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Technical Specification

TS-3GB-X.S0013-010-Av1.0

All-IP Core Network Multimedia Domain - IP Multimedia Subsystem Sh Interface; Signaling Flows and Message Contents Stage 2

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TS-3GB-X.S0013-010-Av1.0

All-IP Core Network Multimedia Domain

- IP Multimedia Subsystem Sh Interface; Signaling Flows and Message Contents Stage 2

＜参考＞ [Remarks]

１．英文記述の適用レベル [Application level of English description]

適用レベル [Application level]：E2

本標準の本文、付属資料および付録の文章および図に英文記述を含んでいる。

[English description is included in the text and figures of main body, annexes and appendices.]

２．国際勧告等の関連 [Relationship with international recommendations and standards]

本標準は、3GPP2 で承認された Technical Specification X.S0013-010-A(Version 1.0) に準拠している。

[This standard is standardized based on the Technical Specification X.S0013-010-A(Version 1.0) approved by 3GPP2.]

３．上記国際勧告等に対する追加項目等 [Departures from international recommendations]

原標準に対する変更項目 [Changes to original standard]

原標準が参照する標準のうち、TTC 標準に置き換える項目。[Standards referred to in the original standard, which are replaced by TTC standards.]

原標準が参照する標準のうち、それらに準拠した TTC 標準等が制定されている場合は自動的に最新版 TTC 標準等に置き換え参照するものとする。 [Standards referred to in the original standard should be replaced by derived TTC standards.]

４．工業所有権 [IPR]

本標準に関わる「工業所有権等の実施の権利に係る確認書」の提出状況は、ＴＴＣホームページによる。

[Status of “Confirmation of IPR Licensing Condition” submitted is provided in the TTC web site.]

５．作成専門委員会 [Working Group]

3GPP2 専門委員会 [3GPP2 Working Group]

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All-IP Core Network Multimedia Domain

IP Multimedia Subsystem Sh Interface; Signaling Flows and Message Contents – Stage 2

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All-IP Core Network Multimedia Domain
IP Multimedia Subsystem Sh interface;
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Contents

Foreword

(This foreword is not part of this document)

This document was prepared by 3GPP2 TSG-X.

This document contains major modifications from the previous revision.

This document is part of the series of documents X.S0013

"Shall" and "shall not" identify requirements to be followed strictly to conform to this document and from which no deviation is permitted. "Should" and "should not" indicate that one of several possibilities is recommended as particularly suitable, without mentioning or excluding others, that a certain course of action is preferred but not necessarily required, or that (in the negative form) a certain possibility or course of action is discouraged but not prohibited. "May" and "need not" indicate a course of action permissible within the limits of the document. "Can" and "cannot" are used for statements of possibility and capability, whether material, physical or causal.

Revision History

Revision	Changes	Date
0 v1.0	Initial Publication	December 2003
0 v2.0	Adding release 5 CRs	July 2005
A v1.0	Release A	November 2005

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1 Scope

This document specifies the interactions between the HSS (Home Subscriber Server) and the SIP AS (Application Server) and between the HSS and the OSA SCS (Service Capability Server). This interface is referred to as the Sh reference point.

This document addresses the signalling flows and message contents for the protocol at the Sh interface.

2 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. ANSI and TIA maintain registers of currently valid national standards published by them.

- 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.

[1] 3GPP2 X.S0013-002-A v1.0: “IP Multimedia (IM) Subsystem – Stage 2”.

[2] 3GPP2 X.S0013-004-A v1.0: “IP Multimedia Call Control Protocol based on SIP and SDP”.

[3] 3GPP2 X.S0013-000-A v1.0: "All-IP Core Network Multimedia Domain; Overview".

[4] 3GPP2 X.S0013-003-A v1.0: “IP Multimedia (IM) session handling; IM call model”.

[5] 3GPP2 X.S0013-011-A v1.0: “Sh Interface based on Diameter – Protocol details”.

[6] 3GPP2 X.S0013-005-A v1.0: “IP Multimedia (IM) Subsystem Cx Interface; Signaling flows and Message Elements”.

[7] 3GPP2 X.S0013-006-A v1.0: “Cx Interface based on the Diameter protocol ; Protocol details”.

[8] IETF RFC 3588, “Diameter Base Protocol”, September 2003.

[9] Void

[10] Void

[11] Void

[12] Void

[13] Void

[14] Void

[15] Void

[16] IETF RFC 3261: "SIP: Session Initiation Protocol".

[17] IETF RFC 3966: "The tel URI for Telephone Numbers ".

[18] X.S0027-001 v1.0: "Presence Service; Architecture and Functional Description"

[19] Void

[20] ANSI X3.4: "Coded Character Set - 7-bit American Standard Code for Information Interchange"

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.

Transparent data: Data that is understood syntactically but not semantically by the HSS. It is data that an AS may store in the HSS to support its service logic. One example is data that an AS stores in the HSS, using it as a repository.

Non-transparent data: Data that is understood both syntactically and semantically by the HSS.

AS (Application Server): a term used to denote either of a SIP Application Server or an OSA Service Capability Server.

3.2 Abbreviations

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

AS	Application Server
CSCF	Call Session Control Function
HSS	Home Subscriber Server
IE	Information Element
IP	Internet Protocol
IM	IP Multimedia
IMS	IP Multimedia Subsystem
SIP	Session Initiation Protocol
S-CSCF	Serving CSCF

4 Main Concept

This document presents the Sh 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.

The IP Multimedia (IM) Core Network Subsystem stage 2 is specified in [1] and the protocol for the IP multimedia call control based on SIP and SDP are specified in [2].

The IP Multimedia (IM) Session Handling with the IP Multimedia (IM) call model is specified in [4].

5 General Architecture

This clause further specifies the architectural assumptions associated with the Sh reference point, building on the IP Multimedia (IM) Core Network Subsystem stage 2 as specified in [1] and the protocol for the IP multimedia call control based on SIP and SDP as specified in [2]

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5.1 Functional requirements of network entities

5.1.1 Functional Requirements of the Application Server

The Application Server may communicate with the HSS over the Sh interface.

For functionality of the Application Server refer to [1], [3] and [4].

5.1.2 Functional requirements of HSS

The HSS may communicate with the Application Server over the Sh interface.

For functionality of the HSS refer to [1], [3] and [4].

5.2 Functional classification of Sh interface procedures

Operations on the Sh interface are classified in functional groups:

1. Data handling procedures
    - The download of data from the HSS to an AS.
    - The update of data in the HSS.
2. Subscription/notification procedures
    - An AS can subscribe to receive notifications from the HSS of changes in data.
    - The HSS can notify an AS of changes in data for which the AS previously had subscribed.

6 Procedure Descriptions

In the tables that describe the Information Elements transported by each command, each Information Element is marked as (M) Mandatory, (C) Conditional or (O) Optional.

- A mandatory Information Element (marked as (M) in the table) shall always be present in the command. If this Information Element is absent, an application error occurs at the receiver and an answer message shall be sent back to the originator of the request with the Result-Code set to DIAMETER_MISSING_AVP. This message shall also include a Failed-AVP AVP containing the missing Information Element i.e. the corresponding Diameter AVP defined by the AVP Code and the other fields set as expected for this Information Element.
- A conditional Information Element (marked as (C) in the table) shall be present in the command if certain conditions are fulfilled.
    - If the receiver detects that those conditions are fulfilled and the Information Element is absent, an application error occurs and an answer message shall be sent back to the originator of the request with the Result-Code set to DIAMETER_MISSING_AVP. This message shall also include a Failed-AVP AVP containing the missing Information Element i.e. the corresponding Diameter AVP defined by the AVP Code and the other fields set as expected for this Information Element.
    - If those conditions are not fulfilled, the Information Element shall be absent. If however this Information Element appears in the message, it shall not cause an application error and it may be ignored by the receiver if this is not explicitly defined as an error case. Otherwise, an application error occurs at the receiver and an answer message with the Result-Code set to DIAMETER_AVP_NOT_ALLOWED shall be sent back to the originator of the request. A Failed-AVP AVP containing a copy of the corresponding Diameter AVP shall be included in this message

- An optional Information Element (marked as (O) in the table) may be present or absent in the command, at the discretion of the application at the sending entity. Absence or presence of this Information Element shall not cause an application error and may be ignored by the receiver.

6.1 User data handling procedures

6.1.1 Data read (Sh-Pull)

This procedure is used between an AS the HSS. The procedure is invoked by the AS and is used:

- To read transparent and/or non-transparent data for a specified IMS Subscription from the HSS.

This procedure is mapped to the commands User-Data-Request/Answer in the Diameter application specified in [5]. Tables 6.1.1.1 and 6.1.1.2 detail the involved information elements.

This release of the specification does not support location retrieval

This release of the specification does not support retrieval of the CS and PS User State data.

1 **Table 6.1.1.1: Sh-Pull**

Information element name	Mapping to Diameter AVP	Cat.	Description
User Identity (See 7.1)	User-Identity	M	IMS Public User Identity or Public Service Identity or MSISDN of the user for whom the data is required. See section 7.1 for the content of this AVP.n
Requested data (See 7.3)	Data-Reference	M	This information element indicates the reference to the requested information. The set of valid reference values are defined in 7.6.
Requested Identity set (See 7.11)	Identity-Set	O	If Data-Reference indicates that IMS Public Identities is the requested data set to be downloaded, this information element should be included. When this information element takes the value IMPLICIT_IDENTITIES, the HSS shall provide all non-barred IMS Public Identities that belong to the same implicit registration set as the IMS Public Identity included in the message in the User-Identity AVP. The MSISDN user identity is not applicable for this value. When this information element takes the value REGISTERED_IDENTITIES, the HSS shall provide all non-barred IMS Public Identities whose state is registered, belonging to all Private Identities that the IMS Public Identity or MSISDN in the User-Identity AVP is associated with. When this information element takes the value ALL_IDENTITIES, the HSS shall provide all non-barred IMS Public Identities, belonging to all Private Identities that the IMS Public Identity or MSISDN in the User-Identity AVP is associated with. If Data-Reference indicates that IMS Public Identities is the requested data set to be downloaded and this information element is not included, the HSS shall download the set of IMS Public Identities that would be downloaded if the value of this information element had been ALL_IDENTITIES.
Requested domain (See 7.2)	Requested-Domain	C	This information element indicates the domains to which the operation is applicable. Check table 7.6.1 to see when it is applicable.
Current Location (See 7.8)	Current-Location	C	This information element indicates whether an active location retrieval has to be initiated or not. It shall be present if Location Information is requested. If this information element takes the value InitiateActiveLocationRetrieval (1) the HSS shall indicate the need to initiate an active location retrieval. Check table 7.6.1 to see when it is applicable.
Service Indication (See 7.4)	Service-Indication	C	IE that identifies, together with the IMS Public User Identity included in the User-Identity and Data-Reference AVP, the set of service related transparent data that is being requested. Check table 7.6.1 to see when it is applicable.
Application Server Identity (See 7.9)	Origin-Host	M	IE that identifies the AS originator of the request and that is used to check the AS permission list.
Application Server Name (See 7.10)	Server-Name	C	IE that is used, together with the IMS Public User Identity included in the User-Identity AVP and Data-Reference, as key to identify the filter criteria. Check table 7.6.1 to see when it is applicable.

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Table 6.1.1.2: Sh-Pull Resp

Information element name	Mapping to Diameter AVP	Cat.	Description
Result (See 7.5)	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 Sh 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.
Data (See 7.6)	User-Data	C	Requested data. This element shall be present if the requested data exists in the HSS and the AS has permissions to read it.

6.1.1.1 Detailed behaviour

The conditions for the inclusion of Requested-Domain as an additional key to the requested data are described in table 7.6.1. If repository data is requested, Service-Indication shall be present in the request. If initial filter criteria are requested, the Server-Name AVP shall contain the SIP URL of the AS that initiates the request; requests for initial filter criteria are limited to those initial filter criteria which are relevant to the requesting AS.

Upon reception of the Sh-Pull request, the HSS shall, in the following order:

1. In the AS permission list (see section 6.2) check that the requested data is allowed to be read (Sh-Pull) by this AS by checking the combination of the identity of the AS sending the request (identified by the Origin-Host AVP) and the supplied Data-Reference.

   - If the data referenced in the request is not allowed to be read, Experimental-Result shall be set to DIAMETER_ERROR_USER_DATA_CANNOT_BE_READ in the Sh-Pull Response.

2. Check that the User Identity exists in HSS. If not, Experimental-Result shall be set to DIAMETER_ERROR_USER_UNKNOWN in the Sh-Pull Response.

3. If Data-Reference is PSIActivation (18), check that the User Identity contains a Public Service Identity. If not, Experimental-Result shall be set to DIAMETER_ERROR_OPERATION_NOT_ALLOWED in the Sh-Pull Response.

4. Check whether or not the data that is requested to be downloaded by the AS is currently being updated by another entity. If there is an update of the data in progress, the HSS may delay the Sh-Pull-Resp message until the update has been completed. The HSS shall ensure that the data returned is not corrupted by this conflict.

If there is an error in any of the above steps then the HSS shall stop processing and shall return the error code specified in the respective step (see [5] and [7] for an explanation of the error codes).

If the HSS cannot fulfil the received request for reasons not stated in the above steps, e.g. due to database error, it shall stop processing the request and set Result-Code to DIAMETER_UNABLE_TO_COMPLY.

Otherwise, the requested operation shall take place and the HSS shall return the Result-Code AVP set to DIAMETER_SUCCESS. Result-Code DIAMETER_SUCCESS is used also if the requested data does not exist in the HSS.

6.1.2 Data Update (Sh-Update)

This procedure is used between the AS and the HSS. The procedure is invoked by the AS and is used:

- To allow the AS to update the transparent (repository) data stored at the HSS for a specified each IMS Public User Identity or Public Service Identity..

- To allow the AS to update the PSI Activation State of a Public Service Identity in the HSS.

This procedure is mapped to the commands Profile-Update-Request/Answer in the Diameter application specified in [5]. Tables 6.1.2.1 and 6.1.2.2 detail the involved information elements.

Table 6.1.2.1: Sh-Update

Information element name	Mapping to Diameter AVP	Cat.	Description
User Identity (See 7.1)	User-Identity	M	IMS Public User Identity or or Public Service Identity for which data is updated. See section 7.1 for the content of this AVP.
Requested data (See 7.3)	Data-Reference	M	This information element includes the reference to the data on which updates are required (possible values of the Data Reference are defined in Table 7.6.1).
Data (See 7.6)	User-Data	M	Updated data.
Application Server Identity (See 7.9)	Origin-Host	M	IE that identifies the AS originator of the request and that is used to check the AS permission list.

Table 6.1.2.2: Sh-Update Resp

Information element name	Mapping to Diameter AVP	Cat.	Description
Result (See 7.5)	Result-Code / Experimental-Result	M	Result of the update of data in the HSS. Result-Code AVP shall be used for errors defined in the Diameter Base Protocol. Experimental-Result AVP shall be used for Sh 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.

6.1.2.1 Detailed behaviour

Within the Sh-Update Request, the keys to determine the updated data are part of the information element Data (See 7.6). When data in the repository is updated (i.e. added, modified or removed) Service-Indication and Sequence-Number are also sent as part of the information element Data.

Newly added transparent data shall be associated with a Sequence Number of 0 in the Sh-Update Request. Sequence Number value 0 is reserved exclusively for indication of newly added transparent data.

Modified and removed transparent data shall be associated within the Sh-Update Request with a Sequence Number of n+1 where n is the original Sequence Number associated with the transparent data before modification or removal. If n equals 65535, then the next modification or deletion of that transparent data shall be associated with a Sequence Number of 1.

Upon reception of the Sh-Update request, the HSS shall, in the following order:

1. In the AS permission list (see section 6.2) check that the user that is requested to be updated (Sh-Update) by this AS, is allowed to be updated by checking the combination of the identity of the AS sending the request (identified by the Origin-Host AVP) and the supplied Data-Reference.

   - If the data is not allowed to be updated, Experimental-Result shall be set to DIAMETER_ERROR_USER_DATA_CANNOT_BE_MODIFIED in the Sh-Update Response.

2. Check that the IMS Public User Identity or Public Service Identity in the request to be updated exists in the HSS. If not, Experimental-Resul- shall be set to DIAMETER_ERROR_USER_UNKNOWN in the Sh-Update Response.

3. If Data-Reference is PSIActivation (18), check that the User Identity contains a Public Service Identity. If it is, then the HSS shall update the corresponding PSI Activation State and return the Result-Code AVP set to DIAMETER_SUCCESS. If not, Experimental-Result shall be set to DIAMETER_ERROR_OPERATION_NOT_ALLOWED in the Sh-Update Response.

   The change of a Public Service Identity from ACTIVE to INACTIVE shall trigger the network initiated deregistration of the Public Service Identity in the HSS.

4. Check whether or not the data that is requested to be updated by the AS, as identified by the Service-Indication, is currently being updated by another entity. If there is an update of the data in progress, Experimental-Result shall be set to DIAMETER_PRIOR_UPDATE_IN_PROGRESS in the Sh-Update Response.

5. Check whether or not there is any repository data stored at the HSS already for the specified Service-Indication and the associated IMS Public User Identity or Public Service Identity.

   - If repository data identified by the Service-Indication is stored at the HSS for the specified IMS Public User Identity or Public Service Identity, check the following premises:

     1. Sequence_Number_in_Sh_Update is not equal to 0

     2. (Sequence_Number_in_Sh_Update - 1) is equal to (Sequence_Number_In_HSS modulo 65535)

   - If either of the above premises is false then Experimental-Result shall be set to DIAMETER_ERROR_TRANSPARENT_DATA_OUT_OF_SYNC in the Sh-Update Response.

   - If both of the above premises are true, then check whether or not Service Data is received within the Sh-Update Req.

     - If Service Data is included in the Sh-Update Req, check whether or not the size of the data is greater than that which the HSS is prepared to accept.

       - If there is more data than the HSS is prepared to accept then Experimental-Result shall be set to DIAMETER_ERROR_TOO_MUCH_DATA and the new data shall be discarded.

       - If the HSS is prepared to accept the data, then the repository data stored at the HSS shall be updated with the repository data sent in the Sh-Update Req and the Sequence Number associated with that repository data shall be updated with that sent in the Sh-Update Req. This triggers the sending of Sh-Notif messages to any other ASs that are subscribed to Notifications for updates to the service data for that IMS Public User Identity or Public Service Identity (see 6.1.4).

     - If Service Data is not received, the data stored in the repository at the HSS shall be removed, and as a consequence the Service Indication and the Sequence Number associated with the removed data shall also be removed. This triggers the sending of Sh-Notif messages to any other ASs that are subscribed to Notifications for updates to the service data for that IMS Public User Identity or Public Service Identity (see 6.1.4). After sending Sh-Notif messages, the subscriptions to Notifications for the removed Repository Data shall be deleted.

- If repository data identified by the Service-Indication is not stored for the IMS Public User Identity or Public Service Identity i.e. the Sh-Update Req intends to create a new repository data,check whether or not the Sequence Number in the Sh-Update Req is 0.
    - If the sequence number is not set to 0, Experimental-Result shall be set to DIAMETER_ERROR_TRANSPARENT_DATA_OUT_OF_SYNC
    - If the sequence number is set to 0 check whether Service Data is included within the Sh-Update Req.
        - If Service Data is not included in the Sh-Update Req, then Experimental-Result shall be set to DIAMETER_ERROR_OPERATION_NOT_ALLOWED and the operation shall be ignored by the HSS.
        - If Service Data is included in the Sh-Update Req, check whether or not the size of the data is greater than that which the HSS is prepared to accept. If there is more data than the HSS is prepared to accept then Experimental-Result-Code shall be set to DIAMETER_ERROR_TOO_MUCH_DATA and the new data shall be discarded.
        - If the HSS is prepared to accept the data included in the Sh-Update Req, then the data shall be stored in the data repository in the HSS.

If there is an error in any of the above steps then the HSS shall stop processing and shall return the error code specified in the respective step (see [5] and [7] for an explanation of the error codes).

If the HSS cannot fulfil the received request for reasons not stated in the above steps, e.g. due to database error, it shall stop processing the request and set Result-Code to DIAMETER_UNABLE_TO_COMPLY.

Otherwise, the requested operation shall take place and the HSS shall return the Result-Code AVP set to DIAMETER_SUCCESS.

NOTE: When an AS receives DIAMETER_ERROR_TRANSPARENT_DATA_OUT_OF_SYNC the AS may attempt to resolve the inconsitency between the version of the repository data that it holds and that stored at the HSS. It may execute a Sh-Pull to retrieve the current version of the data from the HSS or it may wait to receive a subsequent Sh-Notif message from the HSS for the affected repository data.

6.1.3 Subscription to notifications (Sh-Subs-Notif)

This procedure is used between an AS and the HSS of changes in data. . The procedure is invoked by the AS and is used:

- To subscribe to Notifications for when particular transparent and/or non-transparent data for a specified IMS Public User Identity or Public Service Identityis updated, from the HSS

This procedure is mapped to the commands Subscribe-Notifications-Request/Answer in the Diameter application specified in [5]. Tables 6.1.3.1 and 6.1.3.2 detail the information elements involved.

Table 6.1.3.1: Sh-Subs-Notif

Information element name	Mapping to Diameter AVP	Cat.	Description
User Identity (See 7.1)	User-Identity	M	IMS public identity or Public Service Identity for which notifications of data changes are requested. See section 7.1 for the content of this AVP.
Requested data (See 7.3)	Data-Reference	M	This information element includes the reference to the data on which notifications of change are required (valid reference values are defined in 7.6).
Subscription request type (See 7.7)	Subs-Req-Type	M	This information element indicates the action requested on subscription to notifications.
Service Indication (See 7.4)	Service-Indication	C	IE that identifies, together with the IMS Public User Identity and Data-Reference, the set of service related transparent data for which notifications of changes are requested. This element shall be present when the Data-Reference value is RepositoryData (0).
Application Server Identity (See 7.9)	Origin-Host	M	IE that identifies the AS originator of the request and that is used to check the AS permission list.
Application Server Name(See 7.10)	Server-Name	C	IE that is used, together with the IMS Public User Identity and Data-Reference, as key to identify the filter criteria. This element shall be present when the Data-Reference value is InitialFilterCriteria (13).

Table 6.1.3.2: Sh-Subs-Notif Resp

Information element name	Mapping to Diameter AVP	Cat.	Description
Result (See 7.5)	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 Sh 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.

6.1.3.1 Detailed behaviour

The HSS shall take note of the subscription request on the data identified by IMS Public User Identity and Data-Reference. If notifications on changes of repository data are requested, Service-Indication shall be present in the request. If notifications on changes of filter criteria are requested, the Server-Name AVP shall be used as key to the filter criteria. The Server-Name AVP shall contain the SIP URL of the AS sending the request.

Upon reception of the Sh-Subs-Notif request, the HSS shall, in the following order (if there is an error in any of the following steps the HSS shall stop processing and return the corresponding error code, see [5] and [7]):

1. In the AS permission list (see section 6.2) the HSS shall check that the AS is allowed to subscribe to notifications (Sh-Subs-Notif) for the requested data by checking the combination of the identity of the AS sending the request (identified by the Origin-Host AVP) and the supplied Data-Reference.

   - If this AS does not have Sh-Subs-Notif permission for the data referenced, Experimental-Result shall be set to DIAMETER_ERROR_USER_DATA_CANNOT_BE_NOTIFIED in the Sh-Subs-Notif Response.

2. Check that the IMS Public User Identity or Public Service Identity in the request exists in HSS. If not, Experimental-Result shall be set to DIAMETER_ERROR_USER_UNKNOWN in the Sh-Subs-Notif Response.

3. If Data-Reference is PSIActivation (18), check that the User Identity contains a Public Service Identity. If not, Experimental-Result shall be set to DIAMETER_ERROR_OPERATION_NOT_ALLOWED in the Sh-Subs-Notif Response.

4. The HSS shall associate the Application Server Identity with the list of entities that need to be notified when the data identified by Data-Reference is modified and set the Result-Code to DIAMETER_SUCCESS in the Sh-Subs-Notify response.

If the HSS cannot fulfil the received request for reasons not stated in the above steps, e.g. due to database error, it shall stop processing the request and set Result-Code to DIAMETER_UNABLE_TO_COMPLY.

6.1.4 Notifications (Sh-Notif)

This procedure is used between the HSS and the AS. The procedure is invoked by the HSS and is used:

- To inform the AS of changes in transparent and/or non-transparent data to which the AS has previously subscribed to receive Notifications for, using Sh-Subs-Notif (see 6.1.3).

This procedure is mapped to the commands Push-Notification-Request/Answer in the Diameter application specified in [5]. Tables 6.1.4.1 and 6.1.4.2 detail the involved information elements.

Table 6.1.4.1: Sh-Notif

Information element name	Mapping to Diameter AVP	Cat.	Description
User Identity (See 7.1)	User-Identity	M	IMS Public User Identity or Public Service Identity for which data has changed. See section 7.1 for the content of this AVP.
Data (See 7.6)	User-Data	M	Changed data.

Table 6.1.4.2: Sh-Notif Resp

Information element name	Mapping to Diameter AVP	Cat.	Description
Result (See 7.5)	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 Sh 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.

6.1.4.1 Detailed behaviour

The keys to the updated data are part of the information element User-Data (See Annex C). When data repository is updated Service-Indication is also part of the information element User-Data. When Initial Filter Criteria is updated, Application Server Name is also part of the information element User-Data.

Since authentication pending is a transient state of normally very short duration, notification of an IMS user's state change, to and from the authentication pending state shall not be sent to Application Servers, when the previous state before authentication pending and next state after authentication pending are the same. If the states are different before the authentication pending state is entered and after the authentication pending state is left then notification is sent to the AS of this new state.

Removal of the subscribed data is indicated with the content of User-Data AVP. The content shall be compliant with the XML-schema defined in Annex D. Removed repository data shall be indicated with RepositoryData element that does not contain ServiceData element. Removed S-CSCF name shall be indicated with empty SCSCFName element. If all iFCs for the user that are relevant for the AS have been removed it shall be indicated with empty IFCs element.

6.2 AS permissions list

In table 7.6.1, the contents of the Data-AVP are described. Some of the individual elements carried within Data-AVP may be requested by the AS from the HSS using the Sh-Pull command (see section 6.1.1) or may be updated at the HSS by the AS using the Sh-Update command (see section 6.1.2). The AS may also request that the HSS notifies the AS of changes to specific elements within the Data-AVP using the Sh-Subs-Notif command (see section 6.1.3). The HSS will only allow these operations to take place if the element of the Data-AVP is permitted to be included in the specific command requested by the AS, as indicated in table 7.6.1.

To manage whether an AS may request each element of Data-AVP with a specific command, the HSS shall maintain a list of AS permissions (the 'AS Permissions List'). AS permissions are identified by AS identity and Data Reference with the possible permissions associated with each Data Reference being Sh-Pull, Sh-Update, Sh-Subs-Notif or any combination of these permissions (see table 7.6.1 for details of which permissions are allowed for each Data Reference). The permissions apply to all users served by the HSS, they are not user specific. When an AS requests Sh-Pull, Sh-Update or Sh-Subs-Notif the HSS shall check permissions and return an error result if the AS does not have the required permission.

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7 Information element contents

7.1 User Identity

This information element contains a user identity according to the conditions described in table 7.1.1.

Table 7.1.1: User Identity content

Information element name	Mapping to Diameter AVP	Cat.	Description
IMS Public User Identity / Public Service Identity (See 7.1.1)	Public-Identity	C	IMS Public User Identity or Public Service Identity for which data is required. If the MSISDN is not included in the User-Identity AVP, the Public-Identity AVP shall be included in Sh messages only for allowed Data References as described in Table 7.6.1.
MSISDN (See 7.1.2)	MSISDN	C	MSISDN for which data is required. If the Public-Identity AVP is not included in the User-Identity AVP, the MSISDN AVP shall be included in the Sh-Pull message only for allowed Data References as described in Table 7.6.1.

7.1.1 IMS Public User Identity / Public Service Identity

This information element contains an IMS Public User Identity / Public Service Identity (either SIP URI or tel URI). See [1].

7.1.2 MSISDN

This information element contains a Basic MSISDN (see [19]).

7.2 Requested Domain

This information element details the access domains for which certain data (e.g. user state, location information) are requested. See [5] for the list of possible values.

7.3 Requested Data

- Reference to the data that an AS is requesting from the HSS.

- Reference to the data which an AS wants to be notified of, when changed.

- Reference to data for which subscription to notification of change is rejected. See section 7.6.

7.4 Service Indication

Identifier of one set of service related transparent data, which is stored in an HSS in an operator network. It shall be unique within an operator network. Per IMS Public User Identity or Public Service Identity and value of Service Indication the HSS may allocate memory space to implement a data repository to store transparent data.

7.5 Result

This information element contains the result code of the operation. See [5] for the list of possible values.

7.6 Data

This information element contains an XML document conformant to the XML schema defined in Annex D.

Annex C specifies the UML logical model of the data downloaded via the Sh interface.

Table 7.6.1 defines the data reference values and tags, access key and recommended AS permissions (as described in section 6.2) for the the operation(s) on data accessible via the Sh interface, i.e. the listed operation(s) in the Operations column are the only ones allowed to be used with this Data Ref value. It is a matter of operator policy to further restrict the AS permission rights defined in table 7.6.1.

Table 7.6.1: Data accessible via Sh interface

Data Ref.	XML tag	Defined in	Access key	Operations
0	RepositoryData	7.6.1	IMS Public User Identity or Public Service Identity + Data-Reference + Service-Indication	Sh-Pull, Sh-Update, Sh-Subs-Notif
10	IMSPublicIdentity	7.6.2	IMS Public User Identity or MSISDN + Data-Reference + Identity-Set	Sh-Pull
11	IMSUserState	7.6.3	IMS Public User Identity + Data-Reference	Sh-Pull, Sh-Subs-Notif
12	S-CSCFName	7.6.4	IMS Public User Identity or Public Service Identity + Data-Reference	Sh-Pull, Sh-Subs-Notif
13	InitialFilterCriteria	7.6.5	IMS Public User Identity or Public Service Identity + Data-Reference + Server-Name	Sh-Pull, Sh-Subs-Notif
14	LocationInformation	7.6.6	MSISDN + Data-Reference+ Requested-Domain	Sh-Pull
15	UserState	7.6.7		
16	Charging information	7.6.8	IMS Public User Identity or Public Service Identity or MSISDN + Data-Reference	Sh-Pull
17	MSISDN	7.6.9	IMS Public User Identity or MSISDN + Data-Reference	Sh-Pull
18	PSIActivation	7.6.10	Public Service Identity + Data-Reference	Sh-Pull, Sh-Update, Sh-Subs-Notif

7.6.1 Repository Data

This information element contains transparent data. A data repository may be shared by more than one AS implementing the same service.

7.6.2 IMSPublicIdentity

This information element contains an IMS Public User Identity or a Public Service Identity. If a wildcarded PSI is stored in the HSS for the Public Service Identity received, the HSS shall do the matching and return the wildcarded PSI.

An IMS Public User Identity would be either

- associated with the Private Identity of the subscriber for whom the IMS Public User Identity is included in the request or
- associated with the MSISDN present in the request.

Multiple instances of this information element may be included in the message.

7.6.3 IMSUser State

This information element contains the IMS USER State of the public identifier referenced. Its possible values are: REGISTERED, NOT_REGISTERED, AUTHENTICATION_PENDING and REGISTERED_UNREG_SERVICES.

If the IMS Public User Identity is shared between multiple Private User Identities, HSS shall indicate the most registered state of the shared IMS Public User Identity to an AS. The most registered state of a shared IMS Public User Identity is defined as follows:

- If the shared IMS Public User Identity is registered with any of the Private User Identities, the most registered state of the shared IMS Public User Identity is REGISTERED.

- If the shared IMS Public User Identity is not currently registered with any of the Private User Identities, but it is in state REGISTERED_UNREG_SERVICES, then the most registered state of the shared IMS Public User Identity is REGISTERED_UNREG_SERVICES.

- If the shared IMS Public User Identity is not currently registered with any of the Private User Identities, and it is not in state REGISTERED_UNREG_SERVICES, but it is in the process of being authenticated with any of the Private User Identities, then the most registered state of the shared IMS Public User Identity is AUTHENTICATION_PENDING.

- If the shared IMS Public User Identity is not currently registered with any of the Private User Identities, and it is not in state REGISTERED_UNREG_SERVICES, and it is not in the process of being authenticated with any of the Private User Identities, then the most registered state of the shared IMS Public User Identity is NOT_REGISTERED.

7.6.4 S-CSCF Name

This information element contains the name of the S-CSCF where a multimedia public identity is registered.

7.6.5 Initial Filter Criteria

This information element contains the triggering information for a service.

For a more detailed description, refer to [4] and [6].

7.6.6 void

7.6.6.1 void

7.6.6.2 void

7.6.7 Void

7.6.8 Charging information

This information element contains the addresses of the charging functions: primary Online Charging Function (PrimaryEventChargingFunctionName), secondary Online Charging Function (SecondaryEventChargingFunctionName), primary Charging Data Function (PrimaryChargingCollectionFunctionName), and secondary Charging Data Function (SecondaryChargingCollectionFunctionName). When a clash occurs between the charging function address(es) received over the ISC interface and those received over the Sh interface, the address(es) received over the ISC interface should take precedence.

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NOTE: The use of the Sh interface to retrieve charging function addresses is not intended as a general-purpose alternative to receiving charging function addresses from the ISC interfaces. Rather, it is meant to address a special case where the AS needs to interact with the charging system before initiating a request to a user when the AS has not received the third party REGISTER for that user.

7.6.9 MSISDN

This information element contains a Basic MSISDN that is associated with the User Identity present in the request. All valid instances of this information element shall be included in the message.

7.6.10 PSIActivation

This information element contains the activation state of the Public Service Identity present in the request. Its possible values are:

- ACTIVE,
- INACTIVE.

7.7 Subscription request type

This information element indicates the action requested for subscription to notifications. See [5] for the list of valid values.

7.8 Void

.

7.9 Application Server Identity

This information element contains the identity of the Application Server. It is used for the AS permission check (see 6.2).

7.10 Application Server Name

This information element indicates application server's SIP URI. See [7] for the detailed definition of the AVP.

7.11 Requested Identity Set

This information element indicates the set of IMS Public Identities that the AS wishes to download. See [5] for the detailed definition of the AVP.

8 Protocol version identification

See [5].

9 Operational Aspects

See [5].

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

A.1 Introduction

This appendix gives mappings from Sh to Diameter protocol elements. Diameter protocol elements are defined in [5].

A.2 Sh message to Diameter command mapping

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

Table A.2.1: Sh message to Diameter command mapping

Sh message	Source	Destination	Command-Name	Abbreviation
Sh-Pull	AS	HSS	User-Data-Request	UDR
Sh-Pull Resp	HSS	AS	User-Data-Answer	UDA
Sh-Update	AS	HSS	Profile-Update-Request	PUR
Sh-Update Resp	HSS	AS	Profile-Update-Answer	PUA
Sh-Subs-Notif	AS	HSS	Subscribe-Notifications-Request	SNR
Sh-Subs-Notif Resp	HSS	AS	Subscribe-Notifications-Answer	SNA
Sh-Notif	HSS	AS	Push-Notification-Request	PNR
Sh-Notif Resp	AS	HSS	Push-Notification-Answer	PNA

A.3 Void

Annex B (informative): Message flow

B.1 Message flows

The following message flows give examples regarding which Diameter messages shall be sent in scenarios described in [4].

B.1.1 Data Update, Registration, Notification Subscription.

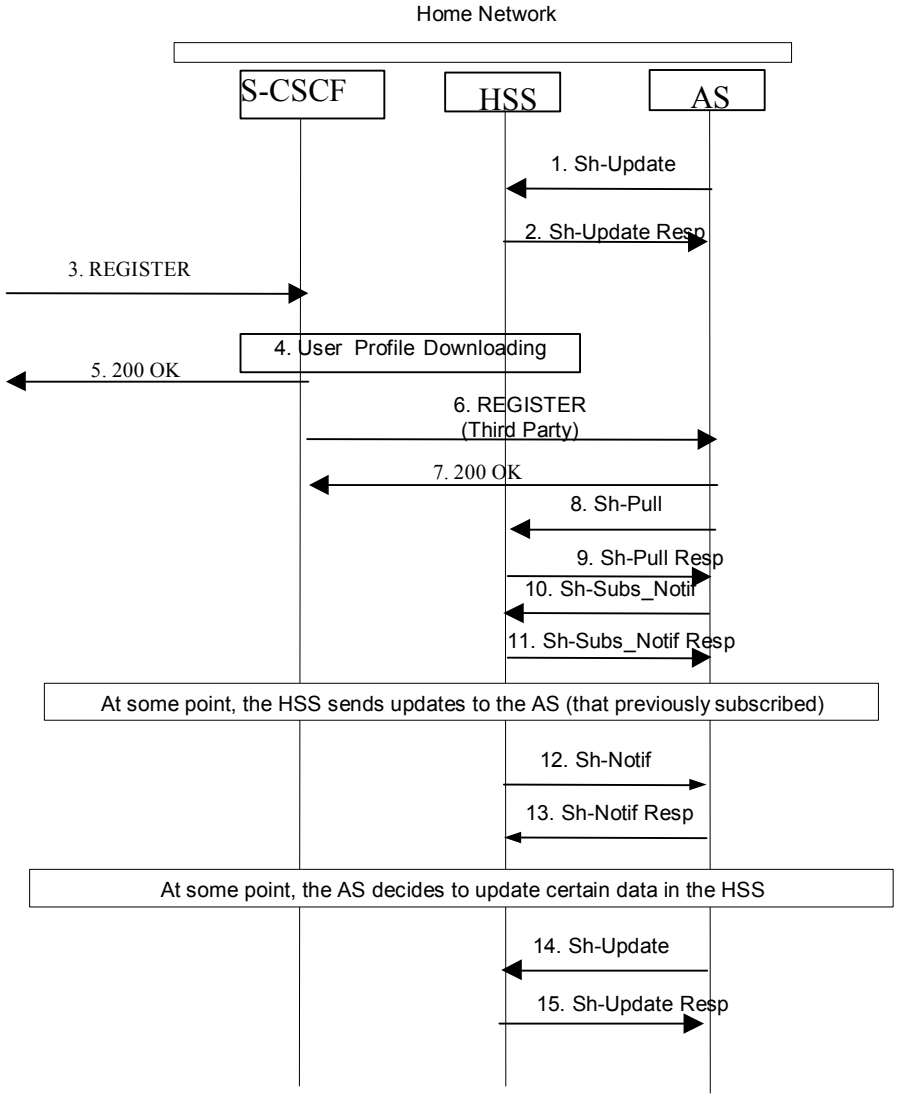

Figure B.1.1: Data Update, Registration, Notification Subscription

1. A user subscribes to a new service. The operator provisions the service in an AS. The AS stores some service data for a user in the HSS, Sh-Update (user identity, updated data) e.g. repository data.
2. HSS confirms the data is updated
3. Some time later, user registers with the network
4. S-CSCF downloads the data from the HSS (during the procedure S-CSCF Registration Notification on Cx interface). Filter criteria specify that the AS wants to be notified that the end user is registered.
5. 200 OK
6. S-CSCF sends third party registration message to the application server to notify that user is registered.

7. 200 OK
8. The AS downloads data needed for providing service from HSS, by means of Sh-Pull (user identity, requested data, and service information).
9. HSS sends data to AS
10. The AS subscribes to notifications from the HSS of changes in data, by means of Sh-Subs-Notif (user identity, requested data, and/or service information).
11. The HSS confirms the subscription request.
12. At some moment, user data is updated in the HSS. As the AS subscribed to notifications (step 10), the HSS sends to the AS the requested updates, by means of Sh-Notif (user identity, updated data).
13. The AS acknowledges the notification.
14. At some moment, the AS decides to update user's service data e.g. repositary data in the HSS, by means of Sh-Update (user identity, updated data).
15. The HSS confirms the service data is updated.

Annex C (informative): UML model of the data downloaded over Sh interface

The purpose of this UML model is to define in an abstract level the structure of the data downloaded over the Sh interface and describe the purpose of the different information classes included in it.

C.1 General description

The following picture gives an outline of the UML model of the user profile, which is exchanged between the HSS and an AS:

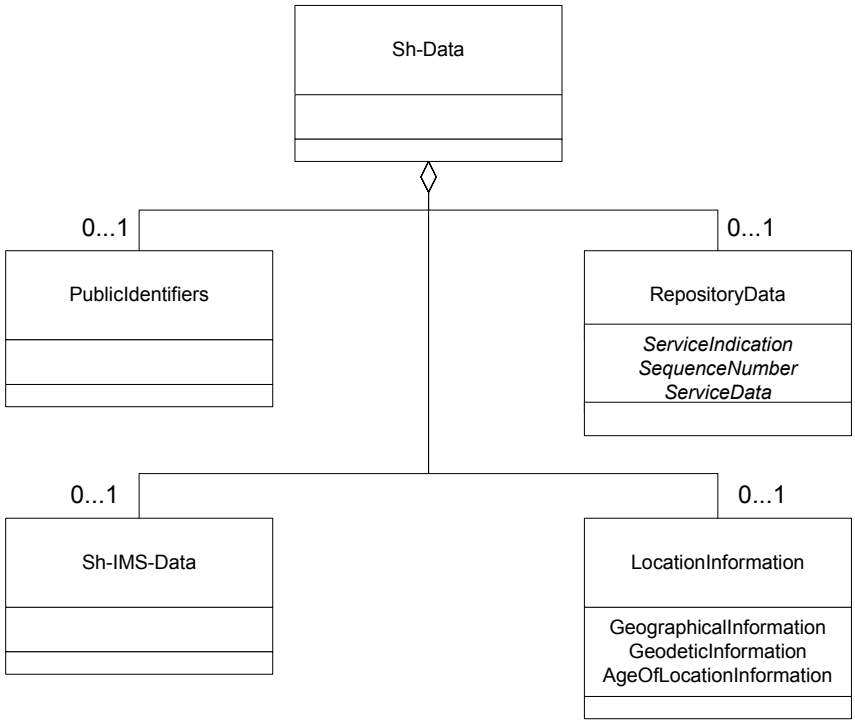

Figure C.1.1: Sh-Data

Each instance of the Sh-Data class contains 0 or 1 instance of the class PublicIdentifiers, 0 or 1 instance of the class RepositoryData, 0 or 1 instance of the class Sh-IMS-Data.

Class RepositoryData contains repository data (transparent data) for a given service. It has attributes ServiceIndication, SequenceNumber and ServiceData.

C.2 PublicIdentifiers

The following picture details the UML model of the class PublicIdentifiers:

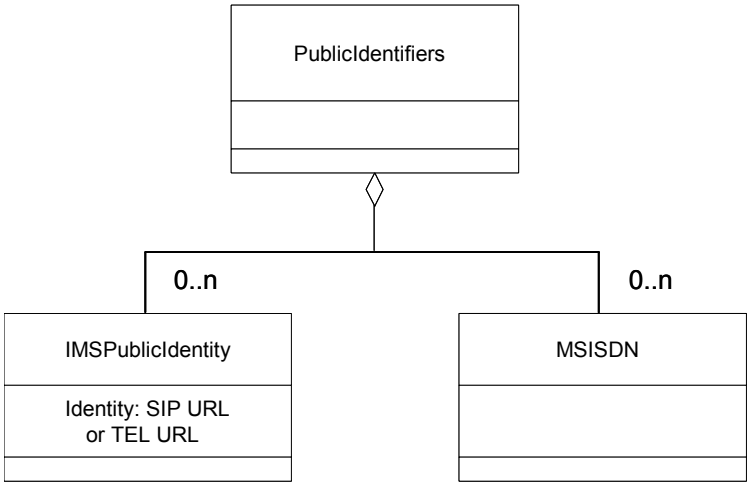

Figure C.2.1: The UML model of the class PublicIdentifiers

Class PublicIdentifiers contains 0 to more public user identities which may be either of class IMSPublicIdentity or of class MSISDN. The identifiers are of format SIP URL, tel URI or MDN.

C.3 Sh-IMS-Data

The following picture details the UML model of the class Sh-IMS-Data.

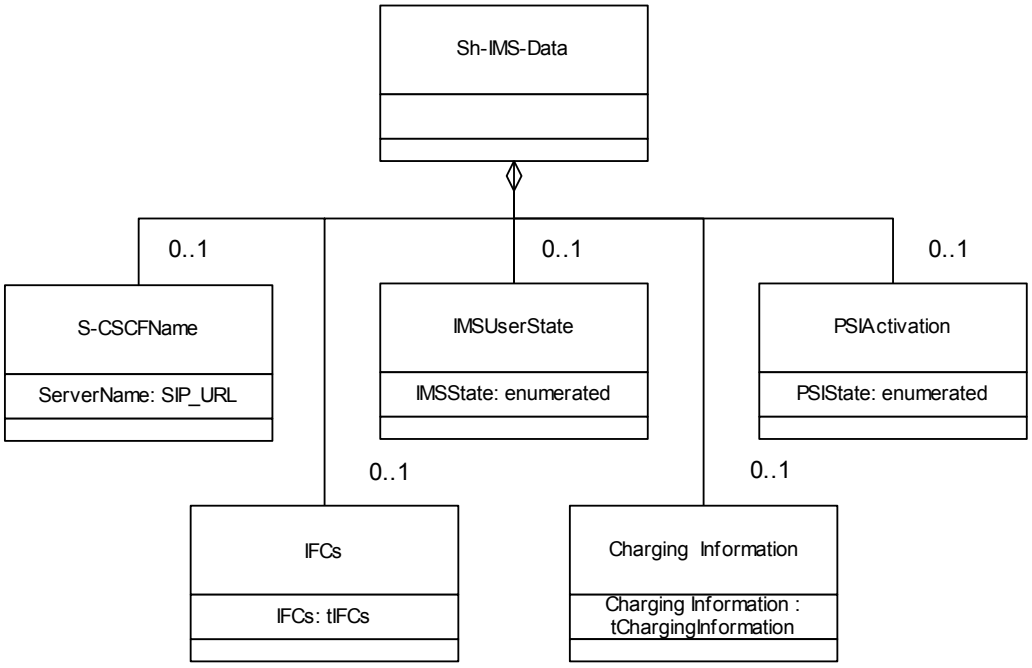

Figure C.3.1: Sh-IMS-Data

Each instance of the class Sh-IMS-Data contains 0 or 1 instance of the class S-CSCFName, 0 to n instances of the class InitialFilterCriteria, 0 or 1 instance of the class Charging Information and/or 0 or 1 instance or the IMSUserState class and/or 0 or 1 instance of the class PSIActivation..

Class S-CSCFName contains the SIP URL of the S-CSCF where the multimedia public identity that the AS included in the request is registered.

Class IFCs contains 0 to n instances of the the initial filter criteria of the multimedia public identity that the AS included in the request. The initial filter criteria is defined in [6]

Class IMSUserState contains the registration state of the identity given by the attribute of class Sh-IMS-Data. See section 7.6 for possible values.

Class Charging Information contains the online and offline charging function addresses. See section 7.6 for possible values.

Class PSIActivation contains the activation state of the Public Service Identity given by the attribute of class Sh-IMS-Data. See section 7.6 for possible values.

Annex D (normative): XML schema for the Sh interface user profile

The file ShDataType.xsd, in Annex E, contains the XML schema for the user profile that is sent over the Sh interface. The user profile XML schema defines the data types that are used in the user profile XML. The data that is allowed to be sent in the user profile may vary depending on the features supported by the Diameter end points, see [5]. The user profile XML schema file is intended to be used by an XML parser. The version of the Sh application sending the user profile XML shall be the same as the version of the sent user profile XML and thus it implies the version of the user profile XML schema to be used to validate it.

Tables D.1 and D.2 describe the data types and the dependencies among them that configure the user profile XML schema.

Table D.1: XML schema for the Sh interface user profile: simple data types

Data type	Tag	Base type	Comments
tPriority	Priority	integer	>= 0
tProfilePartIndicator	ProfilePartIndicator	enumerated	Possible values: 0 (REGISTERED) 1 (UNREGISTERED)

tGroupID	Group	integer	>= 0
tRegistrationType	RegistrationType	enumerated	Possible values: 0 (INITIAL_REGISTRATION) 1 (RE-REGISTRATION) 2 (DE-REGISTRATION)
tDefaultHandling	DefaultHandling	enumerated	Possible values: 0 (SESSION_CONTINUED) 1 (SESSION_TERMINATED)
tDirectionOfRequest	SessionCase	enumerated	Possible values: 0 (ORIGINATING_SESSION) 1 TERMINATING_SESSION 2 (TERMINATING_UNREGISTERED)
tIMSUserState	IMSUserState	Enumerated	Possible values: 0 (NOT_REGISTERED) 1 (REGISTERED) 2 (REGISTERED_UNREG_SERVICES) 3 (AUTHENTICATION_PENDING)
tCSUserState	CSUserState	Enumerated	Possible values (as defined in 3GPP TS 23.078): 0 (CAMELBusy) 1 (NetworkDeterminedNotReachable) 2 (AssumedIdle) 3 (NotProvidedfromVLR)
tPSUserState	PSUserState	Enumerated	Possible values (as defined in 3GPP TS 23.078): 0 (Detached) 1 (AttachedNotReachableForPaging) 2 (AttachedReachableForPaging)

			3 (ConnectedNotReachableForPaging) 4 (ConnectedReachableForPaging) 5 (NotProvidedFromSGSN)
tLocationNumber	LocationNumber	string	Syntax described in ITU-T Q.763 (base 64 encoded according to RFC 2045). Length >=4 and <=16 (multiples of 4).
tCellGlobalId	CellGlobalId	string	Syntax described in 3GPP TS 29.002 (base 64 encoded according to RFC 2045). Length = 12.
tServiceAreaId	ServiceAreaId	string	Syntax described in 3GPP TS 29.002 (base 64 encoded according to RFC 2045). Length = 12.
tLocationAreaId	LocationAreaId	string	Syntax described in 3GPP TS 29.002 (base 64 encoded according to RFC 2045). Length = 8.
tRoutingAreaId	RoutingAreaId	string	Syntax described in 3GPP TS 29.002 (base 64 encoded according to RFC 2045). Length = 8.
tGeographicalInformation	GeographicalInformation	string	Syntax described in 3GPP TS 29.002 (base 64 encoded according to RFC 2045). Length = 12.
tGeodeticInformation	GeodeticInformation	string	Syntax described in 3GPP TS 29.002 (base 64 encoded according to RFC 2045). Length = 16.
tAgeOfLocationInformation	AgeOfLocationInformation	integer	>=0, <=32767
tAddressString	AddressString	string	Syntax described in 3GPP TS 29.002 (base 64 encoded according to RFC 2045). Length >= 4 and <=28 (multiples of 4).
tMSISDN	MSISDN	string	Number structure described in 3GPP TS 23.003 [11]. ASCII encoded according to ANSI X3.4 [20].

tSIP_URL	PublicIdentity	anyURI	Syntax described in [16]
tTEL_URL	PublicIdentity	anyURI	Syntax described in [17]
tDiameterURI	DiameterURI	string	Syntax of a Diameter URI as described in [7]
tIMSPublicIdentity	IMSPublicIdentity	(union)	Union of tSIP_URL and tTEL_URL
tServiceInfo	ServiceInfo	string	
tString	Method, Header, Content, Line	string	
tBool	ConditionTypeCNF, ConditionNegated	boolean	Possible values: 0 (false) 1 (true)
tSequenceNumber	SequenceNumber	integer	>=0, <=65535
tPSIActivation	PSIActivation	Enumerated	Possible values: 0 (INACTIVE) 1 (ACTIVE)

Table D.2: XML schema for the Sh interface user profile: complex data types

Data type	Tag	Compound of		
		Tag	Type	Cardinality
tSh-Data	Sh-Data	PublicIdentifiers	tPublicIdentity	0 to 1
		RepositoryData	tTransparentData	0 to 1
		Sh-IMS-Data	tShIMSData	0 to 1
		CSLocationInformation	tCSLocationInformation	0 to 1
		PSLocationInformation	tPSLocationInformation	0 to 1
		CSUserState	tCSUserState	0 to 1
		PSUserState	tPSUserState	0 to 1
tTransparentData	RepositoryData	ServiceIndication	string	0 to 1
		SequenceNumber	tSequenceNumber	1

		ServiceData	tServiceData	1
tServiceData	any	any	any	1
tIFCs	IFCs	InitialFilterCriteria	tInitialFilterCriteria	0 to n
tShIMSData	Sh-IMS-Data	SCSCFName	tSIP_URL	0 to 1
		IFCs	tIFCs	0 to 1
		IMSUserState	tIMSUserState	0 to 1
		ChargingInformation	tChargingInformation	0 to 1
		PSIActivation	tPSIActivation	0 to 1

tCSLocationInformation	CSLocationInformation	LocationNumber	tLocationNumber	0 to 1
		CellGlobalId	tCellGlobalId	0 to 1
		ServiceAreaId	tServiceAreaId	0 to 1
		LocationAreaId	tLocationAreaId	0 to 1
		GeographicalInformation	tGeographicalInformation	0 to 1
		GeodeticInformation	tGeodeticInformation	0 to 1
		VLRNumber	tISDNAddress	0 to 1
		MSCNumber	tISDNAddress	0 to 1
		CurrentLocationRetrieved	tBool	0 to 1
		AgeOfLocationInformation	tAgeOfLocationInformation	0 to 1
tPSLocationInformation	PSLocationInformation	CellGlobalId	tCellGlobalId	0 to 1
		ServiceAreaId	tServiceAreaId	0 to 1
		LocationAreaId	tLocationAreaId	0 to 1
		RoutingAreaId	tRoutingAreaId	0 to 1
		GeographicalInformation	tGeographicalInformation	0 to 1
		GeodeticInformation	tGeodeticInformation	0 to 1
		SGSNNumber	tISDNAddress	0 to 1

		CurrentLocationRetrieved	tBool	0 to 1
		AgeOfLocationInformation	tAgeOfLocationInformation	0 to 1
tPublicIdentity	PublicIdentifiers	IMSPublicIdentity	tIMSPublicIdentity	0 to n
		MSISDN	tMSISDN	0 to n
tInitialFilterCriteria	InitialFilterCriteria	Priority	tPriority	1
		TriggerPoint	tTrigger	0 to 1
		ApplicationServer	tApplicationServer	1
		ProfilePartIndicator	tProfilePartIndicator	(0 to 1)

tTrigger	TriggerPoint	ConditionTypeCNF		tBool	1
		SPT		tSePoTri	1 to n
SePoTri	SPT	ConditionNegated		tBool	0 to 1
		Group		tGroupID	1 to n
		Choice of	RequestURI	tString	1
			Method	tString	1
			SIPHeader	tHeader	1
			SessionCase	tDirectionOfRequest	1
			SessionDescription	tSessionDescription	1
		RegistrationType		tRegistrationType	(0 to 2)
tHeader	SIPHeader	Header		tString	1
		Content		tString	0 to 1
tSessionDescription	SessionDescription	Line		tString	1
		Content		tString	0 to 1
tApplicationServer	ApplicationServer	ServerName		tSIP_URL	1
		DefaultHandling		tDefaultHandling	0 to 1
		ServiceInfo		tServiceInfo	0 to 1
tChargingInformation	ChargingInformation	PrimaryEventChargingFunctionName		tDiameterURI	0 to 1
		SecondaryEventChargingFunctionName		tDiameterURI	0 to 1
		PrimaryChargingCollectionFunctionName		tDiameterURI	0 to 1
		SecondaryChargingCollectionFunctionName		tDiameterURI	0 to 1
NOTE: “n” shall be interpreted as non-bounded.					

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Annex E (ShDataType.xsd):

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:simpleType name="tSIP_URL" final="list restriction">
    <xs:restriction base="xs:anyURI"/>
  </xs:simpleType>
  <xs:simpleType name="tTEL_URL" final="list restriction">
    <xs:restriction base="xs:anyURI"/>
  </xs:simpleType>
  <xs:simpleType name="tDiameterURI" final="list restriction">
    <xs:restriction base="xs:anyURI"/>
  </xs:simpleType>
  <xs:simpleType name="tIMSPublicIdentity" final="#all">
    <xs:union memberTypes="tSIP_URL tTEL_URL"/>
  </xs:simpleType>
  <xs:simpleType name="tProfilePartIndicator" final="list restriction">
    <xs:restriction base="xs:unsignedByte">
      <xs:maxInclusive value="1"/>
      <xs:enumeration value="0">
        <xs:annotation>
          <xs:documentation>
            <label xml:lang="en">REGISTERED</label>
            <definition xml:lang="en">iFC is part of the registered
profile</definition>
          </xs:documentation>
        </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="1">
        <xs:annotation>
          <xs:documentation>
            <label xml:lang="en">UNREGISTERED</label>
            <definition xml:lang="en">iFC is part of the unregistered
profile</definition>
          </xs:documentation>
        </xs:annotation>
      </xs:enumeration>
    </xs:restriction>
  </xs:simpleType>
  <xs:simpleType name="tServiceInfo" final="list restriction">
    <xs:restriction base="xs:string">
      <xs:minLength value="0"/>
    </xs:restriction>
  </xs:simpleType>
  <xs:simpleType name="tString" final="list restriction">
    <xs:restriction base="xs:string">
      <xs:minLength value="0"/>
    </xs:restriction>
  </xs:simpleType>
  <xs:simpleType name="tMSISDN" final="list restriction">
    <xs:restriction base="xs:string">
      <xs:minLength value="0"/>
    </xs:restriction>
  </xs:simpleType>
```

```
  <xs:simpleType name="tIMSUserState" final="list restriction">
    <xs:restriction base="xs:unsignedByte">
      <xs:maxInclusive value="3"/>
      <xs:enumeration value="0">
        <xs:annotation>
          <xs:documentation>
            <label xml:lang="en">NOT_REGISTERED</label>
            <definition xml:lang="en">Not registered</definition>
          </xs:documentation>
        </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="1">
        <xs:annotation>
          <xs:documentation>
            <label xml:lang="en">REGISTERED</label>
            <definition xml:lang="en">Registered</definition>
          </xs:documentation>
        </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="2">
        <xs:annotation>
          <xs:documentation>
            <label xml:lang="en">REGISTERED_UNREG_SERVICES</label>
            <definition xml:lang="en">Registered, with services for
unregistered</definition>
          </xs:documentation>
        </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="3">
        <xs:annotation>
          <xs:documentation>
            <label xml:lang="en">AUTHENTICATION_PENDING </label>
            <definition xml:lang="en">Pending of
authentication</definition>
          </xs:documentation>
        </xs:annotation>
      </xs:enumeration>
    </xs:restriction>
  </xs:simpleType>
  <xs:simpleType name="tCSUserState" final="list restriction">
    <xs:restriction base="xs:unsignedByte">
      <xs:maxInclusive value="3"/>
      <xs:enumeration value="0">
        <xs:annotation>
          <xs:documentation>
            <label xml:lang="en">CAMELBusy</label>
          </xs:documentation>
        </xs:annotation>
      </xs:enumeration>
      <xs:enumeration value="1">
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