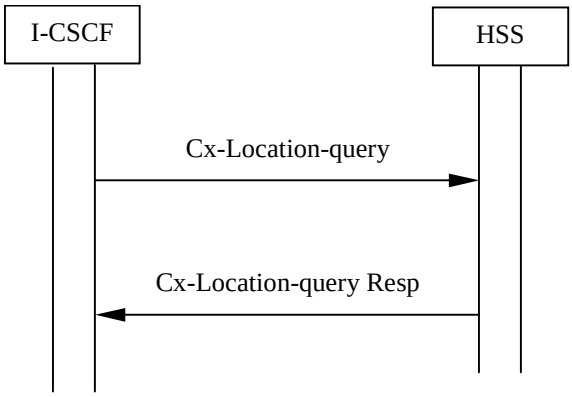


Figure 5: Query of assigned S-CSCF for a user

If the user has been previously registered the response sent to the I-CSCF contains the name of the S-CSCF assigned to the user.

The response may contain information about the required S-CSCF capabilities, which enables the I-CSCF to select an S-CSCF, if the user is unregistered and has services related to unregistered state. If there are no capabilities included and the user is unregistered and has services related to unregistered state, the I-CSCF can select any S-CSCF for the user.

For details of call flows refer to 3GPP TS 23.228 [5].

6.2 User data handling procedures

6.2.1 User Profile download

As part of the registration procedure (3GPP TS 23.228 [5]) S-CSCF obtains user data and service related information by means of the Cx-Put Resp operation (see 6.1.2).

6.2.2 HSS initiated update of User Profile

The HSS can initiate a User Profile update by sending Cx-Update_Subscr_Data to the S-CSCF. For detailed description of the procedure refer to 3GPP TS 23.228 [5].

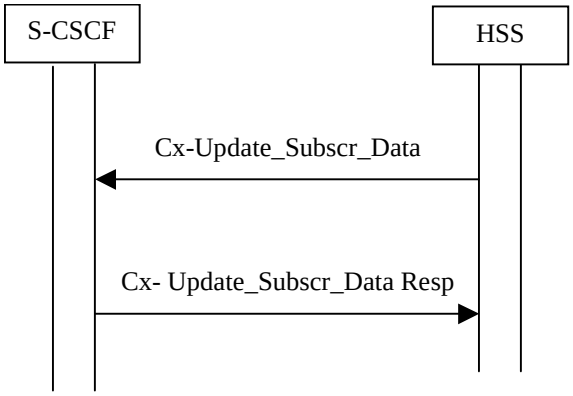


Figure 7: User Profile update

The response sent to the HSS confirms the successful update.

6.3 Authentication procedures

Note: the exact procedures shall be defined by SA3.

With this transaction the S-CSCF retrieves a set of authentication vectors (quintuplets) from the HSS. The S-CSCF name is included if the user has not been authenticated yet by the S-CSCF yet.

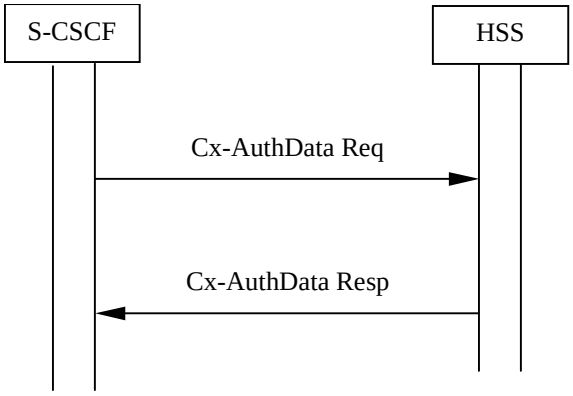


Figure 8: Download of authentication information

The response sent to the S-CSCF contains the authentication data.

7 Cx Messages Contents

This clause contains the detailed description of the information flows used in the Cx interface.

Each Information Element, IE, is marked as (M) Mandatory, (C) Conditional or (O) Optional. A mandatory information element shall always be present. A conditional information shall be present if certain conditions are fulfilled; if those conditions are not fulfilled it shall be absent. An optional information element may be present or absent, at the discretion of the application at the sending entity.

7.1 Cx-Query

Table 1 shows the message content for the Cx-Query message sent from I-CSCF to HSS.

Table 1: Cx-Query message

Message	Information	Mapping to	Information	Description	Reference	Note

source & destination	element name	Diameter AVP	element required			
I-CSCF to HSS	User Identity	Public-Identity	M	This information element indicates the ID of the user whose service is to be registered.	8.2	
	Visited Network Identifier	Visited-Network-Identifier	M	This information indicates the network identifier of the visited network	8.1	
	Private User Identity	User-Name	M	This IE indicates the private user ID	8.3	

7.2 Cx-Query Resp

Table 2 shows the message content for the Cx-Query Resp message sent from HSS to I-CSCF.

Table 2: Cx-Query Resp message

Message source & destination	Information element name	Mapping to Diameter AVP	Information element required	Description	Reference	Note
HSS to I-CSCF	Registration status	Result-Code	M	This information element indicates the user registration status	8.4	
	S-CSCF capabilities	Server-Capabilities	O	This information element indicates required capabilities of the S-CSCF to be assigned to the user.	8.6	
	S-CSCF Name	Server-Name	C	This information element indicates the assigned S-CSCF name.	8.5	Included in case of the user already registered

7.5 Cx-Put

Table 5 shows the message content for the Cx-Put message sent from S-CSCF to HSS.

Table 5: Cx- Put message

Message source & destination	Information element name	Mapping to Diameter AVP	Information element required	Description	Reference	Note
S-CSCF to HSS	User Identity	Public-Identity	O	This information element indicates the ID of the user for whom registration is made.	8.2	
	S-CSCF Name	Server-Name	M	Name of the S-CSCF.	8.5	
	Private User Identity	User-Name	M	This IE indicates the private user ID	8.3	

	Server Assignment Type	Server-Assignment-Type	M	This information element indicates type of update the S-CSCF requests in the HSS (e.g: deregistration)	8.10	

7.6 Cx-Put Resp

Table 6 shows the message content for the Cx- Put Resp message sent from HSS to S-CSCF.

Table 6: Cx- Put Resp message

Message source & destination	Information element name	Mapping to Diameter AVP	Information element required	Description	Reference	Note
HSS to S-CSCF	Registration result	Result-Code	M	This information element indicates the result of registration.	8.7	
	User Profile	User-Data	O	This information element contains the user profile	8.8	

7.7 Cx-Deregister

Table 7 shows the message content for the Cx- Deregister message sent from HSS to S-CSCF.

Table 7: Cx- Deregister message

Message source & destination	Information element name	Mapping to Diameter AVP	Information element required	Description	Reference	Note
HSS to S-CSCF	User Identity	Public-Identity	M	This information element indicates the ID of the user for who de-registration shall be made.	8.2	
	Private User Identity	User-Name	M	This IE indicates the private user ID	8.3	

7.8 Cx-Deregister Resp

Table 8 shows the message content for the Cx- Deregister Resp message sent from HSS to S-CSCF.

Table 8: Cx- Deregister Resp message

Message source & destination	Information element name	Mapping to Diameter AVP	Information element required	Description	Reference	Note
S-CSCF to HSS	Result	Result-Code	M	This information element indicates the result of de-registration.	8.7	

7.9 Cx-Location-query

Table 9 shows the message content for the Cx- Location-query message sent from I-CSCF to HSS.

Table 9: Cx- Location-query message

Message source & destination	Information element name	Mapping to Diameter AVP	Information element required	Description	Reference	Note
I-CSCF to HSS	Public User Identity	Public-Identity	M	This information element indicates the Public ID of the user	8.2	

7.10 Cx-Location-query Resp

Table 10 shows the message content for the Cx- Location-query Resp message sent from HSS to I-CSCF.

Table 10: Cx- Location-query Resp message

Message source & destination	Information element name	Mapping to Diameter AVP	Information element required	Description	Reference	Note
HSS to I-CSCF	Result	Result-Code	M	This information element contains the result of the operation	8.7	
	S-CSCF Name	Server-Name	C	This information element indicates the name of the S-CSCF serving the user.	8.5	Included if the user has already registered
	S-CSCF capabilities	Server-Capabilities	O	This information element indicates required capabilities of the S-CSCF to be assigned to the user.	8.6	

7.11 Cx-Update_Subscr_Data

Table 13 shows the message content for the Cx-Update_Subscr_Data message sent from HSS to S-CSCF.

Table 13: Cx-Update_Subscr_Data message

Message source & destination	Information element name	Mapping to Diameter AVP	Information element required	Description	Reference	Note
HSS to S-CSCF	User Identity	Public-Identity	M	This information element indicates the user whose profile is to be downloaded.	8.2	
	Private User Identity	User-Name	M	This IE indicates the private user ID	8.3	
	User profile	User-Data	M	This information element contains the user profile.	8.8	

7.12 Cx-Update_Subscr_Data Resp

Table 14 shows the message content for the Cx-Update_Subscr_Data Resp message sent from S-CSCF to HSS.

Table 14: Cx-Update_Subscr_Data Resp message

Message source & destination	Information element name	Mapping to Diameter AVP	Information element required	Description	Reference	Note
S-CSCF to HSS	Result	Result-Code	M	This information element indicates the result of the update of User Profile in S-CSCF.	8.7	

7.13 Cx-AuthData Req

Table 15 shows the message content for the Cx-AuthData Req message sent from S-CSCF to HSS.

Table 15: Cx-AuthData Req message

Message source & destination	Information element name	Mapping to Diameter AVP	Information element required	Description	Reference	Note
S-CSCF to HSS	Public User Identity	Public-Identity	M	This information element indicates the public ID of the user	8.2	
	Private User Identity	User-Name	M	This IE indicates the private user ID	8.3	
	Authentication Scheme	Authentication-Scheme	M	This information element the authentication scheme	8.11	
	Authentication Parameters	Authentication-Parameters	M	This information element indicates authentication parameters	8.12	
	Number Authentication Items	Number-Authentication-Items	M	This information element indicates the number of authentication vectors requested	8.13	
	S-CSCF Name	Server-Name	C	This information element contains the name of the S-CSCF	8.5	The presence of this IE indicates that the user has not been authenticated yet by the S-CSCF.

7.14 Cx-AuthData Resp

Table 16 shows the message content for the Cx-AuthData Resp message sent from HSS to S-CSCF.

Table 16: Cx-AuthData Resp message

Message source & destination	Information element name	Mapping to Diameter AVP	Information element required	Description	Reference	Note
HSS to S-CSCF	Authentication data	Authentication-Data-Item	M	The authentication vectors (quintuplets)	8.10	
	Number Authentication Items	Number-Authentication-Items	M	This information element indicates the number of authentication vectors delivered	8.13	
	Result	Result-Code	M	This information element contains the result of the operation	8.7	

8 Information element contents

8.1 Visited Network Identifier

This information element contains the domain name of the visited network.

8.2 Public User Identity

This information element contains the public identity of the user.

8.3 Private User Identity

This information element contains the private identity of the user.

8.4 Registration Status

This information element contains the registration status for a user: unknown / reject / allowed / already registered.

8.5 S-CSCF Name

This information element contains the SIP Address of S-CSCF.

8.6 S-CSCF Capabilities

This information element carries information to assist the I-CSCF during the process of selecting an S-CSCF for a certain user.

The contents of this IE shall allow operators to distribute users between S-CSCFs attending to mandatory and optional capabilities required per user by each operator, depending on the different capabilities (features, role, etc.) that each S-CSCF may have. The I-CSCF shall match the required capabilities to the capabilities of each S-CSCF of which it has knowledge. The I-CSCF shall first try to select an S-CSCF that has all the capabilities required for the subscriber. Only if that is not possible shall the I-CSCF apply a ‘best-fit’ algorithm. The ‘best-fit’ algorithm is implementation dependent and out of the scope of this specification.

The operator shall define (possibly based on the functionality offered by each S-CSCF installed in the network) the exact meaning of the mandatory and optional capabilities. about It is a configuration task for the operator to ensure that

the I-CSCF has a correct record of the capabilities of each S-CSCF available in his network. The I-CSCF does not need to know the semantic of to the capabilities received from the HSS. This semantic is exclusively an operator issue.

It is the responsibility of the operator to ensure that there are S-CSCFs which meet the “mandatory” requirements indicated by the HSS. However, configuration errors may occur. If such errors occur and they prevent the I-CSCF from selecting an S-CSCF which meets the “mandatory” requirements indicated by the HSS, the I-CSCF shall inform the HSS via O&M. However, the I-CSCF should still select the ‘best fit’ S-CSCF. This will provide better user service experience than the user receiving a ‘no service (no S-CSCF) available’ indication.

In additional to the possibility to select an S-CSCF based on the list of capabilities received from the HSS, it is possible to steer users to certain S-CSCFs.This is an operator issue; the reason for the selection (e.g. all the users belonging to the same company/group could be in the same S-CSCF to implement a VPN service) and the method of selection are out of the scope of this specification.

8.7 Result

This information element contains result of an operation: successful or unsuccessful.

8.8 User Profile

This information element contains the profile of a user.

Note: Annex B, as a basis for further development, details the UML logical model of the user profile downloaded via the Cx interface.

Note: Annex C, as a basis for further development, contains a high level representation of the wire representation of user profile data.

Note: The concrete abstract syntax notation to be used for the coding of the user profile downloaded over Cx interface is FFS.

8.9 Server Assignment Type

Indicates the type of server assignment: Registration, Re-registration, Unregistered user, Timeout de-registration, User de-registration, Authentication failure.

8.10 Authentication Data

This information element contains one or more authentication vectors. Reference 3GPP TS 33.203 [8] describes the detailed authentication procedures.

8.11 Authentication Scheme

This information element contains the authentication scheme, which is used to encode the authentication parameters.

For 3GPP EAP shall be used.

8.12 Authentication Parameters

This information element contains parameters EAP encoded. For authentication vector request the private user identity is contained. In case of synchronization failure AUTS and RAND are contained.

8.13 Number Authentication Items

This information element contains the number of authentication vectors requested or delivered.

9 Error handling procedures

Note: FFS.

10 Protocol version identification

Note : The set of protocol elements described in this document shall be identified to support IMS in 3GPP release 5 .

11 Operational Aspects

Note : This clause specifies the lower layer operational requirements such as reliability and security assumptions.

Annex A (normative): Mapping of Cx operations and terminology to Diameter

A.1 Introduction

This appendix gives mappings from Cx to Diameter protocol elements. Diameter protocol elements are defined in 3GPP TS 29.229.

Note: The present mapping represents the current way of understanding of 3GPP procedures. The mapping is also based on the current state of 3GPP TS 29.229. Especially items marked "FFS." might further be optimised.

A.2 Cx message to Diameter command mapping

Note: Command names in 3GPP TS 29.229 are subject to change.

The following table defines the mapping between stage 2 operations and Diameter commands:

Table A.2.1: Cx message to Diameter command mapping

Cx message	Source	Destination	Command-Name	Abbreviation
Cx-Query	I-CSCF	HSS	Registration-Authorisation-Request	RAR
Cx-Query Resp	HSS	I-CSCF	Registration-Authorisation-Answer	RAA
Cx-Put + Cx-Pull	S-CSCF	HSS	Server-Assignment-Request	SAR
Cx-Put Resp + Cx-Pull Resp	HSS	S-CSCF	Server-Assignment-Answer	SAA
Cx-Location-Query	I-CSCF	HSS	Location-Info-Request	LIR
Cx-Location-Query Resp	HSS	I-CSCF	Location-Info-Answer	LIA
Cx-AuthDataReq	S-CSCF	HSS	Multimedia-Authentication-Request	MAR
Cx-AuthDataResp	HSS	S-CSCF	Multimedia-Authentication-Answer	MAA
Cx-Deregister	HSS	S-CSCF	Registration-Termination-Request	RTR
Cx-Deregister Resp	S-CSCF	HSS	Registration-Termination-Answer	RTA
Cx-Update_Subscr_Data	HSS	S-CSCF	Push-Profile-Request	PPR
Cx-Update_Subscr_Data Resp	S-CSCF	HSS	Push-Profile-Answer	PPA

A.3 Cx message parameters to Diameter AVP mapping

Note: AVP names and types in 3GPP TS 29.229 are subject to change. 3GPP TS 29.229 defines only generic containers. The exact message contents will be defined in 3GPP TS 23.228.

The following table gives an overview about the mapping:

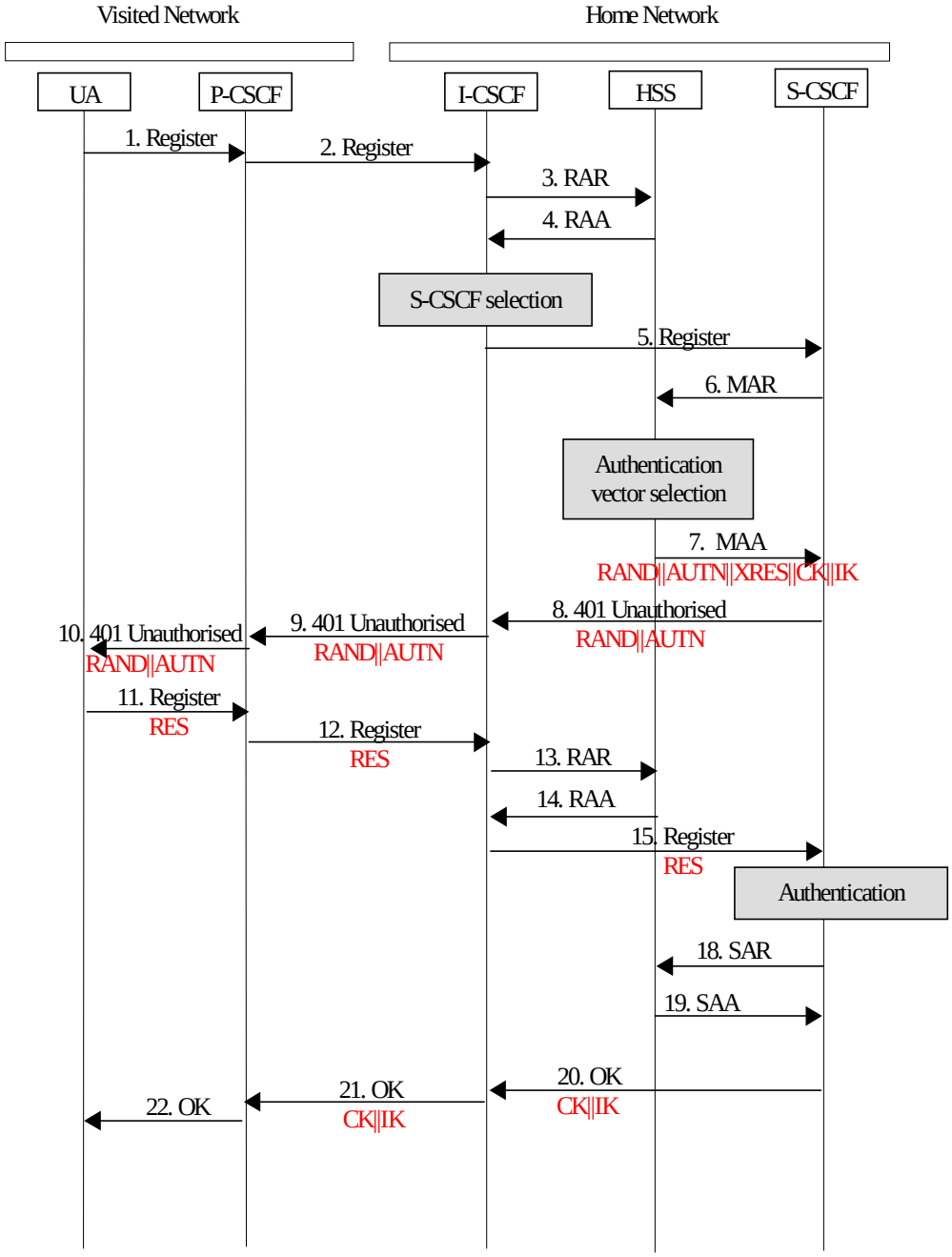
Table A.3.1: Cx message parameters to Diameter AVP mapping

Cx parameter	AVP Name
Visited Network Identifier	Visited-Network-Identifier
Public User ID	Public-Identity
Private User ID	User-Name
Registration status	Result-Code
S-CSCF name	Server-Name
S-CSCF capabilities	Server-Capabilities
Result	Result-Code
User profile	User-Data
Server Assignment Type	Server Assignment Type
Authentication data	Authentication-Data-Item
Authentication Scheme	Authentication-Scheme
Authentication Parameters	Authentication-Parameters
Number Authentication Items	Number-Authentication-Items

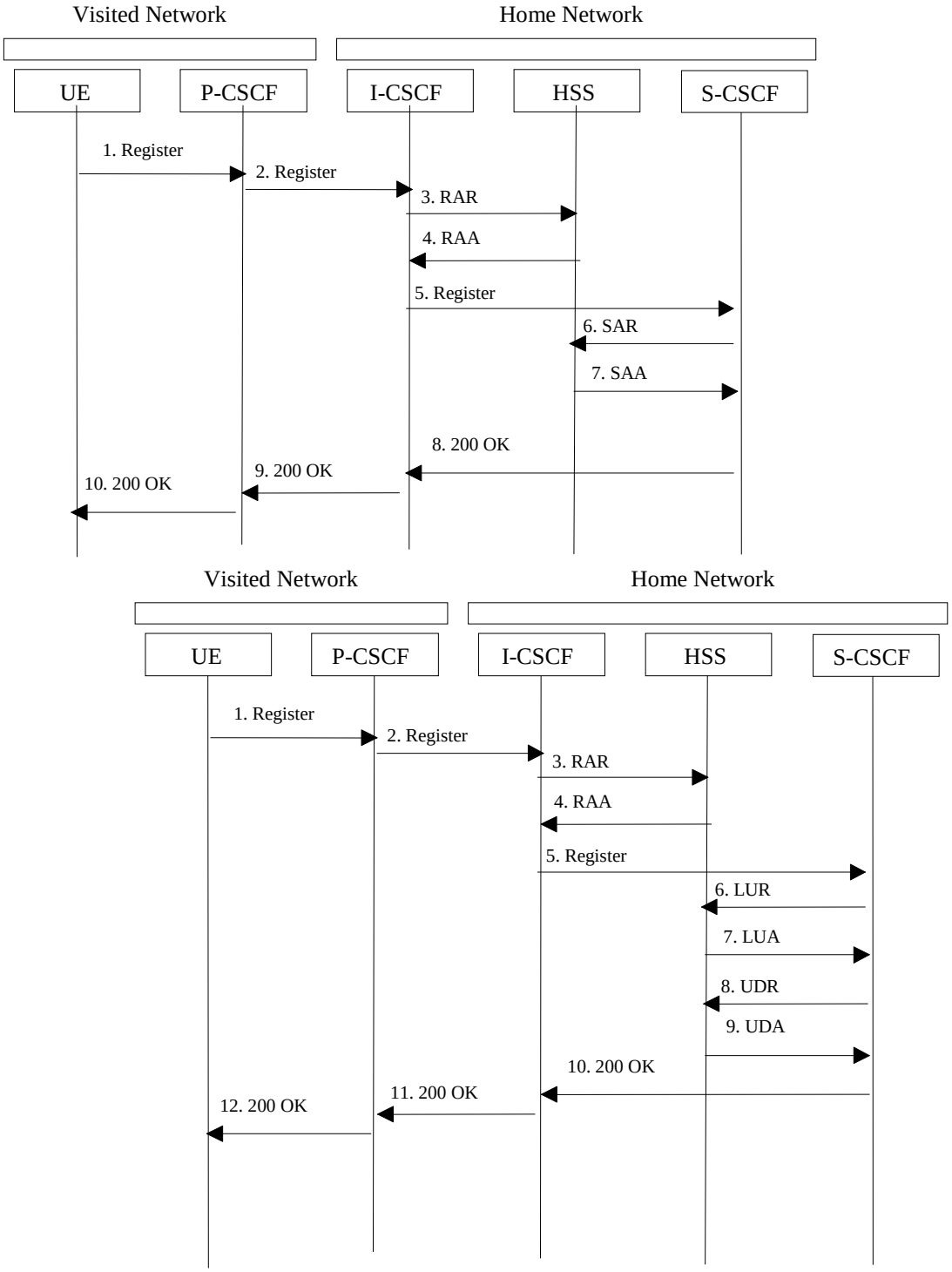
A.4 Message flows

The following message flows give examples regarding which Diameter messages shall be sent in scenarios described in 3GPP TS 23.228.

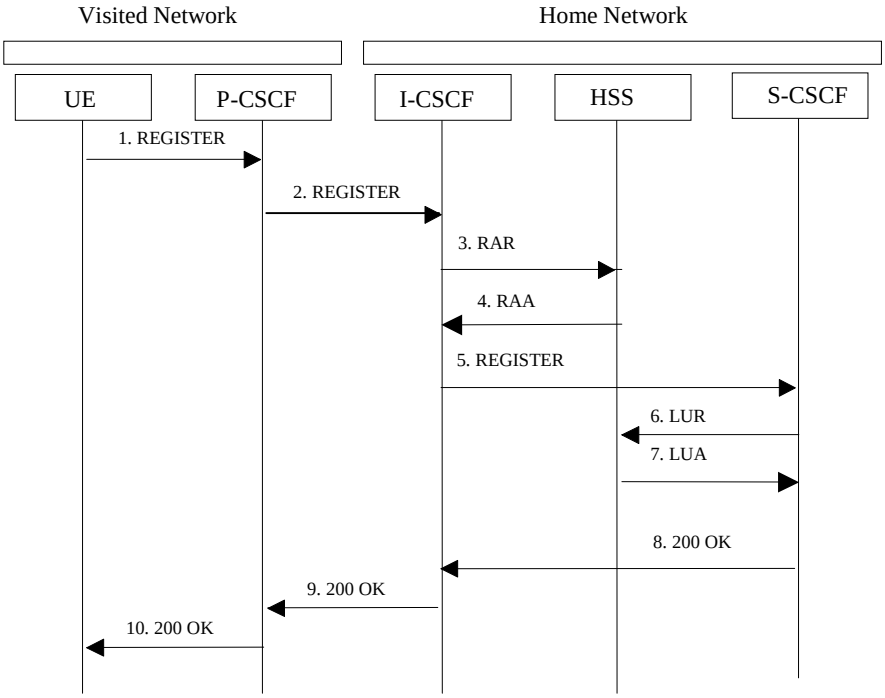
A.4.1 Registration with (proposed) authentication – user not registered



A.4.2 Re-registration – user currently registered

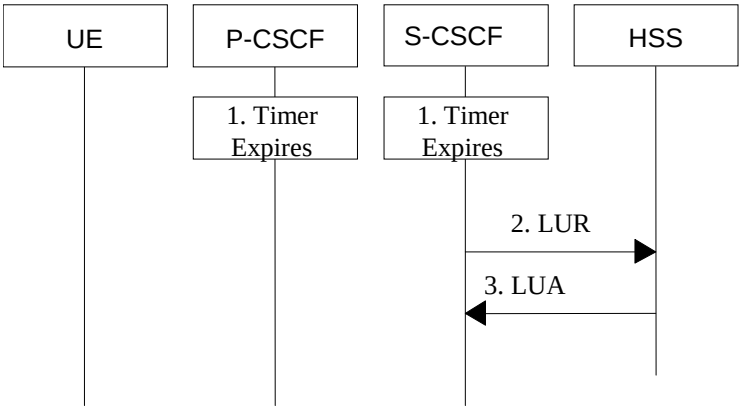


A.4.3 Mobile initiated de-registration

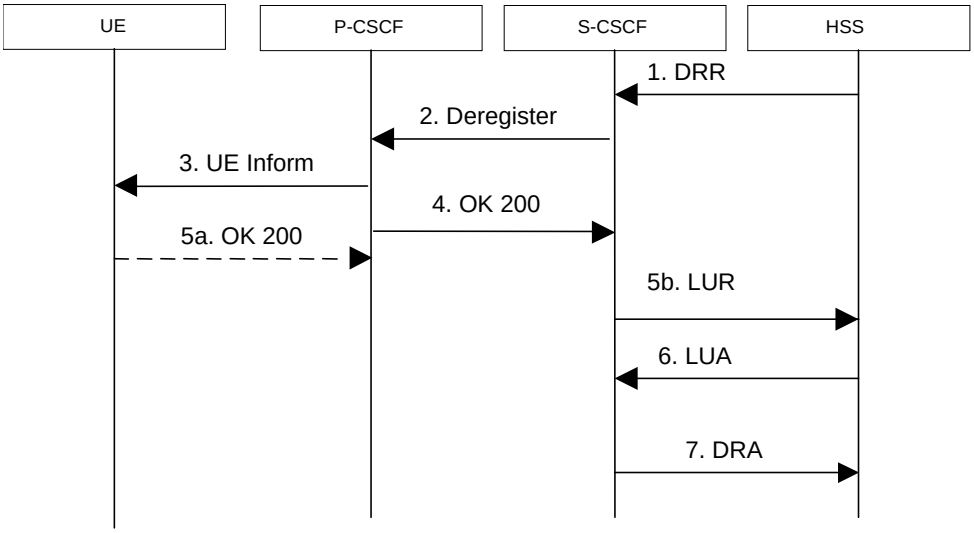


A.4.4 Network initiated de-registration

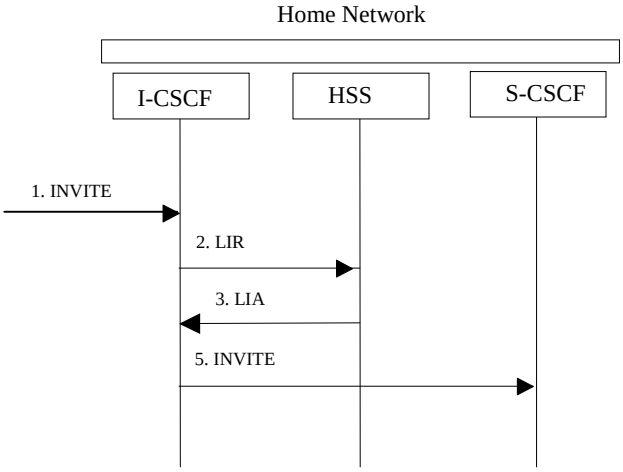
A.4.4.1 Registration timeout



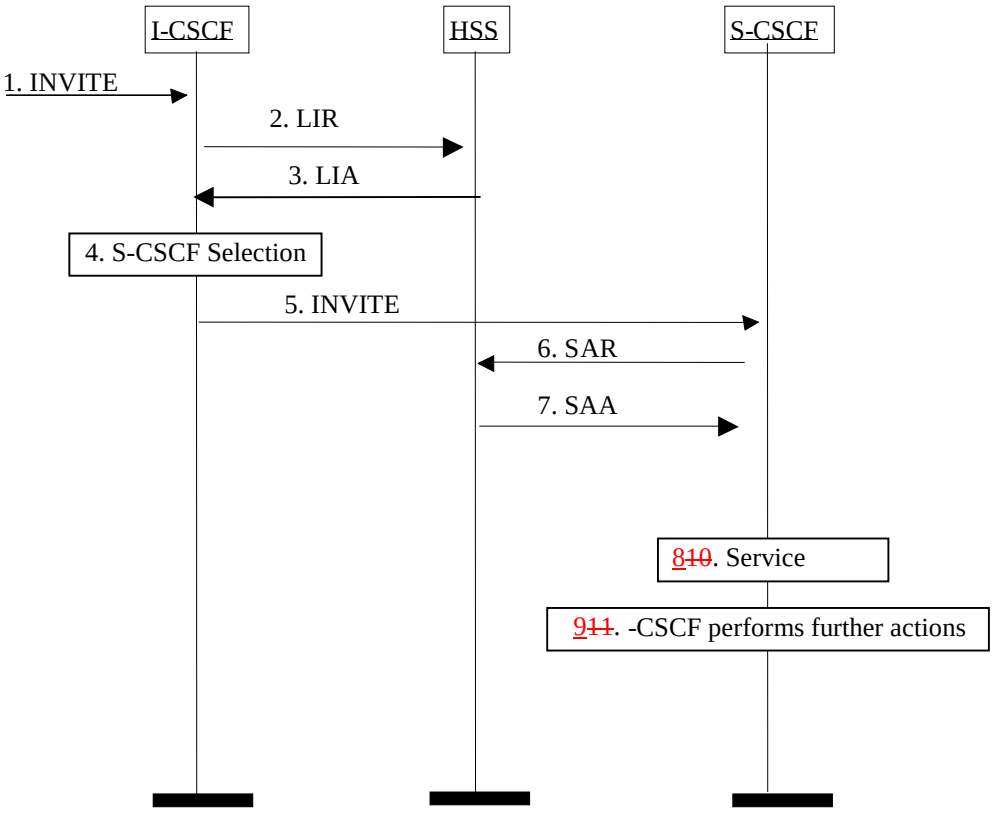
A.4.4.2 Administrative de-registration



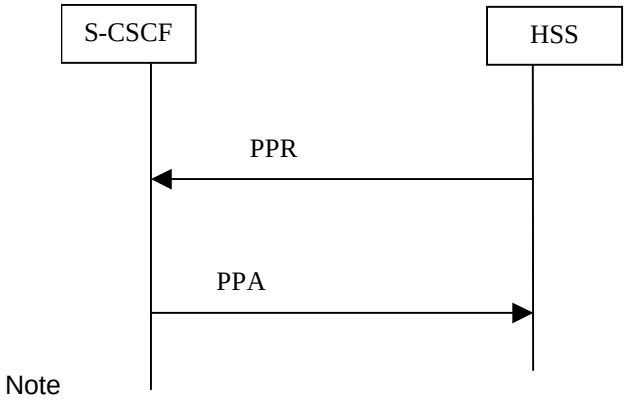
A.4.5 MT SIP session setup



A.4.6 Initiation of a session to a non-registered user

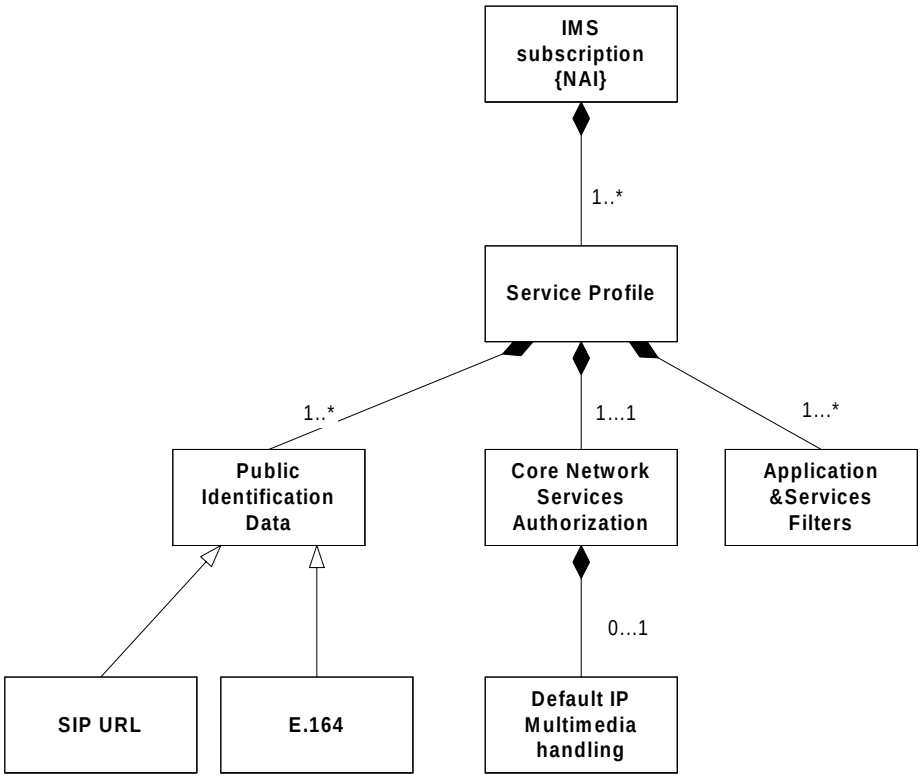


A.4.6 User Profile update



Annex B (informative): User profile UML model

The following picture gives an outline of the user profile UML data model downloaded from HSS to S-CSCF:

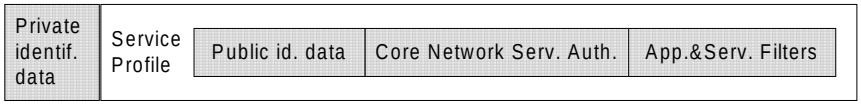


The boxes in the picture are explained as follows:

- IMS Subscription class contains as a parameter the private identity of the user in NAI format.
- Each instance of the IMS Subscription class contains one or several instances of the class Service Profile. Service Profile class contains the meaningful data in the profile: Public Identification Data, Core Network Services Authorization and Application & Services Triggers.
- Each instance of the Service Profile class consists of one or several instances of the class Public Identification Data. Public Identification Data class contains the public identity of the user associated with that service profile
- Each instance of the Service Profile class contains one instance of the class Core Network Services Authorization. Core Network Services Authorization class affects one or several services, but is not tied to any specific service.
- An instance of the Core Network Services Authorization class contains, for example, an instance of the class Default IP Multimedia Handling (see TS 23.218 [12]).
- Each instance of the class Service Profile contains one or several instances of the class Application & Services Filters. Application & Services Filters class consists of filter criteria and application server name (see TS 23.218 [12]).

Annex C (informative): High-level format for the User Profile

The way the information will be transferred through the Cx interface can be seen from a high-level point of view in the following picture:



If more than one service profile is created, for example to assign a different set of services to public identifiers 1 and 2 and public identity 3, the information will be packaged in the following way:

Annex D (informative): Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
May 2001	CN4#8	N4-010619	-	-	First draft created based on 3GPP TS 23.228, N4-010027, N4-010133, N4-010141		
Jul 2001	CN4#9	N4-010619	-	-	Updates based on updates at CN4 #8 (N4-010697), the introduction of 3GPP TS 29.229, S2-011317, S2-011535.		
Oct 2001	CN4#10	N4-01xxxx	-	-	Included editorial review and changes accepted at CN4 #9: user profile update, mapping to Diameter (N4-010837). Also includes incoming session for non-registered user. The term Subscriber has generally been replaced by user. User Identifier has been split to private and public user identity. Merged Cx_select-pull with Cx_query and Cx_location_query.		
Nov 2001	CN4#11	N4-011295	-	-	Incorporated decisions related to N4-011166, N4-011169, N4-011065, N4-011066. Alignment with TS 29.229 + minor editorial changes. Incorporated decisions related to N4-011300, N4-011376.	0.3.0	0.4.0
Nov 2001	CN4#11	N4-01407	-	-	Incorporated decisions related to N4-010872, N4-011300, N4-011376, N4-011301. Minor corrections (some old LUR/LUA messages changed to the new SAR/SAA).	0.5.0	1.0.0