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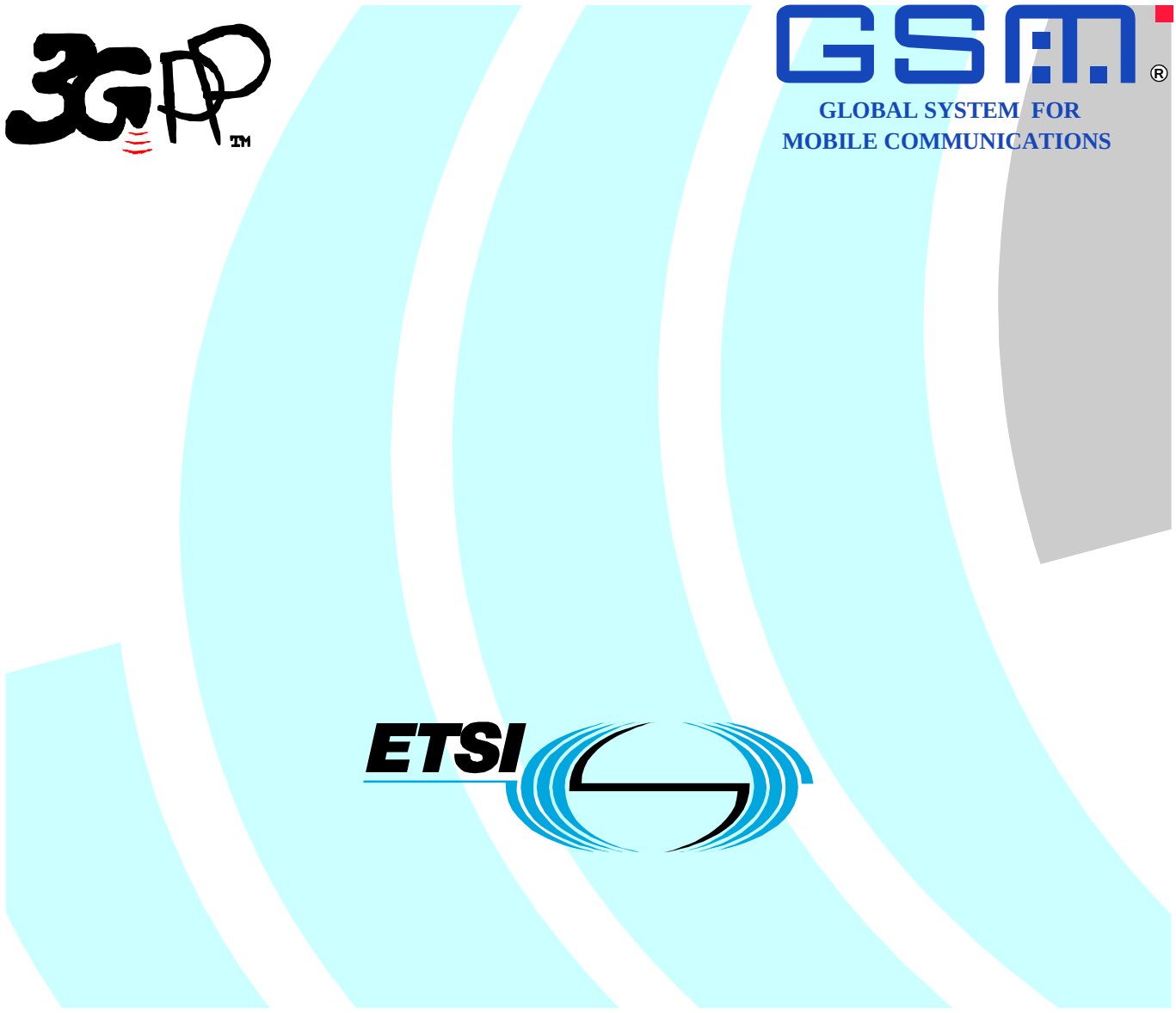

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Foreword

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1 Scope

The present document covers both online and offline charging for the IMS. For clarity, the terms Offline Charging and Online charging as applied to the IMS are defined here in clause 3. These definitions are the same as listed in TS 32.200 [2].

The IMS charging architecture details, requirements, definitions and principles are listed in TS 32.200 [2] and therefore are not repeated here.

In the present document the charging data triggers, message content and format are specified along with the transport of these messages using the Diameter protocol. Details about charging message flows and the definitions of the Diameter AVPs are also included in the present document. This information is divided into two main clauses: Online Charging and Offline Charging.

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.
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- 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 32.200: "Telecommunication management; Charging management; Charging principles".

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

[4] 3GPP TS 33.201: "Access domain security".

[5] 3GPP TS 23.218: "IP Multimedia (IM) session handling; IM call model; Stage 2".

[6] IETF RFC 2486: "The Network Access Identifier".

[7] 3GPP TS 23.207: "End to end quality of service concept and architecture".

[8] 3GPP TS 29.207: "Policy control over Go interface".

[9] ITU-T Recommendation X.690: "Information technology - ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)".

[10] ITU-T Recommendation X.691: "Information technology - ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)".

[11] ITU-T Recommendation X.693: "Information Technology - ASN.1 encoding rules: XML encoding Rules (XER)".

[12] 3GPP TS 24.228: "Signalling flows for the IP multimedia call control based on SIP and SDP; Stage 3".

[13] IETF Internet-Draft, "Diameter Credit Control Application". - Included in Annex A

NOTE: The above reference will need to be updated to reference the assigned RFC number, once the draft achieves RFC status within the IETF.

[14] 3GPP TS 24.229: "IP Multimedia Call Control Protocol based on SIP and SDP; Stage 3."

[15] IETF Internet-Draft, "Private Extensions to the Session Initiation Protocol (SIP) for the 3rd Generation Partnership Projects (3GPP)". http://www.ietf.org/internet-drafts/draft-garcia-sipping-3gpp-p-headers-02.txt or ftp://ftp.rfc-editor.org/in-notes/rfc3455.txt

NOTE: The above reference will need to be updated to reference the assigned RFC number, once the draft achieves RFC status within the IETF.

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

[17] IETF Internet-Draft, "SDP: Session Description Protocol". http://www.ietf.org/internet-drafts/draft-ietf-mmusic-sdp-new-13.txt

NOTE: The above reference will need to be updated to reference the assigned RFC number, once the draft achieves RFC status within the IETF.

[18] 3GPP TS 23.228: "IP Multimedia Subsystem (IMS); Stage 2".

[19] 3GPP TS 29.229: "Cx and Dx Interfaces based on the Diameter protocol; Protocol Details".

[20] IETF RFC 2806: "URLs for Telephone Calls".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

offline charging: charging mechanism where charging information **does not** affect, in real-time, the service rendered

online charging: charging mechanism where charging information can affect, in real-time, the service rendered and therefore a direct interaction of the charging mechanism with session/service control is required

3.2 Symbols

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

Bi The Interface between the IMS charging function and the BS
Rb Online Charging Reference Point between Session Charging Function and Correlation Function
Rc Online Charging Reference Point between ECF and Correlation Function
Re Online Charging Reference Point towards a Rating Server
Rf Offline Charging Reference Point between an IMS Network Entity or an AS and CCF
Ro Online Charging Reference Point between an AS or MRFC and the ECF

3.3 Abbreviations

For the purposes of the present document, the abbreviations defined in TR 21.905 [1], TS 32.200 [2] and the following apply:

ABNF Augmented Backus-Naur Form
ACA Accounting Answer
ACR Accounting Request
AS Application Server
AVP Attribute Value Pair
B2BUA Back-to-Back User Agent
BGCF Breakout Gateway Control Function
BS Billing System

CCF	Charging Collection Function
CDR	Charging Data Record
CPCF	Content Provider Charging Function
ECF	Event Charging Function
ECUR	Event Charging with Unit Reservation
CSCF	Call Session Control Function (I-Interrogating; P-Proxy; and S-Serving)
IANA	Internet Assigned Numbers Authority
IEC	Immediate Event Charging
IMS	IP Multimedia Subsystem
ISC	IMS Service Control
MGCF	Media Gateway Control Function
MRFC	Media Resource Function Controller
MRFP	Multimedia Resource Function Processor
OCS	Online Charging System
SCCF	Subscriber Content Charging Function
SDP	Session Description Protocol
SIP	Session Initiation Protocol
UA	User Agent
UE	User Equipment

4 Offline and Online Charging

4.1 Implementation of Offline and Online Charging

The IMS charging architecture, described in TS 32.200 [2], specifies that for offline charging all communications between the IMS network entities and the CCF are carried out on the Rf interface. On the other hand, for online charging the Ro interface is used by the AS and MRFC towards the Event Charging Function and the ISC interface is used between the S-CSCF and the Session Charging Function. The rules governing the selection of the proper interfaces are described in the subclauses below.

4.1.1 Usage of Rf and Ro Interfaces

The AS and MRFC are able to distinguish whether to apply offline or online charging, i.e. whether to send charging information on the Rf interface to the CCF or on the Ro interface to the ECF (or to use both). The decision of which interface to use is based on the information (CCF and/or ECF address) the AS/MRFC receive in the SIP signalling and the system configuration as provisioned by the operator. If the AS/MRFC only receive the CCF address and do not receive an ECF address then they use only the Rf interface. If only the ECF address was provided then they use only the Ro interface. In cases where both CCF and ECF addresses are provided it is possible to use both interfaces simultaneously.

However, operators may overrule the addresses received via the SIP signalling and use their own configured rules instead. Operators may configure locally on the AS/MRFC an ECF and/or CCF address. The CCF address may be locally configured on all other IMS nodes. The choice of whether the IMS nodes use the locally configured addresses or the addresses received by SIP signalling, and the decision on which interface(s) to use, is left for operator configuration.

4.1.2 Usage of Rf and ISC Interfaces

All other IMS nodes (S-CSCF, P-CSCF, I-CSCF, BGCF and MGCF) apply offline charging via the Rf interface using the CCF address as received via SIP signalling or the locally configured CCF address. The S-CSCF supports online charging using the ISC interface, i.e. if the application server addressed over ISC is the Session Charging Function of the OCS.

4.1.3 Support of Local File Storage

The present document does not mandate the support of persistent storage on the IMS nodes nor does it require any protocol except Diameter to be used for either online or offline charging. However, if an IMS node supports a local persistent storage media, the IMS application may copy the accounting information sent to the Diameter client to this

local filestore. Operator's post-processing systems may then pull the contents of the filestore via FTP applying the same file transfer procedures as those specified for the 'Bi' interface. Further details are implementation specific and are out of the scope of standardisation.

4.2 Diameter Protocol Basic Principles and Use

The present document defines a 3GPP IMS charging Diameter application, which utilizes the Diameter Base Protocol [3]. This application is used for both online and offline charging. The generic description of the protocol is provided in the subclauses below while the portions of the protocol application associated with offline and online charging are described in clauses 5 and 6, respectively.

4.2.1 Basic Principles

The IMS charging Diameter application is based on the following general principles:

- The basic functionality of Diameter, as defined by the Diameter Base Protocol [3] is re-used in IMS.
- For offline charging IMS network elements report accounting information to the Charging Collection Function (CCF). The CCF uses this information to construct and format CDRs.
- For online charging, the AS and MRFC in the IMS network report accounting information to the Event Charging Function (ECF). The ECF uses this information to support the event based charging (content charging) function of the OCS.

4.2.2 Application Requirement for the Base Protocol

4.2.2.1 Offline Specific Base Protocol Requirements

A configurable timer is supported in the CCF to supervise the reception of the ACR [Interim] and/or ACR [Stop]. An instance of the 'Timer' is started at the beginning of the accounting session, reset on the receipt of an ACR [Interim] and stopped at the reception of the ACR [Stop]. Upon expiration of the timer, the CCF stops the accounting session with the appropriate error indication.

For offline charging, the client implements the state machine described in [3]. The server (CCF) implements the STATELESS ACCOUNTING state machine as specified in [3], i.e. there is no order in which the server expects to receive the accounting information.

4.2.2.2 Online Specific Base Protocol Requirements

The usage and values of *Acct-Interim-Interval* AVP and the timer 'Ts' are under the sole control of the credit control server (OCS) and determined by operator configuration of the OCS. There are no specific requirements on the client concerning the *Acct-Interim-Interval* AVP population in the ACR.

The online client (e.g. AS, MRFC) implements the state machine described in [13] for "CLIENT, EVENT BASED" or "CLIENT, SESSION BASED", i.e. when the client applies Immediate Event Charging (IEC) it uses the "CLIENT, EVENT BASED" state machine, or when the client applies Event Charging with Unit Reservation (ECUR) it uses the "CLIENT, SESSION BASED" state machine.

The online charging server that is part of the OCS implements the state machine described in [13] for the "SERVER, SESSION AND EVENT BASED" in order to support Immediate Event Charging and Event Charging with Unit Reservation.

4.2.2.3 Security Considerations

Diameter security is addressed in the base protocol [3]. Network security is specified in TS 33.201 [4].

5 Offline Charging

5.1 Diameter Description on the Rf Interfaces

5.1.1 Basic Principles

The offline charging functionality is based on the IMS network nodes reporting accounting information upon reception of various SIP methods or ISUP messages, as most of the accounting relevant information is contained in these messages. This reporting is achieved by sending Diameter *Accounting Requests* (ACR) [Start, Interim, Stop and Event] from the IMS nodes to the CCF and/or ECF.

The Diameter client uses ACR Start, Interim and Stop in procedures related to successful SIP sessions. It uses ACR Events for unsuccessful SIP sessions and for session unrelated procedures. Further details are specified in the tables below and in subclause 5.1.2.

It is operator configurable in the nodes for which SIP method or ISUP messages an *Accounting Request* is sent, with the exception that if accounting information is collected for sessions the ACR [Start] and ACR [Stop] messages are mandatory according to the tables below. Table 5.1 describes all possible ACRs that might be sent from a P-CSCF, I-CSCF, S-CSCF, MGCF or BGCF. A list of node specific ACRs, along with the AVPs to be included are detailed in section 5.1.3.3.

The ACRs to be sent from a MRFC are described in table 5.2.

In the tables below, the terms "configurable" implies that operators may enable or disable the generation of an ACR message by the IMS node in response to a particular "Triggering SIP Method /ISUP Message". However, for those table entries marked with *, the operator can enable or disable the ACR message based on whether or not the SIP (Re) Invite message that is replied to by the "Triggering SIP Method /ISUP Message" carried piggybacked user data.

Table 5.1: Accounting Request Messages Triggered by SIP Methods or ISUP Messages for all IMS nodes except for MRFC and AS

Diameter Message	Triggering SIP Method /ISUP Message	Mandatory/ Configurable
ACR [Start]	SIP 200 OK acknowledging an initial SIP INVITE	Mandatory
	ISUP:ANM (applicable for the MGCF)	Mandatory
ACR [Interim]	SIP 200 OK acknowledging a SIP RE-INVITE or SIP UPDATE [e.g. change in media components]	Configurable
	Expiration of AVP [Acct-Interim-Interval]	Configurable
ACR [Stop]	SIP BYE message (both normal and abnormal session termination cases)	Mandatory
	ISUP:REL (applicable for the MGCF)	Mandatory
ACR [Event]	SIP 200 OK acknowledging non-session related SIP messages, which are:	
	SIP NOTIFY	Configurable
	SIP MESSAGE	Configurable
	SIP REGISTER	Configurable
	SIP SUBSCRIBE	Configurable
	SIP Final Response (4xx, 5xx or 6xx), indicating an unsuccessful SIP session set-up	Configurable *
	SIP Final Response (4xx, 5xx or 6xx), indicating an unsuccessful session-unrelated procedure	Configurable *
	SIP CANCEL, indicating abortion of a SIP session set-up	Configurable *
	I-CSCF completing a Cx Query that was issued in response to a SIP INVITE	Configurable
NOTE: SIP SUBSCRIBE with the field "Expires" set to 0 means unsubscribe. SIP REGISTER with its "Expires" header field or "Expires" parameter equal to 0 means Deregistration [14].		

Table 5.2: Accounting Request Messages Triggered by SIP Methods for the MRFC

Diameter Message	Trigger	Mandatory/ Configurable
ACR [Start]	SIP 200 OK acknowledging an SIP INVITE for initiating a multimedia ad hoc conferencing session	Mandatory
ACR [Interim]	SIP ACK acknowledging a SIP INVITE to connect an UE to the conferencing session	Configurable
	Expiration of AVP [Acct-Interim-Interval]	Configurable
ACR [Stop]	SIP BYE message	Mandatory
	SIP Final Response with error codes 4xx, 5xx or 6xx indicating termination of an ongoing session	Mandatory

ASs support all four ACR types (Start/Interim/Stop/Event). The use of ACR Start, Interim and Stop (Session Charging) versus ACR Event (Event Charging) depends on the services provided by the application server. Example flows for an AS employing Event Charging and an AS using Session Charging are shown in subclause 5.1.2.1.3.

The ability of SIP methods not listed in tables 5.1 and 5.2 to trigger ACRs is for further study.

5.1.2 Message Flows and Types

The flows described in the present document specify the charging communications between IMS entities and the charging functions for different charging scenarios. The SIP messages associated with these charging scenarios are shown primarily for general information and to illustrate the charging triggers. They are not intended to be exhaustive of all the SIP message flows discussed in TS 24.228 [12].

5.1.2.1 Message Flows - Successful Cases and Scenarios

5.1.2.1.1 Session Related Procedures

5.1.2.1.1.1 Session Establishment - Mobile Origination

Figure 5.1 shows the Diameter transactions that are required between CSCF and CCF during session establishment originated by a UE.

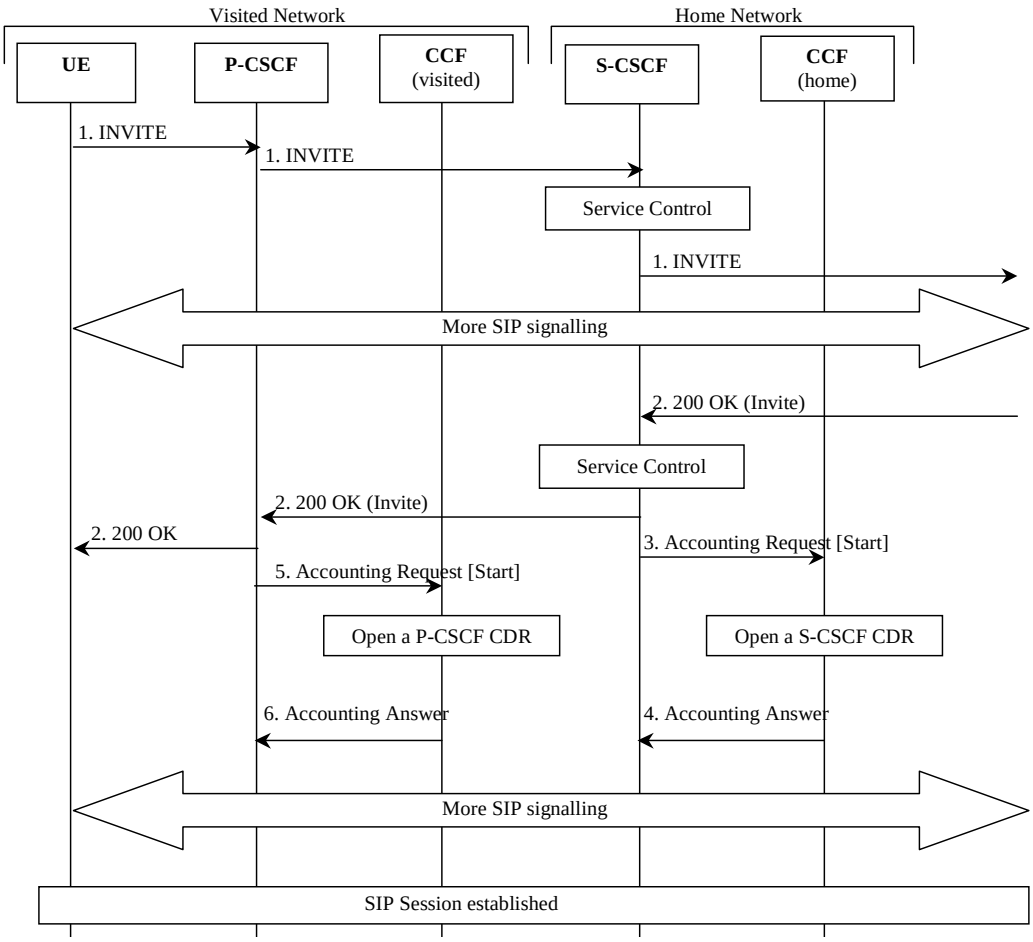

Figure 5.1: Message Sequence Chart for Session Establishment (Mobile Origination)

1. The session is initiated.
2. The destination party answers and a final response is received.
3. Upon reception of the final response, the S-CSCF sends an *Accounting-Request* with *Accounting-Record-Type* indicating START_RECORD to record start of a user session and start of a media component in the S-CSCF CDR.
4. The CCF acknowledges the reception of the data and opens a S-CSCF CDR.
5. Same as 3, but for P-CSCF.
6. Same as 4, but creating a P-CSCF CDR.

5.1.2.1.1.2 Session Establishment - Mobile Termination

Figure 5.2 shows the Diameter transactions that are required between CSCF and CCF during a session establishment that is terminated to a mobile. The I-CSCF is only involved in the INVITE transaction.

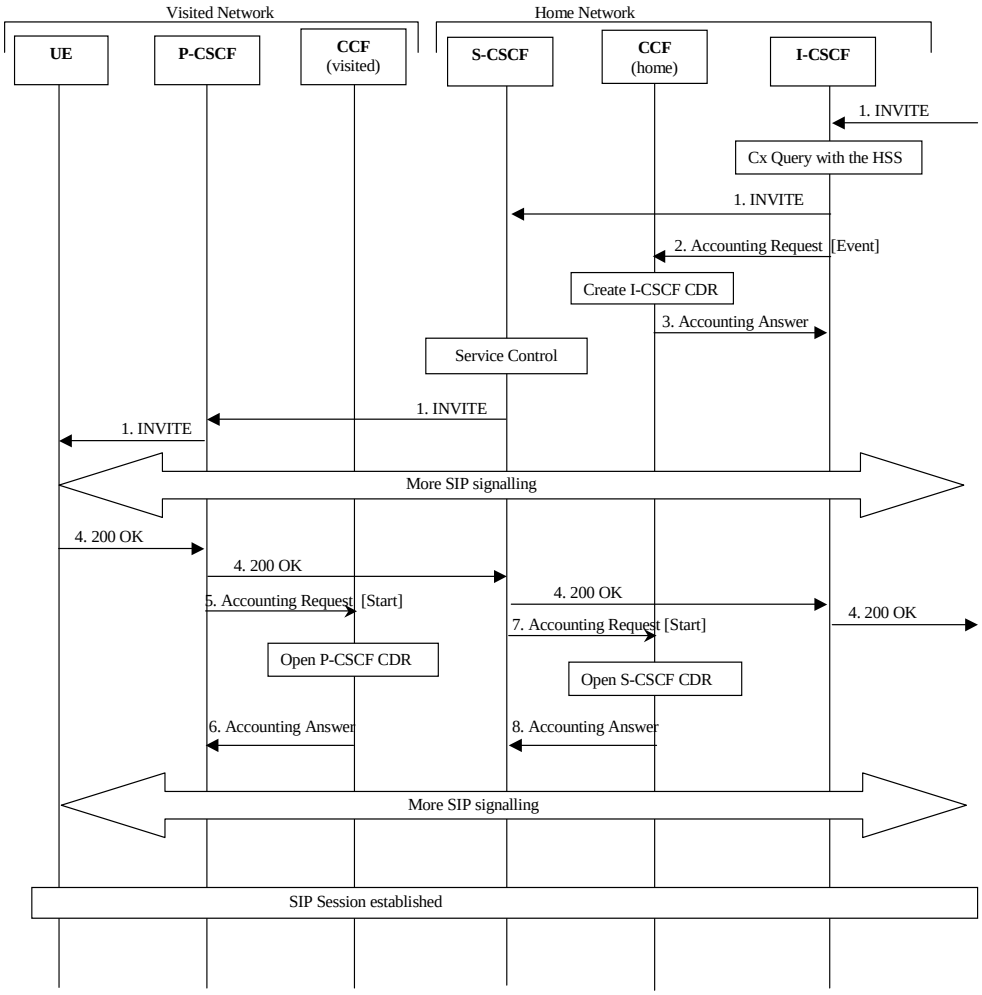

Figure 5.2: Message Sequence Chart for Session Establishment (Mobile Termination)

1. The session is initiated.
2. Upon completing a Cx query the I-CSCF sends an *Accounting Request* with the *Accounting-Record-Type* set to EVENT.
3. The CCF acknowledges the data received and creates an I-CSCF CDR.
4. The destination party answers and a final response is sent.
5. - 8. These steps are identical to the corresponding steps described in subclause 5.1.2.1.1.1.

5.1.2.1.1.3 Mid-Session Procedures

Figure 5.3 shows the Diameter transactions that are required between CSCF and CCF when a UE generates a SIP (Re-)INVITE or SIP UPDATE in mid-session, e.g. in order to modify media component(s), or when the hold and resume procedure is executed.

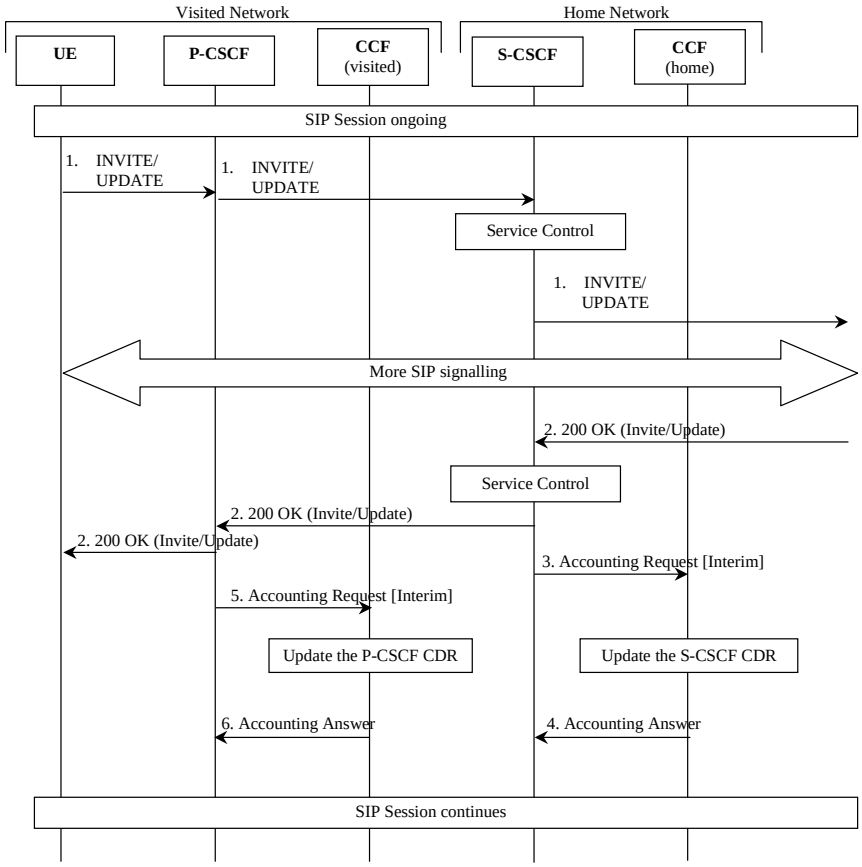

Figure 5.3: Message Sequence Chart for Media Modification

1. Modified media information is received from the subscriber.
2. The destination party acknowledges the media modification.
3. At modification of a media, the S-CSCF sends *Accounting-Request* with *Accounting-Record-Type* indicating INTERIM_RECORD to record modification of a media component in the S-CSCF CDR.
4. The CCF acknowledges the reception of the data and updates the S-CSCF CDR.
5. Same as 3, but for P-CSCF.
6. Same as 4, updating the P-CSCF CDR.

5.1.2.1.1.4 Session Release - Mobile Initiated

Figure 5.4 shows the Diameter transactions that are required between CSCF and CCF for a session release that is initiated by the UE.

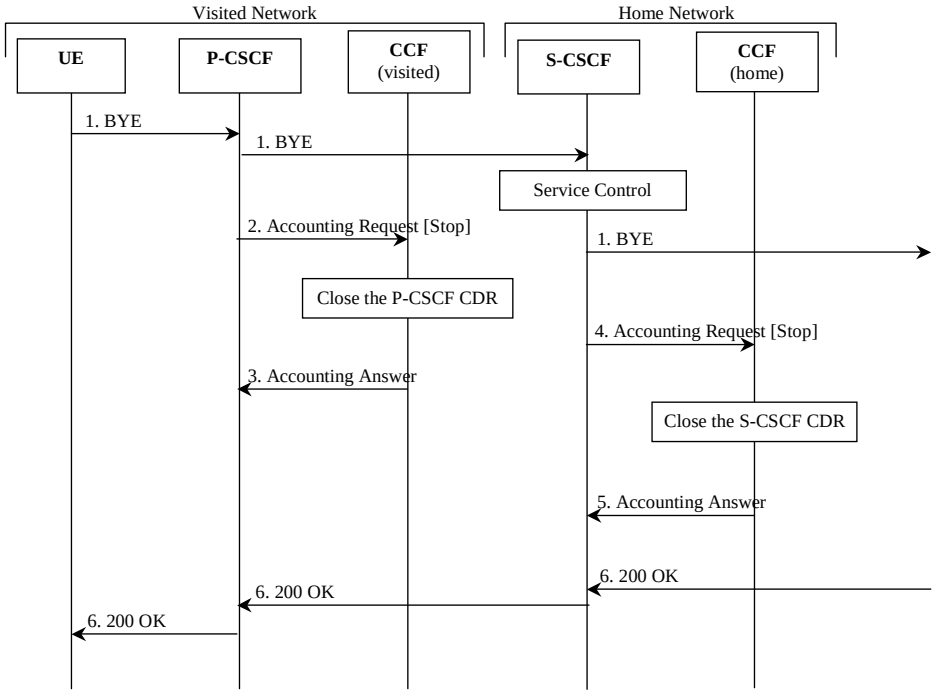

Figure 5.4: Message Sequence Chart for Session Release

1. The session is released.
2. At session termination the P-CSCF sends *Accounting-Request* with *Accounting-Record-Type* indicating STOP_RECORD to record stop of a session and stop of a media component in the P-CSCF CDR.
3. The CCF acknowledges the reception of the data and closes the P-CSCF CDR.
4. Same as 2, but for S-CSCF.
5. Same as 3, closing the S-CSCF CDR.
6. The release is acknowledged.

5.1.2.1.1.5 Session Release - Network Initiated

In the case of network initiated session release the IMS node sends a SIP BYE message which is replied to by the UE with a SIP 200 OK message. The charging message flow for this case is identical to the mobile initiated session release described in subclause 5.1.2.1.1.4.

5.1.2.1.1.6 Session Release - CCF initiated

The IMS operator may request the release of SIP session(s) upon certain trigger conditions being met, for example as soon as a fraud is detected.

Figure 5.5 shows the Diameter transactions that are required in order to release an ongoing SIP session.

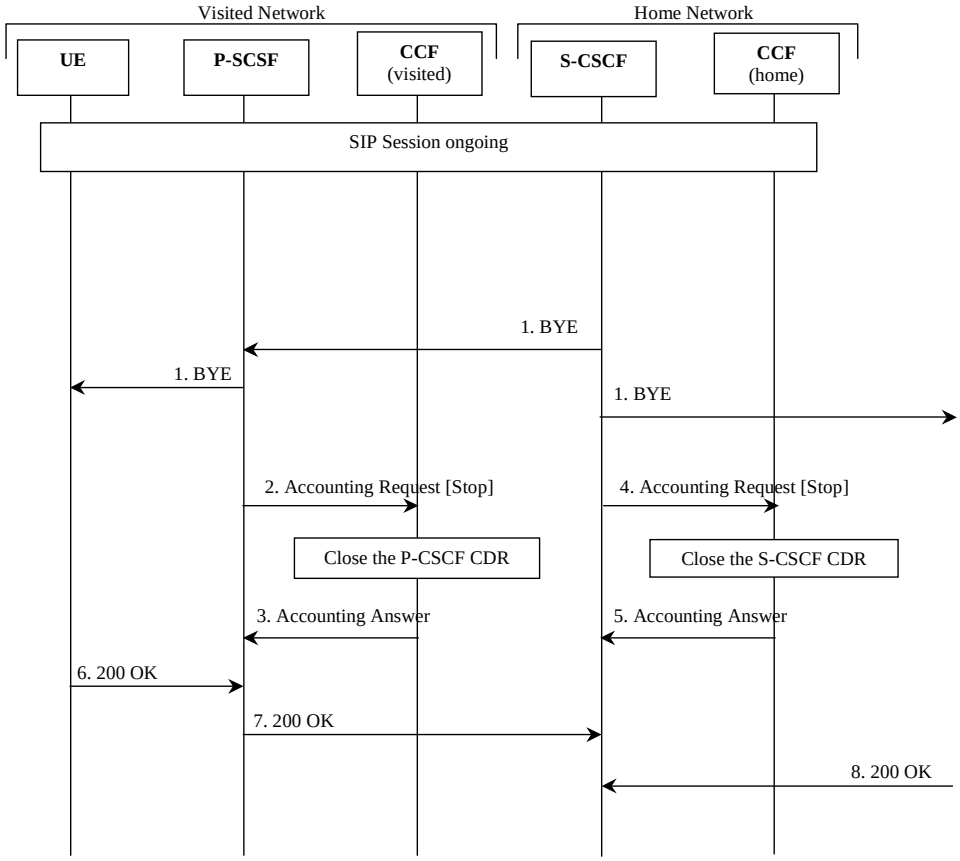

Figure 5.5: Message Sequence Chart for Network Initiated Session Release

1. The S-CSCF initiates the SIP session release by sending SIP BYE request to both the originating and the terminating parties, as specified in TS 23.218 [5].
2. At session termination the P-CSCF sends *Accounting-Request* with *Accounting-Record-Type* indicating STOP_RECORD to record stop of a session and stop of a media component in the P-CSCF CDR.
3. The CCF acknowledges the reception of the data and closes the P-CSCF CDR.
4. Same as 2, but for S-CSCF.
5. Same as 3, but for S-CSCF CDR.
6. - 8. The S-CSCF receives the 200 OK responses from originating and terminating parties.

5.1.2.1.2 Session-Unrelated Procedures

Figure 5.6 shows the Diameter transactions that are required between CSCF and CCF for session-unrelated IMS procedures, i.e. those that relate to the Diameter ACR [Event], as listed in table 5.1.

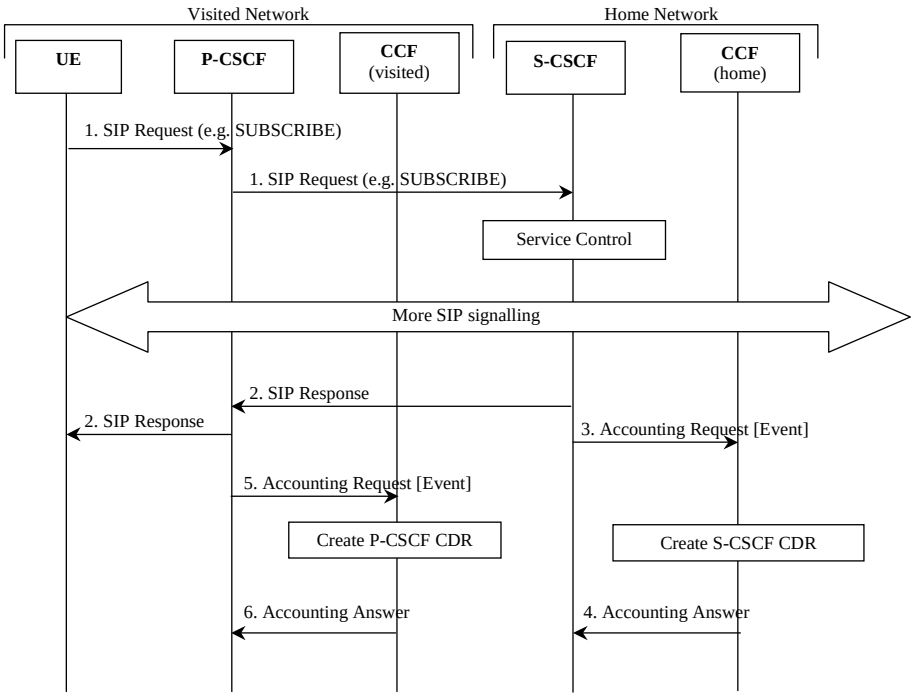

Figure 5.6: Message Sequence Chart for Session-Unrelated Procedure

1. The P-CSCF receives a "SIP Request" (e.g. SUBSCRIBE) from the subscriber.
2. The "SIP Request" is acknowledged by the "SIP Response" as follows:
   - in the successful case, a 200 OK message is returned;
   - in case of failure an appropriate SIP error message is returned.

Depending on the used SIP method, there might be additional signalling between steps 1 and 2.

3. After the completion of the procedure, the S-CSCF sends *Accounting-Request* with *Accounting-Record-Type* indicating EVENT_RECORD to record transaction specific information in the S-CSCF CDR.
4. The CCF acknowledges the reception of the data and produces an S-CSCF CDR.
5. Same as 3, but for P-CSCF.
6. Same as 4, creating a P-CSCF CDR.

5.1.2.1.3 PSTN Related Procedures

5.1.2.1.3.1 Session Establishment - PSTN Initiated

Figure 5.7 shows the Diameter transactions that are required between MGCF and CCF during session establishment initiated from the PSTN side.

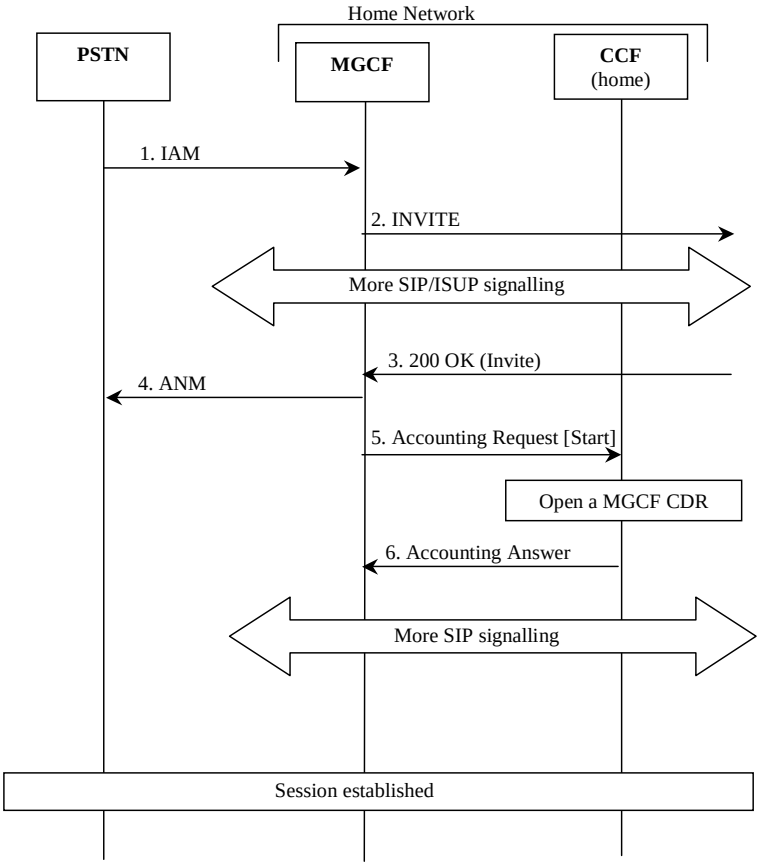

Figure 5.7: Message Sequence Chart for Session Establishment (PSTN Initiated)

1. The session is originated from the PSTN.

2. The session setup is triggered in the IMS.

3. The destination party answers and a final response is received.

4. MGCF forwards an answer message to the PSTN.

5. Upon reception of the final response, the MGCF sends an *Accounting-Request* with *Accounting-Record-Type* indicating START_RECORD to record start of a user session and start of a media component in the MGCF CDR.

6. The CCF acknowledges the reception of the data and opens a MGCF CDR.

5.1.2.1.3.2 Session Establishment - IMS Initiated

Figure 5.8 shows the Diameter transactions that are required between BGCF, MGCF and CCF during session establishment initiated from the IMS side.

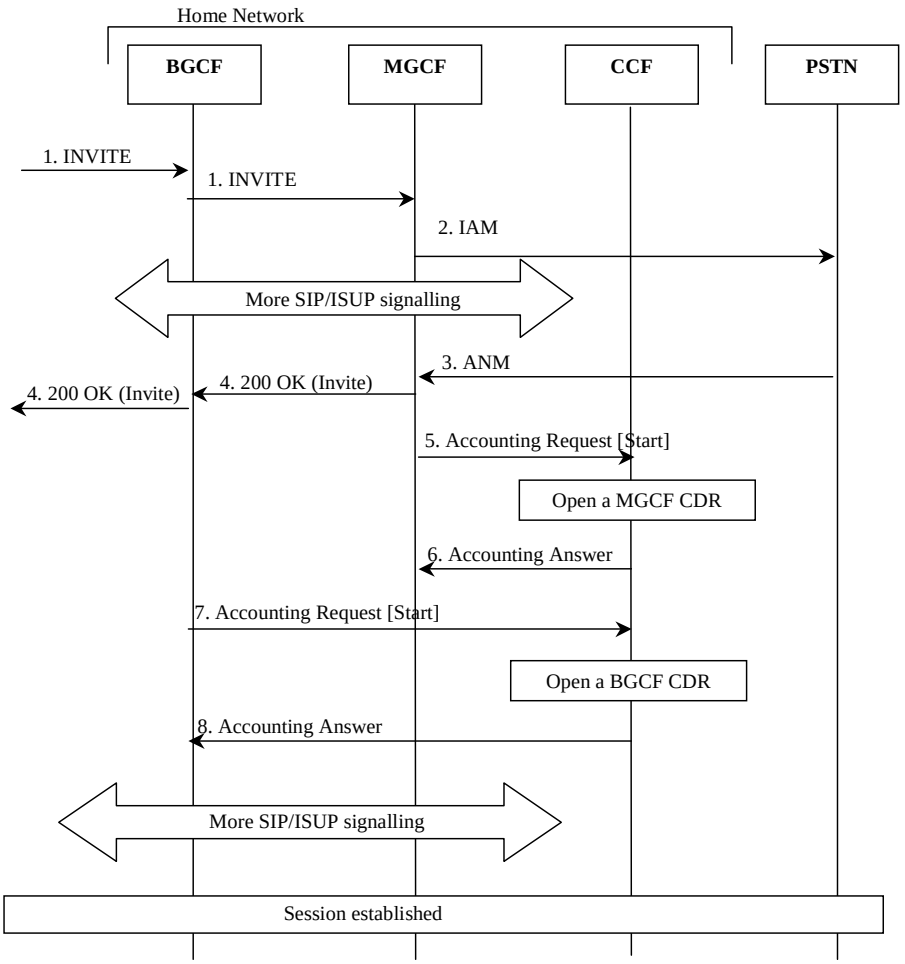

Figure 5.8: Message Sequence Chart for Session Establishment (IMS Initiated)

1. The session is originated from the IMS.
2. A session towards PSTN is established.
3. The destination party answers and an answer message is received.
4. A final response message is sent to the session originator.
5. Upon reception of the answer message, the MGCF sends an *Accounting-Request* with *Accounting-Record-Type* indicating START_RECORD to record start of a user session and start of a media component in the MGCF CDR.
6. The CCF acknowledges the reception of the data and opens a MGCF CDR.
7. Upon reception of the 200 OK message, the BGCF sends an *Accounting-Request* with *Accounting-Record-Type* indicating START_RECORD to record start of a user session and start of a media component in the BGCF CDR.
8. The CCF acknowledges the reception of the data and opens a BGCF CDR.

5.1.2.1.3.3 Session Release - PSTN Initiated

Figure 5.9 shows the Diameter transactions that are required between BGCF, MGCF and CCF during a PSTN initiated session release. The BGCF is only involved if the session had been initiated from the IMS side.

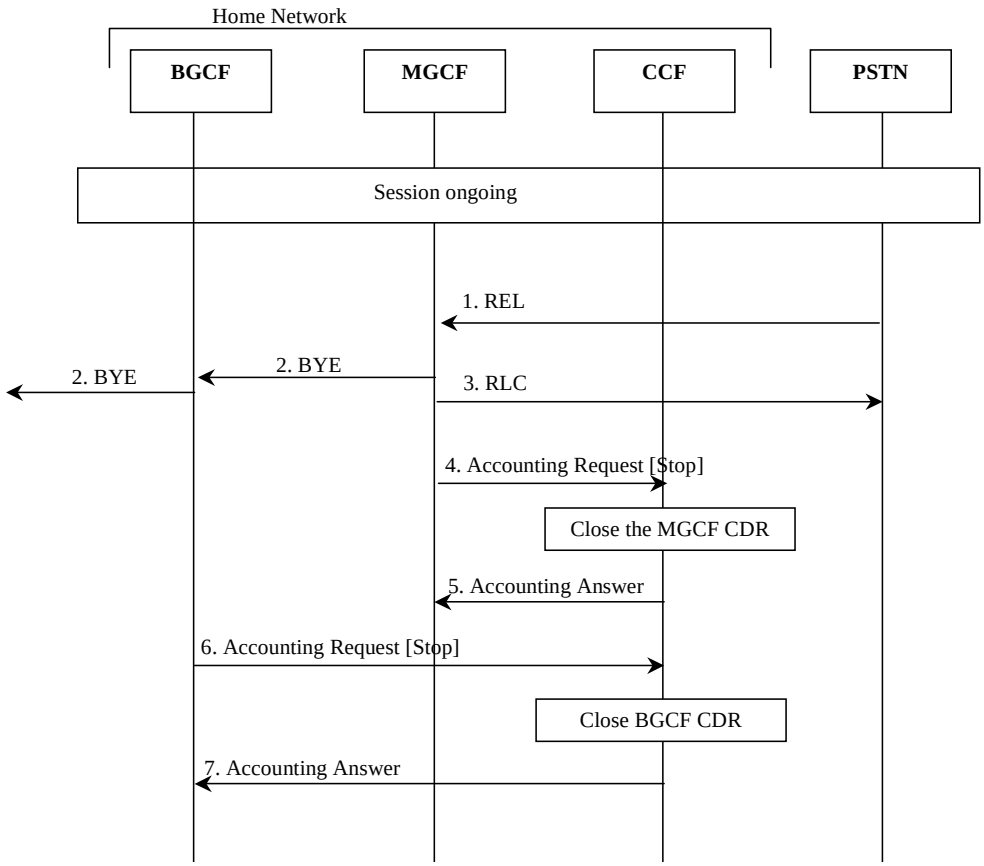

Figure 5.9: Message Sequence Chart for Session Release (PSTN initiated)

1. The session release is initiated from PSTN.
2. Session release continues within IMS.
3. The reception of the release message is acknowledged.
4. Upon reception of the release message, the MGCF sends an *Accounting-Request* with *Accounting-Record-Type* indicating STOP_RECORD to record stop of a session in the MGCF CDR.
5. The CCF acknowledges the reception of the data and closes the MGCF CDR.
6. Same as 4, but for BGCF.
7. Same as 5, but for BGCF.

5.1.2.1.3.4 Session Release - IMS Initiated

Figure 5.10 shows the Diameter transactions that are required between BGCF, MGCF and CCF during a IMS initiated session release.

The BGCF is only involved if the session had been initiated from the IMS side.

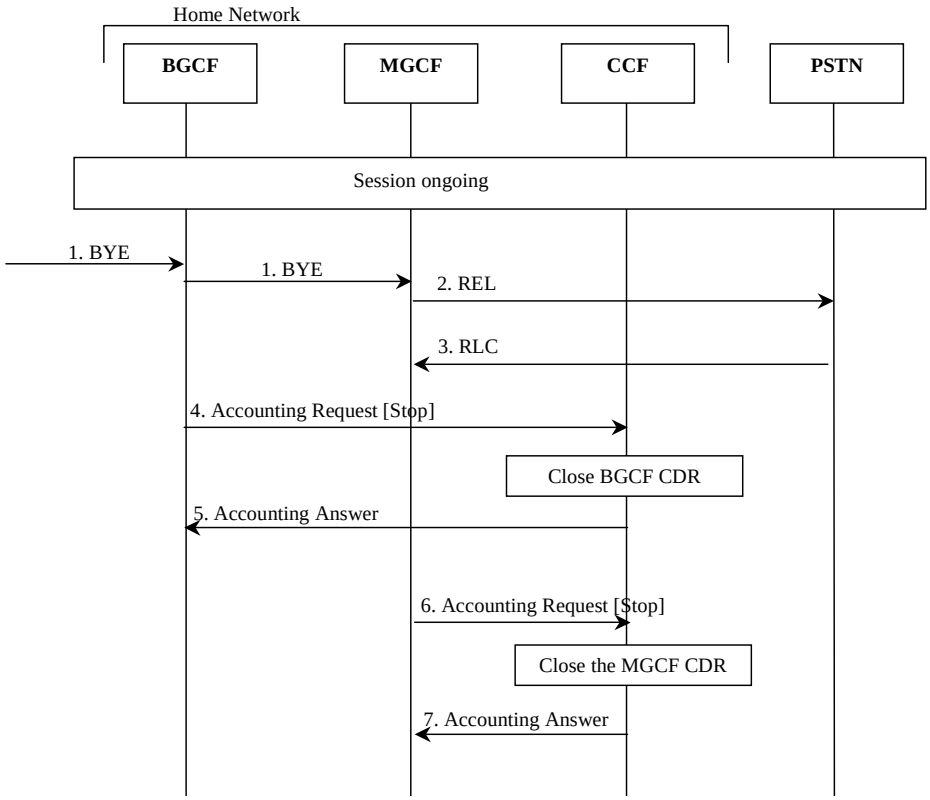

Figure 5.10: Message Sequence Chart for Session Release (IMS initiated)

1. The session release is initiated from the IMS side.
2. A release message is sent towards PSTN.
3. The acknowledgement of the release message is received from PSTN.
4. Upon reception of the BYE message, the BGCF sends an *Accounting-Request* with *Accounting-Record-Type* indicating STOP_RECORD to record stop of a session in the BGCF CDR.
5. The CCF acknowledges the reception of the data and closes the BGCF CDR.
6. Same as 4, but for MGCF.
7. Same as 5, but for MGCF.

5.1.2.1.4 MRFC Related Procedures

5.1.2.1.4.1 Multi-Party Call

Figure 5.11 shows the establishment of an ad hoc conference (multiparty call). An AS (acting as B2BUA) performs third party call control with the MRFC, where the S-CSCF is in the signalling path. The Application Server that is in control of the ad hoc conference is aware of the MRFC capabilities.

NOTE: Only accounting information sent from the MRFC is shown in detail in the figure. The SIP messages are for illustrative purpose only.

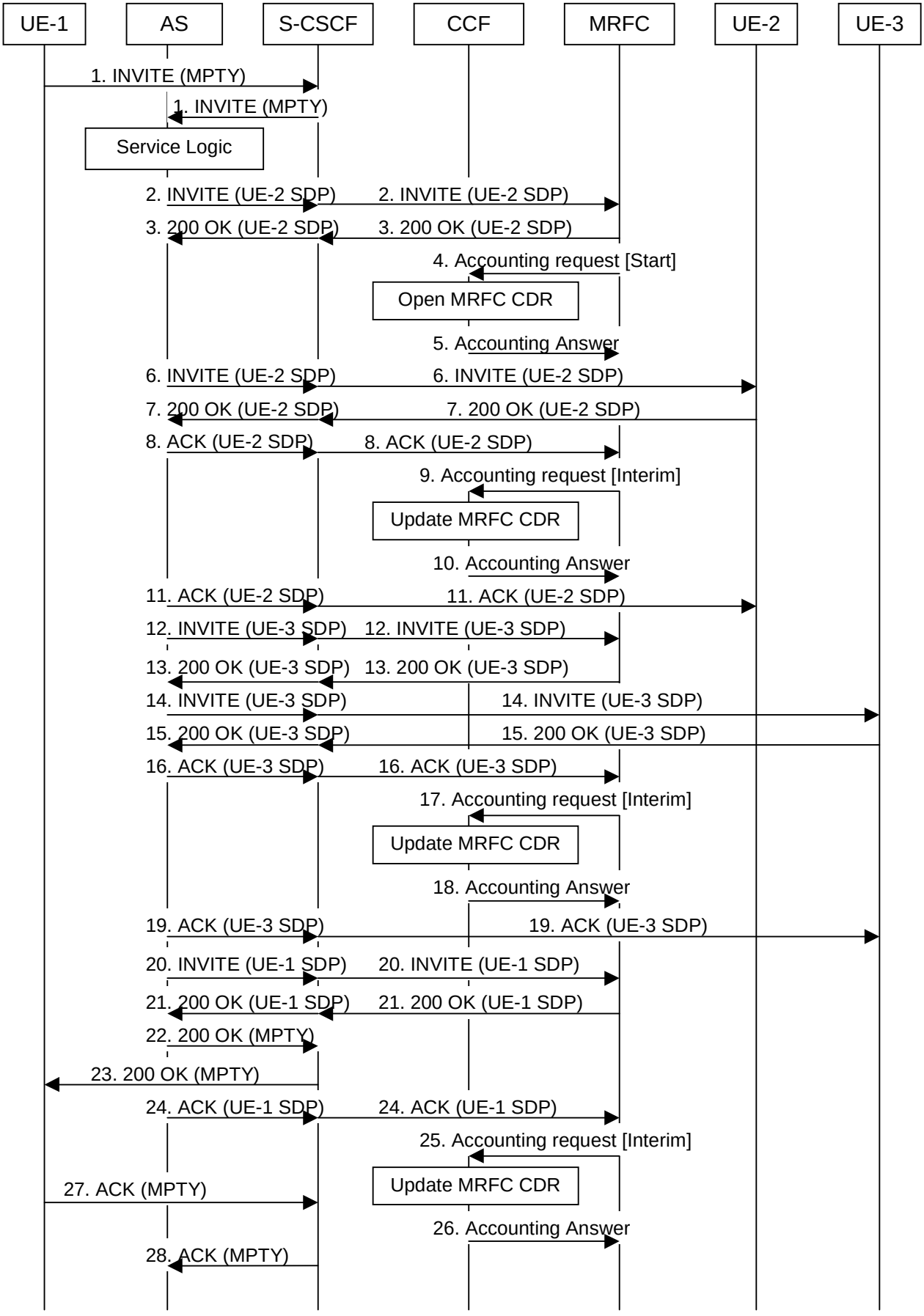

Figure 5.11: Message Sequence Chart for Multi-Party Call Establishment in MRFC

1. Sessions exist between UE-1 and UE-2, and between UE-1 and UE-3. A request is received from UE-1for putting all parties together to a multi-party call.
2 - 3. Request and acknowledgement to initiate a multi-party call. MRFC assigns a conference-ID that is used by the AS in subsequent interactions with the MRFC in INVITE messages connecting other endpoints (see TS 23.228 [18]). Path establishment between AS and MRFC for UE-2.
4. At start of session establishment the MRFC sends an *Accounting-Request* with *Accounting-Record-Type* indicating START_RECORD to record start of a multi-party call in the MRFC CDR.
5. The CCF acknowledges the reception of the data and creates the MRFC CDR. 'Calling Party Address', 'Service Request Time Stamp', 'Service ID' (holding the conference-ID) etc. are included in the MRFC CDR
6 - 7. Path establishment between UE-2 and AS. Same ICID is used as for the path between AS and MRFC for UE-2 (step 2. - 3.).
8. Acknowledgement of path between AS and MRFC for UE-2.
9. The MRFC may send an *Accounting-Request* with *Accounting-Record-Type* indicating INTERIM_RECORD to report that UE-2 has been connected to the multi-party call.
10. The CCF acknowledges the reception of the data and includes UE-2 in the field 'Application Provided Called Parties' of the MRFC CDR.
11. Acknowledgement of path between AS and UE-2.
Now a path between UE-2 and MRFP via AS is established
12 - 13. Request and acknowledgement to establish path between AS and MRFC for UE-3.
14 - 15. Path establishment between UE-3 and AS. Same ICID is used as for the path between AS and MRFC for UE-3 (step 12. - 13.).
16. Acknowledgement of path between AS and MRFC for UE-3.
17. The MRFC may send an *Accounting-Request* with *Accounting-Record-Type* indicating INTERIM_RECORD to report that UE-3 has been connected to the multi-party call.
18. The CCF acknowledges the reception of the data and includes UE-3 in a new field 'Application Provided Called Parties' of the MRFC CDR.
19. Acknowledgement of path between AS and UE-3.
Now a path between UE-3 and MRFP via AS is established.
20 - 21. Request and acknowledgement to establish path between AS and MRFC for UE-1. Same ICID is used as for the path between UE-1 and AS (step 1.).
22 - 23. Request for multi-party conference with UE-2 and UE-3 is acknowledged to UE-1.
Implicit acknowledgement of path UE-1 to AS.
24. Acknowledgement of path between AS and MRFC for UE-1.
Now a path between UE-1 and MRFP via AS is established
25. The MRFC may send an *Accounting-Request* with *Accounting-Record-Type* indicating INTERIM_RECORD to report that UE-1 has been connected to the multi-party call.
26. The CCF acknowledges the reception of the data and includes the field 'Service Delivery Start Time Stamp' into the MRFC CDR.
27 - 28. UE-1 acknowledges the multi-party call session establishment.

NOTE: It is in the responsibility of the AS to terminate the sessions existing at the beginning of the multi-party call establishment between UE-1 and UE-2 and between UE-1 and UE-3 (see step 1.) in case of successful multi-party call establishment. This is not shown in figure 5.11.

5.1.2.1.5 AS Related Procedures

Application servers may support a multitude of services which are not specified in 3GPP standards. Therefore it is not possible to standardise charging flows and procedures for those services. However, for all such services, the AS may apply either Event Charging, where ACR [Event] messages are generated, or Session Charging, using ACR [Start, Stop and Interim]. The following subclauses depict one example for each of the two scenarios. The first procedure, AS acting as a Redirect Server, depicts the "event" case, while the second procedure, AS acting as a Voice Mail Server, depicts the "session" case.

5.1.2.1.5.1 AS Acting as a Redirect Server

Figure 5.12 shows the case where an Application Server acts as a Redirect Server. In the figure below, UE-1 sets up a session towards UE-2 but due to Call Forwarding functionality located in the AS, a new number (to UE-3) is returned to UE-1. Finally UE-1 sets up the session towards UE-3.

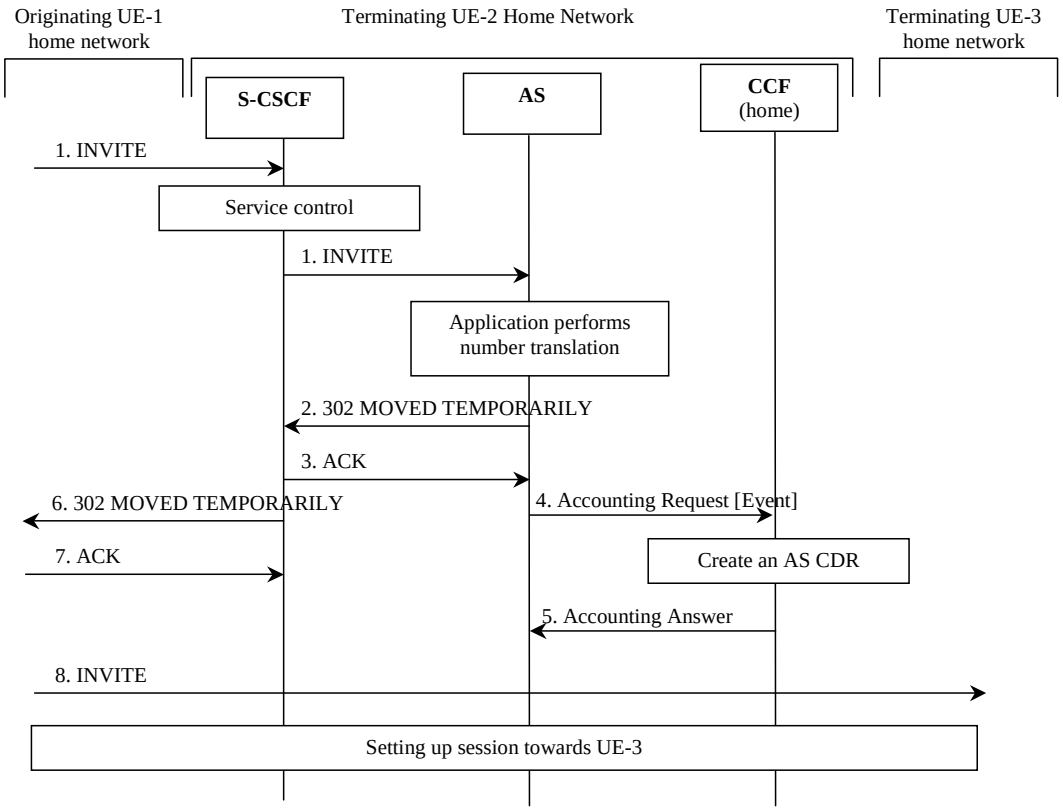

Figure 5.12: Message Sequence Chart for AS Acting as a Redirect Server

1. Sessions initiated by UE-1 towards UE-2.
2. - 3. Response indicating that session should be redirected towards another number (UE-3).
4. After successful service execution, the AS sends *Accounting-Request* with *Accounting-Record-Type* indicating EVENT_RECORD to record service specific information in the AS CDR.
5. The CCF acknowledges the reception of the data and creates the AS CDR.
6-7. Response indicating that session should be redirected towards another number (UE-3).
8. Session is initiated by UE-1 towards UE-3.

5.1.2.1.5.2 AS Acting as a Voice Mail Server

Figure 5.13 shows the case where an Application Server acts as a Voice Mail Server. S-CSCF invokes the AS acting as Voice Mail Server according to procedure as defined in TS 23.218 [5].

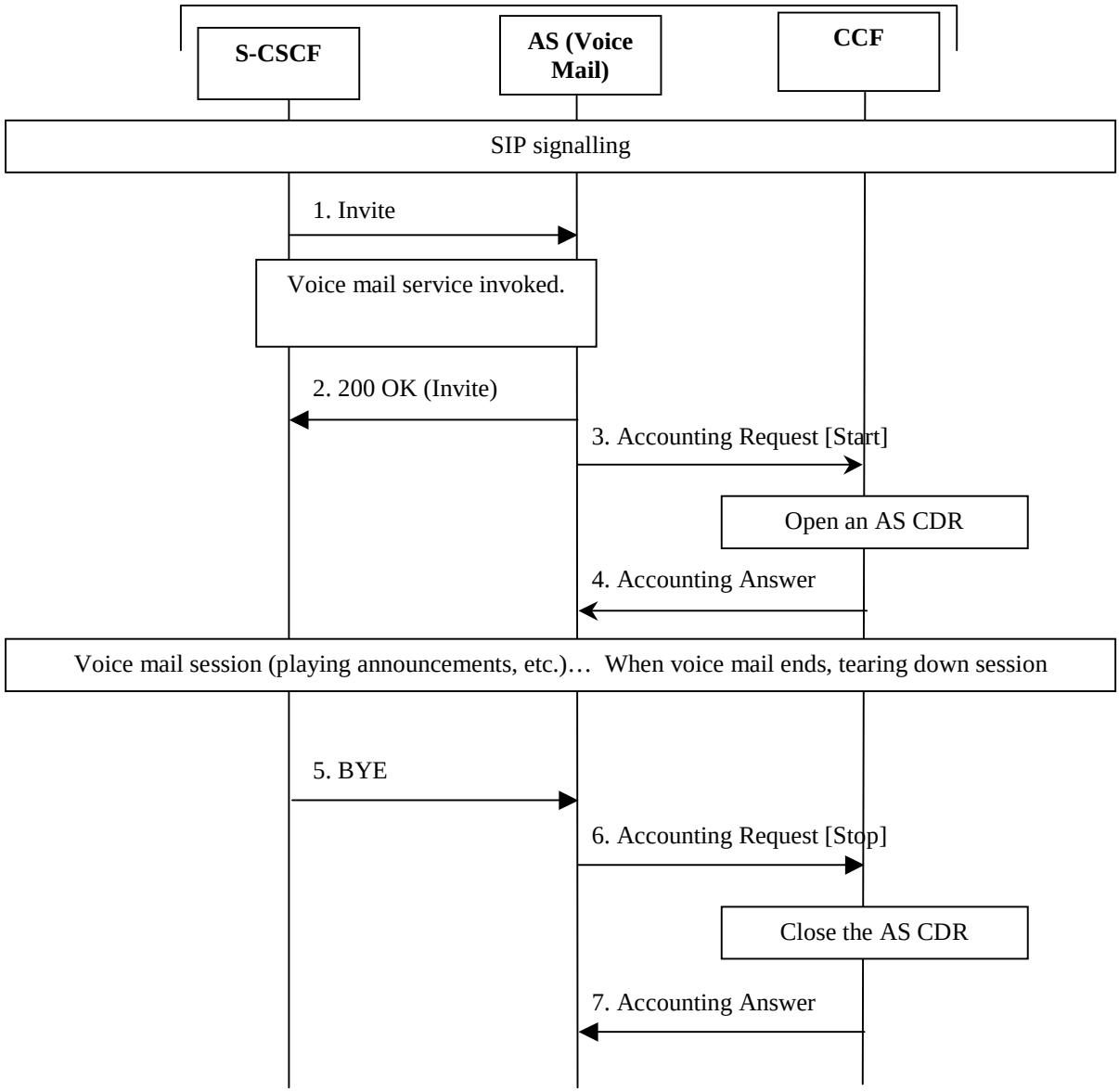

Figure 5.13: Message Sequence Chart for AS Acting as a Mail Server

1. AS receives the INVITE from the S-CSCF.
2. AS acknowledges the initiated Voice Mail session by issuing a 200 OK in response to the INVITE.
3. AS sends *Accounting-Request* with *Accounting-Record-Type* indicating START_RECORD to record start of a voice mail session.
4. The CCF acknowledges the reception of the *Accounting-Request* with *Accounting-Record-Type* indicating START_RECORD and opens a AS CDR.
5. Voice mail session release is initiated.
6. Upon reception of release message AS sends an *Accounting-Request* with *Accounting-Record-Type* indicating STOP_RECORD to record stop of a session in the AS CDR.
7. The CCF acknowledges the reception of the data and closes the AS CDR.

5.1.2.2 Message Flows - Error Cases and Scenarios

This subclause describes various error cases and how these should be handled. The error cases are grouped into the following categories:

- Failure in SIP Related Procedures:
  - Session Related Error Scenarios;
  - Session Unrelated Error Scenarios.
- Errors in Diameter (Accounting) Related Procedures.

5.1.2.2.1 Error Cases - Session Related SIP Procedures

5.1.2.2.1.1 Reception of SIP error messages

A SIP session is closed abnormally by the reception of a BYE message indicating the reason for such termination.

In this case, an ACR [Stop] message that includes an appropriate error indication is sent.

5.1.2.2.1.2 SIP session failure

All nodes involved in the SIP session are expected to exercise some kind of session supervision. In case a node detects an error in the SIP session, such as a timeout or the occurrence of an invalid SIP message that results in the inability to maintain the session, this IMS node will generate a BYE message towards both ends of the connection.

The node that sent the BYE to trigger session termination identifies the cause of the failure in the ACR [Stop] towards the CCF. All other nodes, i.e. those that receive the BYE, are not aware of an error, and therefore they treat this situation as any normal SIP session termination.

5.1.2.2.2 Error Cases - Session Unrelated SIP procedures

As described in subclause 5.1.2.1.2, a session unrelated SIP procedure may either be completed with the reception of a 200OK, or a SIP error message. If the latter occurs, i.e. there is a failure in the procedure, the ACR [Event] sent towards the CCF includes an appropriate error indication.

5.1.2.2.3 Error Cases - Diameter procedures

5.1.2.2.3.1 CCF Connection Failure

When the connection towards the primary CCF is broken, the process of sending accounting information should continue towards a secondary CCF (if such a CCF is configured). For further CCF connection failure functionality, see subclause "*Transport Failure Detection*" in [3].

If no CCF is reachable the network element may buffer the generated accounting data in non-volatile memory. Once the CCF connection is working again, all accounting messages stored in the buffer is sent to the CCF, in the order they were stored in the buffer.

5.1.2.2.3.2 No Reply from CCF

In case an IMS node does not receive an ACA in reply to an ACR, it may repeat the ACR message. The waiting time until a repetition is sent, and the maximum number of repetitions are both configurable by the operator. When the maximum number of repetitions is reached and still no ACA reply has been received, the IMS node executes the CCF connection failure procedure as specified above.

If retransmitted ACRs are sent, they are marked with the T-flag as described in [3] , in order to allow duplicate detection in the CCF, as specified in the next subclause.

5.1.2.2.3.3 Duplicate Detection

A Diameter client marks possible duplicate request messages (e.g. retransmission due to the link failover process) with the T-flag as described in [3].

If the CCF receives a message that is marked as retransmitted and this message was already received, then it discards the duplicate message. However, if the original of the re-transmitted message was not yet received, it is the information in the marked message that is taken into account when generating the CDR. The CDRs are marked if information from duplicated message(s) is used.

5.1.2.2.3.4 CCF Detected Failure

The CCF closes a CDR when it detects that expected Diameter ACRs for a particular SIP session have not been received for a period of time. The exact behaviour of the CCF is operator configurable.

5.1.3 Message Formats

5.1.3.1 Summary of Offline Charging Message Formats

The IMS nodes generate accounting information that can be transferred from the nodes to the CCF. For this purpose, the IMS Charging application employs the *Accounting-Request* and *Accounting-Answer* messages from the base Diameter protocol.

Table 5.3 describes the use of these messages for offline charging.

Table 5.3: Offline Charging Messages Reference Table

Command-Name	Source	Destination	Abbreviation
Accounting-Request	S-CSCF, I-CSCF, P-CSCF, MRFC, MGCF, BGCF, AS	CCF	ACR
Accounting-Answer	CCF	S-CSCF, I-CSCF, P-CSCF, MRFC, MGCF, BGCF, AS	ACA

5.1.3.2 Structure for the Accounting Message Formats

The following is the basic structure shared by all offline charging messages. This is based directly on the format of the *Accounting-Request* and *Accounting-Answer* messages defined in the base Diameter protocol specification [3]. Detailed description of the AVPs and their use for offline and online charging are provided in clause 7.

Those Diameter AVPs that are used for offline charging are marked "Yes" in tables 5.4 to 5.7. Those Diameter AVPs that are not used for offline charging are marked "No" in tables 5.4 to 5.7. This implies that their content can (Yes) or can not (No) be used by the CCF to construct CDRs.

The following symbols (adopted from [3]) are used in the tables:

- <AVP> indicates a mandatory AVP with a fixed position in the message.
- {AVP} indicates a mandatory AVP in the message.
- [AVP] indicates an optional AVP in the message.
- *AVP indicates that multiple occurrences of an AVP are possible.

5.1.3.2.1 Accounting-Request Message

Table 5.4 illustrates the basic structure of a Diameter *Accounting-Request* message as used for offline charging. The use of the AVPs is specified in subclause 5.1.3.3 per IMS node and ACR type.

Table 5.4: Accounting-Request (ACR) Message Contents for Offline Charging

Diameter base protocol AVPs	
AVP	**Used in offline ACR**
<Diameter-Header:271,REQ,PXY>	Yes
<Session-Id> -- Diameter Session Id	Yes
{Origin-Host}	Yes
{Origin-Realm}	Yes
{Destination-Realm}	Yes
{Accounting-Record-Type}	Yes
{Accounting-Record-Number}	Yes
[Acct-Application-Id]	No
[Vendor-Specific-Application-Id]	Yes
[User-Name]	Yes
[Accounting-Sub-Session-Id]	No
[Accounting-RADIUS-Session-Id]	No
[Acct-Multi-Session-Id]	No
[Acct-Interim-Interval]	Yes
[Accounting-Realtime-Required]	No
[Origin-State-Id]	Yes
[Event-Timestamp]	Yes
*[Proxy-Info]	No
*[Route-Record]	No
*[AVP]	No
Diameter Credit Control AVP	
[Subscription-Id]	No
[Requested-Action]	No
*[Requested-Service-Unit]	No
*[Used-Service-Unit]	No
*[Service-Parameter-Info]	No
[Abnormal-Termination-Reason]	No
*[Accounting-Correlation-Id]	No
[Credit-Control-Failure-Handling]	No
[Direct-Debiting-Failure-Handling]	No
3GPP Diameter accounting AVPs	
[Event-Type]	Yes
[Role-of-node]	Yes
[User-Session-ID]	Yes
[Calling-Party-Address]	Yes
[Called-Party-Address]	Yes
[Time-stamps]	Yes
*[Application-Server]	Only for S-CSCF
*[Application-provided-Called-Party-Address]	Only for S-CSCF
*[Inter-Operator-Identifier]	Yes
[IMS-Charging-Identifier]	Yes
*[SDP-Session-Description]	Yes
*[SDP-Media-Component]	Yes
[GGSN-Address]	Yes
[Served-Party-IP-Address]	Only for P-CSCF
[Authorised-QoS]	Only for P-CSCF
[Server-Capabilities]	Only for I-CSCF
[Trunk-Group-ID]	Only for MGCF
[Bearer-Service]	Only for MGCF
[Service-ID]	Only for MRFC
[UUS-Data]	Yes
[Cause]	Yes

NOTE: For AVP of type "Grouped" only the group AVP is listed in table 5.4. Detailed descriptions of the AVPs is provided in clause 7.

5.1.3.2.2 Accounting-Answer Message

Table 5.5 illustrates the basic structure of a Diameter *Accounting-Answer* message as used for IMS charging. This message is always used by the CCF as specified below, regardless of the IMS node it is received from and the ACR record type that is being replied to.

Table 5.5: Accounting-Answer (ACA) Message Contents for Offline Charging

Diameter base protocol AVPs	
AVP	**Used in Offline ACA**
<Diameter-Header:271,PXY>	Yes
<Session-Id>	Yes
{Result-Code}	Yes
{Origin-Host}	Yes
{Origin-Realm}	Yes
{Accounting-Record-Type}	Yes
{Accounting-Record-Number}	Yes
[Acct-Application-Id]	No
[Vendor-Specific-Application-Id]	Yes
[User-Name]	Yes
[Accounting-Sub-Session-Id]	No
[Accounting-RADIUS-Session-Id]	No
[Acct-Multi-Session-Id]	No
[Error-Reporting-Host]	No
[Acct-Interim-Interval]	Yes
[Accounting-Realtime-Required]	No
[Origin-State-Id]	Yes
[Event-Timestamp]	Yes
*[Proxy-Info]	No
*[AVP]	No

5.1.3.3 Detailed Message Formats

Following the base protocol specification, the following "types" of accounting data may be sent:

- Start session accounting data.
- Interim session accounting data.
- Stop session accounting data.
- Event accounting data.

ACR types Start, Interim and Stop are used for accounting data related to successful SIP sessions. In contrast, Event accounting data is unrelated accounting data, such as a simple registration or interrogation and successful service event triggered by an AS. In addition, Event accounting data are also used for unsuccessful SIP session establishment attempts.

The following table specifies per ACR type the accounting data that are sent by each of the IMS network elements:

- S-CSCF
- P-CSCF
- I-CSCF
- MRFC
- MGCF
- BGCF
- AS

The ACR types in the table are listed in the following order: S (start)/I (interim)/S (stop)/E (event). Therefore, when all ACR types are possible it is marked as SISE. If only some ACR types are allowed for a node, only the appropriate letters are used (i.e. SIS or E) as indicated in the table heading. The omission of an ACR type for a particular AVP is marked with "-" (i.e. SI-E). Also, when an entire AVP is not allowed in a node the entire cell is marked as "-".

Note that not for all Grouped AVPs the individual AVP members are listed in the table. See clause 7 for a detailed list of the AVP group members and for the description of the AVPs.

For the ACA the same details listed in table 5.8 applies with the addition that *Error-Reporting-Host* AVP is supported in all ACAs in a similar manner as most other base protocol AVPs (e.g. in the same manner as *Origin-State-Id* AVP).

Table 5.8: Detailed Diameter ACR Message Contents for Offline Charging

AVP name	Node Type	S-CSCF	P-CSCF	I-CSCF	MRFC	MGCF	BGCF	AS
	Supported ACRs	S/I/S/E	S/I/S/E	E	S/I/S	S/I/S/E	S/I/S/E	S/I/S/E
AVPs from the Diameter base protocol								
<Session-Id>		SISE	SISE	E	SIS	SISE	SISE	SISE
{Origin-Host}		SISE	SISE	E	SIS	SISE	SISE	SISE
{Origin-Realm}		SISE	SISE	E	SIS	SISE	SISE	SISE
{Destination-Realm}		SISE	SISE	E	SIS	SISE	SISE	SISE
{Accounting-Record-Type}		SISE	SISE	E	SIS	SISE	SISE	SISE
{Accounting-Record-Number}		SISE	SISE	E	SIS	SISE	SISE	SISE
[Vendor-Specific-Application-Id]		SISE	SISE	E	SIS	SISE	SISE	SISE
[Acct-Application-Id]		-	-	-	-	-	-	-
[User-Name] (see note 1)		SISE	SISE	E	SIS	SISE	SISE	SISE
[Accounting-Sub-Session-Id]		-	-	-	-	-	-	-
[Accounting-RADIUS-Session-Id]		-	-	-	-	-	-	-
[Acct-Multi-Session-Id]		-	-	-	-	-	-	-
[Acct-Interim-Interval]		SIS-	SIS-	-	SIS-	SIS-	SIS-	SIS-
[Accounting-Realtime-Required]		-	-	-	-	-	-	-
[Origin-State-Id]		SISE	SISE	E	SIS	SISE	SISE	SISE
[Event-Timestamp]		SISE	SISE	E	SIS	SISE	SISE	SISE
*[Proxy-Info]		-	-	-	-	-	-	-
*[Route-Record]		-	-	-	-	-	-	-
*[AVP]		-	-	-	-	-	-	-
Diameter Credit Control AVP								
[Subscription-Id]		-	-	-	-	-	-	-
[Requested-Action]		-	-	-	-	-	-	-
*[Requested-Service-Unit]		-	-	-	-	-	-	-
*[Used-Service-Unit]		-	-	-	-	-	-	-
*[Service-Parameter-Info]		-	-	-	-	-	-	-
[Abnormal-Termination-Reason]		-	-	-	-	-	-	-
*[Accounting-Correlation-Id]		-	-	-	-	-	-	-
[Credit-Control-Failure-Handling]		-	-	-	-	-	-	-
[Direct-Debiting-Failure-Handling]		-	-	-	-	-	-	-
3GPP Diameter accounting AVPs								
[Event-Type]		SISE	SISE	E	SIS	SISE	SISE	SISE
[Role-of-Node]		SISE	SISE	E	SIS	SISE	SISE	SISE
[User-Session-Id]		SISE	SISE	E	SIS	SISE	SISE	SISE
[Calling-Party-Address]		SISE	SISE	E	SIS	SISE	SISE	SISE
[Called-Party-Address]		SISE	SISE	E	SIS	SISE	SISE	SISE
[Time-stamps]		SISE	SISE	E	SIS	SISE	SISE	SISE
*[Application-server] (see note 1)		SISE	-	-	-	-	-	-
*[Application-Provided-Called-Party-Address] (see note 1)		SISE	-	-	-	-	-	-
[Inter-Operator-Identifiers] (see note 1)		SISE	SISE	E	SIS	SISE	SISE	SISE
[IMS-Charging-Identifier]		SISE	SISE	E	SIS	SISE	SISE	SISE
*[SDP-Session-Description]		SI-E	SI-E	-	SI-	SI-E	SI-E	SI-E
*[SDP-Media-component]		SI-E	SI-E		SI-	SI-E	SI-E	SI-E
[GGSN-Address]		SI-E	SI-E		SI-	SI-E	SI-E	SI-E
[Served-Party-IP-Address] (see note 1)		-	SISE	-	-	-	-	-
[Authorized-QoS] (see note 1)		-	SISE	-	-	-	-	-
[Server-Capabilities]		-	-	E	-	-	-	-
[Trunk-Group-ID]		-	-	-	-	SISE	-	-
[Bearer-Service]		-	-	-	-	SISE	-	-
[Service-Id]		-	-	-	SIS	-	-	-
[UUS-Data] (see note 2)		SISE	SISE					SISE
[Cause]		--SE	--SE	E	--S	--SE	--SE	--SE
NOTE 1: Only present if available in the IMS node. NOTE 2: Present only if user-to-user data is included in the SIP message that triggered the ACR.								

5.2 CDR Description on the Bi Interface

5.2.1 CDR Field Types

The following Standard CDR content and format are considered:

S-CSCF-CDR generated based on information from the S-CSCF.

I-CSCF-CDR generated based on information from the I-CSCF.

P-CSCF-CDR generated based on information from the P-CSCF.

BGCF-CDR generated based on information from the BGCF.

MGCF-CDR generated based on information from the MGCF.

MRFC-CDR generated based on information from the MRFC.

AS-CDR generated based on information from the AS.

The content of each CDR type is defined in Table 5.9 . For each CDR type the field definition includes the field name and category. The field descriptions are provided in clause 5.2.4.

Equipment vendors shall be able to provide all of the fields listed in the CDR content table in order to claim compliance with the present document. However, since CDR processing and transport consume network resources, operators may opt to eliminate some of the fields that are not essential for their operation. This operator provisionable reduction is specified by the field category.

A field category can have one of two primary values:

M This field is **M**andatory and shall always be present in the CDR.

C This field shall be present in the CDR only when certain **C**onditions are met. These Conditions are specified as part of the field definition.

Some of these fields are designated as Operator provisionable. Using TMN management functions or specific tools provided by an equipment vendor, operators may choose if they wish to include or omit the field from the CDR. Once omitted, this field is not generated in a CDR. To avoid any potential ambiguity, a CDR generating element MUST be able to provide all these fields. Only an operator can choose whether or not these fields should be generated in their system.

Those fields that the operator may configure to be present or absent are further qualified with the "Operator provisionable" subscript as follows:

M_o This is a field that, if provisioned by the operator to be present, shall always be included in the CDRs. In other words, an M_o parameter that is provisioned to be present is a mandatory parameter.

C_o This is a field that, if provisioned by the operator to be present, shall be included in the CDRs when the required conditions are met. In other words, a C_o parameter that is configured to be present is a conditional parameter.

The CCF provides the CDRs at the Bi interface in the format and encoding described in the present document. Additional CDR formats and contents may be available at the interface to the billing system to meet the requirements of the billing system, these are outside of the scope of 3GPP standardisation.

5.2.2 CDR Triggers

5.2.2.1 Session Related CDRs

Reflecting the usage of multimedia sessions IMS CDRs are generated by the CCF on a per session level. In the scope of the present document the term "session" refers always to a SIP session. The coherent media components are reflected inside the session CDRs with a media component container comprising of all the information necessary for the description of a media component.

Accounting information for SIP sessions is transferred from the IMS nodes involved in the session to the CCF using Diameter ACR Start, Interim and Stop messages. A session CDR is opened in the CCF upon reception of a Diameter ACR [Start] message. Partial CDRs may be generated upon reception of a Diameter ACR [Interim] message which is sent by the network entity towards the CCF due to a session modification procedure (i.e. change in media). Session CDRs are updated, or partial CDRs are generated upon reception of a diameter ACR [Interim] message which is sent by the network entity due to expiration of the Accounting-Interim-Interval AVP. The CCF closes the final session CDR upon reception of a Diameter ACR [Stop] message, which indicates that the SIP session is terminated. Further details on triggers for the generation of IMS CDRs are specified in [2].

Accounting information for unsuccessful session set-up attempts may be sent by the IMS node to the CCF employing the Diameter ACR [Event] message. The behaviour of the CCF upon receiving ACR [Event] messages is specified in subclause 5.2.2.2.

5.2.2.2 Session Unrelated CDRs

To reflect chargeable events not directly related to a session the CCF may generate CDRs upon the occurrence of session unrelated SIP procedures, such as registration respectively de-registration events. Accounting information for SIP session-unrelated procedures is transferred from the IMS nodes involved in the procedure to the CCF using Diameter ACR [Event] messages. Session unrelated CDRs are created in the CCF in a "one-off" action based on the information contained in the Diameter ACR [Event] message. One session unrelated CDR is created in the CCF for each Diameter ACR [Event] message received, whereas the creation of partial CDRs is not applicable for session unrelated CDRs. The cases for which the IMS nodes send ACR [Event] messages are listed per SIP procedure in tables 5.1 and 5.2.

Further details on triggers for the generation of IMS CDRs are specified in [2].

5.2.3 CDR Content

Table 5.9 specifies the content of each CDR type. For each column describing the CDR type, the field name and its category are specified. The detailed description of the field is provided in section 5.2.1. Diagonal shading of a cell indicates, that the particular CDR field is not included in the particular CDR type.

Table 5.9: Charging Data of IMS CDR Types

Field	CDR Type						
	S-CSCF-CDR	P-CSCF-CDR	I-CSCF-CDR	MRFC-CDR	MGCF-CDR	BGCF-CDR	AS-CDR
Record Type	M	M	M	M	M	M	M
Retransmission	C_O	C_O	C_O	C_O	C_O	C_O	C_O
SIP Method	C_O	C_O	C_O	C_O	C_O	C_O	C_O
Role of Node	M_O	M_O	M_O	M_O	M_O	M_O	M_O
Node Address	M_O	M_O	M_O	M_O	M_O	M_O	M_O
Session ID	M_O	M_O	M_O	M_O	M_O	M_O	M_O
Service ID				M_O			
Calling Party Address	M_O	M_O	M_O	M_O	M_O	M_O	M_O
Called Party Address	M_O	M_O	M_O	C_O	M_O	M_O	M_O
Private User ID	M_O						
Served Party IP Address		M_O					
Service Request Time Stamp	M_O	M_O	M_O	M_O	M_O	M_O	M_O
Service Delivery Start Time Stamp	M_O	M_O		M_O	M_O	M_O	M_O
Service Delivery End Time Stamp	C_O	C_O		C_O	C_O	C_O	C_O
Record Opening Time	C_O	C_O		C_O	C_O	C_O	C_O
Record Closure Time	M_O	M_O		M_O	M_O	M_O	M_O
Application Servers Information	C_O			C_O			
Application Servers Involved	C_O			C_O			
Application Provided Called Parties	C_O			C_O			
Inter Operator Identifiers	C_O	C_O	C_O	C_O	C_O	C_O	C_O
originating IOI	C_O	C_O	C_O	C_O	C_O	C_O	C_O
terminating IOI	C_O	C_O	C_O	C_O	C_O	C_O	C_O
Local Record Sequence Number	M_O	M_O	M_O	M_O	M_O	M_O	M_O
Record Sequence Number	C_O	C_O		C_O	C_O	C_O	C_O
Cause For Record Closing	M_O	M_O	M_O	M_O	M_O	M_O	M_O
Incomplete CDR Indication	C_O	C_O	C_O	C_O	C_O	C_O	C_O
S-CSCF Information			C_O				
IMS Charging Identifier	M_O	M_O	M_O	M_O	M_O	M_O	M_O
SDP Session Description	Co	Co		Co	Co	Co	Co
List of SDP Media Components	C_O	C_O		C_O	C_O	C_O	C_O
SIP Request Timestamp	M_O	M_O		M_O	M_O	M_O	M_O
SIP Response Timestamp	M_O	M_O		M_O	M_O	M_O	M_O
SDP Media Components	M_O	M_O		M_O	M_O	M_O	M_O
SDP Media Name	M_O	M_O		M_O	M_O	M_O	M_O
SDP Media Description	M_O	M_O		M_O	M_O	M_O	M_O
GPRS Charging ID	M_O	M_O		M_O	M_O	M_O	M_O
Media Initiator Flag	C_O	C_O		C_O	C_O	C_O	C_O
Authorised QoS		C_O					
GGSN Address	C_O	C_O	C_O	C_O	C_O	C_O	C_O
Service Delivery Failure Reason	C_O	C_O	C_O	C_O	C_O	C_O	C_O
Service Specific Data							C_O
List of Message Bodies	C_O	C_O					C_O
Content-Type	C_O	C_O					C_O
Content-Disposition	C_O	C_O					C_O
Content-Length	C_O	C_O					C_O
Originator	C_O	C_O					C_O
Trunk Group ID Incoming/Outgoing					M_O		
Bearer Service					M_O		
Record Extensions	C_O	C_O	C_O	C_O	C_O	C_O	C_O

5.2.4 CDR Parameter Description

This clause contains a brief description of each field of the CDRs described in Table 5.9. The fields are listed in alphabetical order according to the field name as specified in the table above.

5.2.4.1 Application Provided Called Parties

Holds a list of the Called Party Address(es), if the address(es) are determined by an AS (SIP URL, E.164…).

5.2.4.2 Application Servers Information

This a grouped CDR field containing the fields: 'Application Server Involved' and 'Application Provided Called Parties'.

5.2.4.3 Application Servers Involved

Holds the ASs (if any) identified by the SIP URLs.

5.2.4.4 Authorised QoS

Authorised QoS as defined in TS 23.207 [7] / TS 29.207 [8] and applied via the Go interface.

5.2.4.5 Bearer Service

Holds the used bearer service for the PSTN leg.

5.2.4.6 Called Party Address

In the context of an end-to-end SIP transaction this field holds the address of the party (Public User ID) to whom the SIP transaction is posted.

For a subscription/registration procedure this field holds the party to be registered/subscribed.

This field contains either a SIP URL (according to IETF RFC3261 [16]) or a TEL URL (according to RFC2806 [20]).

5.2.4.7 Calling Party Address

The address (Public User ID) of the party requesting a service or initiating a session. This field holds either the SIP URL (according to IETF RFC 3261 [16]) or the TEL URL (according to RFC 2806 [20]) of the calling party.

5.2.4.8 Cause for Record Closing

This field contains a reason for the release of the CDR including the following:

- normal release: end of session;
- partial record generation: time (duration) limit, maximum number of changes in charging conditions (e.g. maximum number in 'List of Message Bodies' exceeded) or service change (e.g. change in media components);
- abnormal termination;
- management intervention (request due to O&M reasons).
- CCF initiated record closure;

A more detailed reason may be found in the Service Delivery Failure Reason field.

5.2.4.9 Content Disposition

This sub-field of Message Bodies holds the content disposition of the message body inside the SIP signalling, Content-disposition header field equal to 'render', indicates that 'the body part should be displayed or otherwise rendered to the user'. Content disposition values are: session, render, inline, icon, alert, attachment, etc.

5.2.4.10 Content Length

This sub-field of Message Bodies holds the size of the data of a message body in bytes.

5.2.4.11 Content Type

This sub-field of Message Bodies holds the MIME type of the message body, Examples are: application/zip, image/gif, audio/mpeg, etc.

5.2.4.12 GGSN Address

This parameter holds the control plane IP address of the GGSN that handles one or more media component(s) of a IMS session. If GPRS is used to access the IMS, the GGSN address is used together with the GPRS charging ID as the access part of the charging correlation vector. The charging correlation vector is comprised of an access part and an IMS part, which is the IMS Charging Identifier. For further information regarding the composition of the charging correlation vector refer to the appropriate clause in TS 32.200 [2].

5.2.4.13 GPRS Charging ID

This parameter holds the GPRS charging ID (GCID) which is generated by the GGSN for a GPRS PDP context. There is a 1:1 relationship between the GCID and the PDP context. If GPRS is used to access the IMS, the GCID is used together with the GGSN address as the access part of the charging correlation vector that is comprised of an access part and an IMS part, which is the IMS Charging Identifier.

For further information regarding the composition of the charging correlation vector refer to the appropriate clause in TS 32.200 [2].

5.2.4.14 IMS Charging Identifier

This parameter holds the IMS charging identifier (ICID) as generated by the IMS node for the SIP session. The value of the ICID parameter is identical with the 'icid-value' parameter defined in [15]. The 'icid-value' is a mandatory part of the P-Charging-Vector and coded as a text-based UTF-8 charset (as are all SIP messages). For further information regarding the composition and usage of the P-Charging-Vector refer to TS 32.200 [2], TS 24.229 [14] and [15].

The ICID value is globally unique across all 3GPP IMS networks for a time period of at least one month, implying that neither the node that generated this ICID nor any other IMS node reuse this value before the uniqueness period expires. The one month minimum uniqueness period counts from the time of release of the ICID, i.e. the ICID value no longer being used. This can be achieved by using node specific information, e.g. high-granularity time information and / or topology / location information. The exact method how to achieve the uniqueness requirement is an implementation issue.

An ICID is generated by the P-CSCF during the initial IMS registration procedure for a Private User ID. At each SIP session unrelated method (e.g., REGISTER, NOTIFY, MESSAGE etc.), a new, session unrelated specific ICID is generated at the first IMS network element that processes the method.

At each SIP session establishment a new, session specific ICID is generated at the first IMS network element that processes the session-initiating SIP INVITE message. This ICID is then used in all subsequent SIP messages for that session (e.g., 200 OK, (re-)INVITE, BYE etc.) until the session is terminated.

5.2.4.15 Incomplete CDR Indication

This field provides additional diagnostics when the CCF detects missing ACRs.

5.2.4.16 Inter Operator Identifiers

Holds the identification of the home network (originating and terminating) if exchanged via SIP signalling, as recorded in the *Inter-Operator-Identifier* AVP. For further information on the IOI please refer to TS 24.229 [14].

5.2.4.17 List of Message Bodies

This grouped field comprising several sub-fields describing the data that may be conveyed end-to-end in the body of a SIP message. Since several message bodies may be exchanged via SIP-signalling, this grouped field may occur several times.

The List of Message Bodies contains the following elements:

- Content Type
- Content Disposition
- Content Length
- Originator

They are described in the appropriate subclause. Message bodies with the "Content-Type" field set to *application/sdp* and the "Content-Disposition" field set to *session* are not included in the "Message Bodies" field.

5.2.4.18 List of SDP Media Components

This is a grouped field comprising several sub-fields associated with one media component. It may occur several times in one CDR. The field is present only in a SIP session related case.

The List of SDP Media Components contains following elements:

- SIP Request Timestamp
- SIP Response Timestamp
- SDP Media Components
- Media Initiator flag

These field elements are described in the appropriate subclause.

5.2.4.19 Local Record Sequence Number

This field includes a unique record number created by this node. The number is allocated sequentially for each partial CDR (or whole CDR) including all CDR types. The number is unique within the CCF.

The field can be used e.g. to identify missing records in post processing system.

5.2.4.20 Media Initiator Flag

This field indicates if the called party has requested the session modification and it is present only if the initiator was the called party.

5.2.4.21 Node Address

This item holds the address of the node providing the information for the CDR. This may either be the IP address or the FQDN of the IMS node generating the accounting data. This parameter corresponds to the O*rigin-Host* AVP.

5.2.4.22 Originator

This sub-field of the "List of Message Bodies" indicates the originating party of the message body.

5.2.4.23 Private User ID

Holds the used Network Access Identifier of the served party according to RFC2486 [6]. This parameter corresponds to the *User-Name* AVP.

5.2.4.24 Record Closure Time

A Time stamp reflecting the time the CCF closed the record.

5.2.4.25 Record Extensions

A set of operator/manufacturer specific extensions to the record, conditioned upon existence of an extension.

5.2.4.26 Record Opening Time

A time stamp reflecting the time the CCF opened this record. Present only in SIP session related case.

5.2.4.27 Record Sequence Number

This field contains a running sequence number employed to link the partial records generated by the CCF for a particular session (characterised with the same Charging ID and GGSN address pair). The Record Sequence Number is not present if the record is the only one produced in the CCF for a session. The Record Sequence Number starts from one (1).

5.2.4.28 Record Type

Identifies the type of record. The parameter is derived from the *Origin-Host* AVP.

5.2.4.29 Retransmission

This parameter, when present, indicates that information from retransmitted Diameter ACRs has been used in this CDR.

5.2.4.30 Role of Node

This fields indicates the role of the AS/CSCF. As specified in TS 23.218 [5] the role can be:

- originating (CSCF serving the calling subscriber or AS initiated session)
- terminating (CSCF serving the called subscriber or AS terminated session)
- proxy (only applicable for an AS, when a request is proxied)
- B2BUA (only applicable for an AS, when the AS performs third party control/acts in B2BUA mode.

5.2.4.31 SDP Media Components

This is a grouped field comprising several sub-fields associated with one media component. Since several media components may exist for a session in parallel these sub-fields may occur several times (as much times as media are involved in the session).

The x-CSCF, BGCF, MGCF shall retrieve the value for this parameter from the SDP payload of SIP INVITE messages, if present. The x-CSCF, BGCF, MGCF shall then include this information in the ACR that is triggered when receiving the 200 OK responding to the SIP INVITE. This includes both the case of initial session set-up and SDP changes during the session.

The SDP media component contains the following elements:

- SDP media name
- SDP media description
- GPRS Charging ID

These field elements are described in the appropriate subclause.

5.2.4.32 SDP Media Description:

This field holds the attributes of the media as available in the SDP data tagged with 'i=', 'c=','b=','k=', 'a='. Only the attribute lines relevant for charging are recorded. To be recorded 'SDP lines' shall be recorded in separate 'SDP Media Description' fields, thus multiple occurrence of this field is possible. Always complete 'SDP lines' are recorded per field.

This field corresponds to the *SDP-Media-Description* AVP as defined in Table 5.8.

Example: 'c=IN IP4 134.134.157.81'

For further information on SDP please refer to IETF draft 'SDP.Session Description Protocol' [17].

Note: session unrelated procedures typically do not contain SDP data.

5.2.4.33 SDP Media Name

This field holds the name of the media as available in the SDP data tagged with 'm='. Always the complete 'SDP line' is recorded.

This field corresponds to the *SDP-Media-Name* AVP as defined in Table 5.8.

Example: 'm=video 51372 RTP/AVP 31'

For further information on SDP please refer to IETF draft 'SDP: Session Description Protocol' [17].

5.2.4.34 SDP Session Description

Holds the Session portion of the SDP data exchanged between the User Agents in the SIP transaction.

The x-CSCF, BGCF, MGCF shall retrieve the value for this parameter from the SDP payload of SIP INVITE messages, if present. The x-CSCF, BGCF, MGCF shall then include this information in the ACR that is triggered when receiving the 200 OK responding to the SIP INVITE. This includes both the case of initial session set-up and SDP changes during the session.

This field holds the attributes of the media as available in the session related part of the SDP data tagged with "c=" and "a=" (multiple occurrence possible). Only attribute lines relevant for charging are recorded.

The content of this field corresponds to the SDP-Session-Description AVP of the ACR message.

NOTE: Session unrelated procedures typically do not contain SDP data.

5.2.4.35 Service Delivery End Time Stamp

This field records the time at which the service delivery was terminated. It is Present only in SIP session related case.

The content of this field corresponds to the *SIP-Request-Timestamp* AVP of a received ACR[Stop] message indicating a session termination.

5.2.4.36 Service Delivery Failure Reason

Holds the reason for why a requested service could not be successfully provided (i.e. SIP error codes taken from *SIP-Method* AVP). This field is not present in case of a successful service delivery.

5.2.4.37 Service Delivery Start Time Stamp

This field holds the time stamp reflecting either:

- a successful session set-up: this field holds the start time of a service delivery (session related service)
- a delivery of a session unrelated service: the service delivery time stamp
- an unsuccessful session set-up and an unsuccessful session unrelated request: this field holds the time the network entity forwards the unsuccessful indication (SIP 'RESPONSE' with error codes 3xx, 4xx, 5xx) towards the requesting User direction.

The content of this field corresponds to the *SIP-Response-Timestamp* AVP as defined in Table 5.8.

For partial CDRs this field remains unchanged.

5.2.4.38 Service ID

This field identifies the service the MRFC is hosting. For conferences the conference ID is used here.

5.2.4.39 Service Request Timestamp

This field contains the time stamp which indicates the time at which the service was requested ('SIP request' message) and is present for session related and session unrelated procedures. The content of this item is derived from the *SIP-Request-Timestamp* AVP as defined in Table 5.8. If the *SIP-Request-Timestamp* AVP is not supplied by the network entity this field is not present.

For partial CDRs this field remains unchanged.

This field is present for unsuccessful service requests if the ACR message includes the *SIP-Request-Timestamp* AVP.

5.2.4.40 Service Specific Data

This field contains service specific data.

5.2.4.41 Session ID

The Session identification. For a SIP session the Session-ID contains the SIP Call ID as defined in the Session Initiation Protocol RFC [16].

5.2.4.42 Served Party IP Address

This field contains the IP address of either the calling or called party, depending on whether the P-CSCF is in touch with the calling or called network.

5.2.4.43 SIP Method

Specifies the SIP-method for which the CDR is generated. Only available in session unrelated cases.

5.2.4.44 SIP Request Timestamp

This parameter contains the time of the SIP Request (usually a (Re)Invite).

5.2.4.45 SIP Response Timestamp

This parameter contains the time of the response to the SIP Request (usually a 200 OK).

5.2.4.46 S-CSCF Information

This field contains Information related to the serving CSCF, e.g. the S-CSCF capabilities upon registration event or the S-CSCF address upon the session establishment event. This field is derived from the *Server-Capabilities* AVP if present in the ACR received from the I-CSCF.

5.2.4.47 Trunk Group ID Incoming/Outgoing

Contains the outgoing trunk group ID for an outgoing session/call or the incoming trunk group ID for an incoming session/call.

5.2.5 Bi interface Conventions

The present document gives several recommendations for the main protocol layers for the Bi interface protocol stack. These recommendations are not strictly specified features, since there are a lot of variations among the existing Billing Systems.

As a minimum, all implementations shall support a file based bulk interface for the transfer of CDRs from the CCF to the BS. The recommendation is FTP over TCP/IP.

5.2.6 Abstract Syntax Description

```
TS32225-DataTypes {42} -- to be allocated, value '42' is used to allow compilation of the code

DEFINITIONS IMPLICIT TAGS ::=

BEGIN

-- Exports everything

IMPORTS

TimeStamp
FROM TS32205-DataTypes {itu-t (0) identified-organization (4) etsi(0) mobileDomain (0)
umts-Operation-Maintenance (3) ts-32-205 (205) informationModel (0) asn1Module (2) version1 (1)}

IMSRecord ::= SET
{
        -- Fields used by several multimedia Record types ("Common fields"):
        -- (which field is used in which record type is defined in section 5.2.3)
        recordType                      [0] CallEventRecordType,
        retransmission                  [1] NULL OPTIONAL,
        sIP-Method                      [2] SIP-Method OPTIONAL,
        role-of-Node                    [3] Role-of-Node OPTIONAL,
        nodeAddress                     [4] NodeAddress OPTIONAL,
        session-Id                      [5] Session-Id OPTIONAL,
        calling-Party-Address           [6] InvolvedParty OPTIONAL,
        called-Party-Address            [7] InvolvedParty OPTIONAL,
        privateUserID                   [8] GraphicString OPTIONAL,
        serviceRequestTimeStamp         [9] TimeStamp OPTIONAL,
        serviceDeliveryStartTimeStamp   [10] TimeStamp OPTIONAL,
        serviceDeliveryEndTimeStamp     [11] TimeStamp OPTIONAL,
        recordOpeningTime               [12] TimeStamp OPTIONAL,
        recordClosureTime               [13] TimeStamp OPTIONAL,
        interOperatorIdentifiers        [14] InterOperatorIdentifiers OPTIONAL,
        localRecordSequenceNumber       [15] LocalRecordSequenceNumber OPTIONAL,
        recordSequenceNumber            [16] INTEGER OPTIONAL,
        causeForRecordClosing           [17] CauseForRecordClosing OPTIONAL,
        incomplete-CDR-Indication       [18] Incomplete-CDR-Indication OPTIONAL
        iMS-Charging-Identifier         [19] IMS-Charging-Identifier OPTIONAL,
        sDP-Session-Description         [20] SEQUENCE OF Graphic STRING OPTIONAL,
        list-Of-SDP-Media-Components    [21] SEQUENCE OF Media-Components-List OPTIONAL,
        gGSNaddress                     [22] NodeAddress OPTIONAL,
        serviceDeliveryFailureReason    [23] ServiceDeliveryFailureReason OPTIONAL,
        list-Of-Message-Bodies          [24] SEQUENCE OF MessageBody OPTIONAL,
        recordExtensions                [25] RecordExtensions OPTIONAL,
        -- Space left for further "common fields"

        -- Fields particular used in the S-CSCF-recordType:
        applicationServersInformation   [40] SEQUENCE OF ApplicationServersInformation OPTIONAL,


        -- Fields particular used in the P-CSCF-recordType:
        servedPartyIPAress              [50] ServedPartyIPAddress OPTIONAL,
        -- < ServedPartyIPAddress to be defined >

        -- Fields particular used in the I-CSCF-recordType:
        transactionTimestamp            [60] TimeStamp OPTIONAL,
        s-CSCF-Information              [61] S-CSCF-Information OPTIONAL,
        -- < S-CSCF-Information to be defined >

        -- Fields particular used in the MRFC-recordType:
        service-Id                      [70] Service-Id OPTIONAL,
        -- <Service-Id to be defined>

        -- Fields particular used in the MGCF-recordType:
        trunkGroupID                    [80] TrunkGroupID OPTIONAL,
        bearerService                   [81] TransmissionMedium OPTIONAL,

        -- Fields particular used in the BGCF-RecordType (start with tag 90):
        -- <empty so far>

        -- Fields particular used in the AS-RecordType:
        serviceSpecificData             [100] OCTET STRING OPTIONAL
}
```

```
ACRInterimLost ::= ENUMERATED
{
       no (0),
       yes (1),
       unknown (2)
}

ApplicationServersInformation ::= SEQUENCE
{
       applicationServersInvolved       [0] NodeAddress OPTIONAL,
       applicationProvidedCalledParties [1] SEQUENCE OF InvolvedParty OPTIONAL
}

CauseForRecordClosing ::= ENUMERATED
{
       serviceDeliveryEndSuccessfully (0),
       unSuccessfulServiceDelivery    (1),
       timeLimit                      (3),
       serviceChange                  (4), -- e.g. change in media due to Re-Invite
       managementIntervention         (5), -- partial record generation reasons to be added
--  Additional codes are for further study
}


IMS-Charging-Identifier ::= OCTET STRING

Incomplete-CDR-Indication ::= SET
{
       aCRStartLost [0] BOOLEAN, –- TRUE if ACR[Start] was lost, FALSE otherwise
       aCRInterimLost [1] ACRInterimLost,
       aCRStopLost [2] BOOLEAN –- TRUE if ACR[Stop] was lost, FALSE otherwise
}

InterOperatorIdentifiers ::= SEQUENCE
{
       originatingIOI [0] GraphicString OPTIONAL,
       terminatingIOI [1] GraphicString OPTIONAL
}

InvolvedParty ::= CHOICE
{
       sIP-URL [0] GraphicString, -- refer to rfc3261
       tEL-URL [1] GraphicString  -- refer to rfc3261
}

IPAddress ::= CHOICE
{
       ipV4Addr [0] GraphicString, -- "dot" notation is used
       ipV6Addr [1] GraphicString  -- "dot" notation is used
}

LocalRecordSequenceNumber ::= INTEGER (0..+2147483647)
-- A unique number assigned by the CCF and supplied to all CDRs. The value range
-- limits the field to a maximum 4 octet INTEGER.

Media-Components-List ::= SEQUENCE
{
       sIP-Request-Timestamp  [0] TimeStamp OPTIONAL,
       sIP-Response-Timestamp [1] TimeStamp OPTIONAL,
       sDP-Media-Components   [2] SDP-Media-Components OPTIONAL,
       mediaInitiatorFlag     [3] NULL OPTIONAL,
       authorized-QoS         [3] GraphicString OPTIONAL
}

MessageBody ::= SEQUENCE
{
       Content-Type          [0] GraphicString OPTIONAL,
       Content-Disposition   [1] GraphicString OPTIONAL,
       Content-Length        [2] INTEGER OPTIONAL,
       Originator            [3] InvolvedParty OPTIONAL
}

NodeAddress ::= CHOICE
{
       iPAddress  [0] IPAddress,
       domainName [1] GraphicString
}
```

```
RecordExtensions ::= SEQUENCE
{
        -- ...
        -- operator specific record extensions
        -- ...
}

Role-of-Node ::= ENUMERATED
{
        originating (0),
        terminating (1),
        proxy       (2),
        b2bua       (3)
}

SDP-Media-Components ::= SEQUENCE
{
        sDP-Media-Name         [0] SEQUENCE OF GraphicString OPTIONAL,
        sDP-Media-Descriptions [1] SEQUENCE OF SDP-Media-Description OPTIONAL,
        gPRS-Charging-Id       [2] INTEGER OPTIONAL,
}

SDP-Media-Description ::= SEQUENCE OF GraphicString OPTIONAL,

ServiceDeliveryFailureReason ::= GraphicString
-- holds the SIP error code as received via a SIP Final response (4xx, 5xx or 6xx)

Session-Id ::= GraphicString
-- rfc3261: example for SIP Call-ID: f81d4fae-7dec-11d0-a765-00a0c91e6bf6@foo.bar.com

Sip-Method ::= GraphicString

TransmissionMedium ::= SEQUENCE {
        -- Transmission Medium Required, refer to ITU-T Q.763:
        tMR [0] OCTET STRING (SIZE (1)) OPTIONAL,
        -- Transmission Medium USED, refer to ITU-T Q.763:
        tMU [1] OCTET STRING (SIZE (1)) OPTIONAL
}

TrunkGroupID ::= CHOICE {
        incoming [0] GraphicString,
        outgoing [1] GraphicString
}

END
```

5.2.7 Data Encoding Rules

Data encoding rules are descried in [9] for BER, in [10] for PER, or in [11] for XER.

6 Online Charging

6.1 Diameter Description on the Ro Interface

6.1.1 Basic Principles

IMS online charging essentially uses the same protocol that is used for offline charging. However, for online charging the protocol may include additional Attribute-Value Pairs (AVPs) within the existing messages.

Two cases for online event charging are distinguished:

- Immediate Event Charging (IEC); and
- Event Charging with Unit Reservation (ECUR).

In the case of Immediate Event Charging (IEC), granting units to the AS is performed in a single operation that also includes the deduction of the corresponding monetary units from the subscriber's account. The charging process is controlled by the corresponding *Accounting-Record-Type* EVENT_RECORD which is sent with an ACR for a given accounting event.

In contrast, Event Charging with Unit Reservation (ECUR) also includes the process of requesting, reserving, releasing and returning unused units. The deduction of the corresponding monetary units then occurs upon conclusion of the ECUR transaction. In this case, the *Accounting-Record-Type* START / INTERIM / STOP_RECORD are used to control the accounting session. During a SIP session there can be repeated execution of unit reservation and debit operations as specified in TS 32.200 [2].

The AS/MRFC may apply either IEC, where ACR Event messages are generated, or ECUR, using ACR Start, Stop and Interim. The decision whether to apply IEC or ECUR is based on the service and/or operator's policy.

NOTE: To the extent possible alignment with the IETF Credit Control Application, [13], is planned. However, this can only be accomplished when the current IETF draft receives an official RFC status.

6.1.2 Message Flows and Types

This subclause describes the message flows for the event charging procedures on the Ro interface.

6.1.2.1 Immediate Event Charging (IEC)

This subclause provides the details of the "Debit Units" operation specified in TS 32.200 [2].

6.1.2.1.1 Message Flows - Successful Cases and Scenarios

6.1.2.1.1.1 IEC - Debit Units Operation

Figure 6.1 shows the transactions that are required on the Ro interface in order to perform IEC with Debit Units operations. The Debit Units operation may alternatively be carried out prior to, concurrently with or after service/content delivery. The AS/MRFC must ensure that the requested service execution is successful, when this scenario is used.

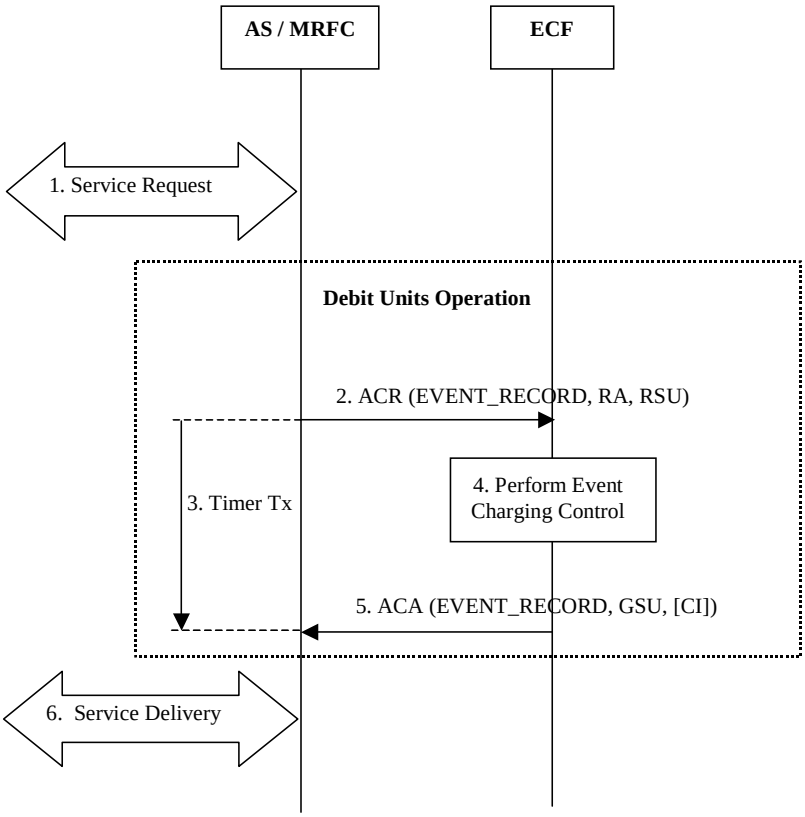

Figure 6.1: IEC - Debit Units Operation

1. The AS/MRFC receives a SIP related service request from S-CSCF.

   The Debit Units Operation is performed as described in TS 32.200 [2].
2. The AS/MRFC performs IEC prior to service execution. AS/MRFC sends *Accounting-Request* (ACR) with *Accounting-Record-Type* AVPset to EVENT_RECORD to indicate service specific information to the ECF. The *Requested-Action* AVP (RA) is set to DIRECT_DEBITING. If known, the AS/MRFC may include *Requested-Service-Unit* AVP (RSU) (monetary or non monetary units) in the request message.
3. Having transmitted the *Accounting-Request* message the AS/MRFC starts the communication supervision timer Tx [13]. Upon receipt of the *Accounting Answer* (ACA) message the AS/MRFC shall stop timer Tx.
4. The ECF determines the relevant service charging parameters in conjunction with the other internal charging functions of the OCS.
5. The ECF returns *Accounting-Answer* message with *Accounting-Record-Type* AVP set to EVENT_RECORD to the AS/MRFC in order to authorize the service execution (*Granted-Service-Unit* AVP (GSU) and possibly *Cost-Information* AVP (CI) indicating the cost of the service are included in the *Accounting-Answer* message). The *Accounting-Answer* message has to be checked by the AS/MRFC accordingly and the requested service is controlled concurrently with service delivery.
6. Service is being delivered.

6.1.2.1.2 Message Flows - Error Cases and Scenarios

This subclause describes various error cases and how these should be handled.

The failure handling behaviour is locally configurable in the AS/MRFC. If the *Direct-Debiting-Failure-Handling* AVP is not used, the locally configured values are used instead.

6.1.2.1.2.1 Reception of SIP Error Messages

If SIP errors occur during service delivery, as defined in [5] and [12], it is up to the AS/MRFC to determine to what extent the service was delivered before the error occurred and act appropriately with respect to charging. This may imply that no units at all (or no more units) are debited.

6.1.2.1.2.2 Debit Units Operation Failure

This case comprises situations where either no, or an erroneous response, is received from the ECF. The 'no response' case is detected by the AS/MRFC when the connection supervision timer Tx expires [13] before a response *Accounting-Answer* (ACA) is received. The case of receiving an erroneous response implies that the AS/MRFC receives an *Accounting-Answer* (ACA), which it is unable to process, while Tx is running. The failure handling complies with the failure procedures for "Direct Debiting" scenario described in [13].

6.1.2.1.2.3 Duplicate Detection

The detection of duplicate request is needed and must be enabled. To speed up and simplify as much as possible the duplicate detection, the all-against-all record checking should be avoided and just those records marked as potential duplicates need to be checked against other received requests (within a reasonable time window) by the receiver entity.

The AS/MRFC mark the request messages that are retransmitted after a link failover as possible duplicates with the T-flag as described in [3]. For optimized performance, uniqueness checking against other received requests is only necessary for those records marked with the T-flag received within a reasonable time window. This focused check is based on the inspection of the *Session-Id* and *Accounting-Record-Number* AVP pairs.

Note that for IEC the duplicate detection is performed in the Correlation Function that is part of the OCS. The ECF that receives the possible duplicate request should mark as possible duplicate the corresponding request that is sent over the Rc interface.

6.1.2.2 Event Charging with Unit Reservation (ECUR)

This subclause provides the details of the "Reserve Units" and "Debit Units" operations specified in TS 32.200 [2].

6.1.2.2.1 Message Flows - Successful Cases and Scenarios

6.1.2.2.1.1 ECUR - Reserve Units and Debit Units Operations

Figure 6.2 shows the transactions that are required on the Ro interface in order to perform ECUR with Reserve Units and Debit Units operations. Multiple replications of both of these operations are possible.

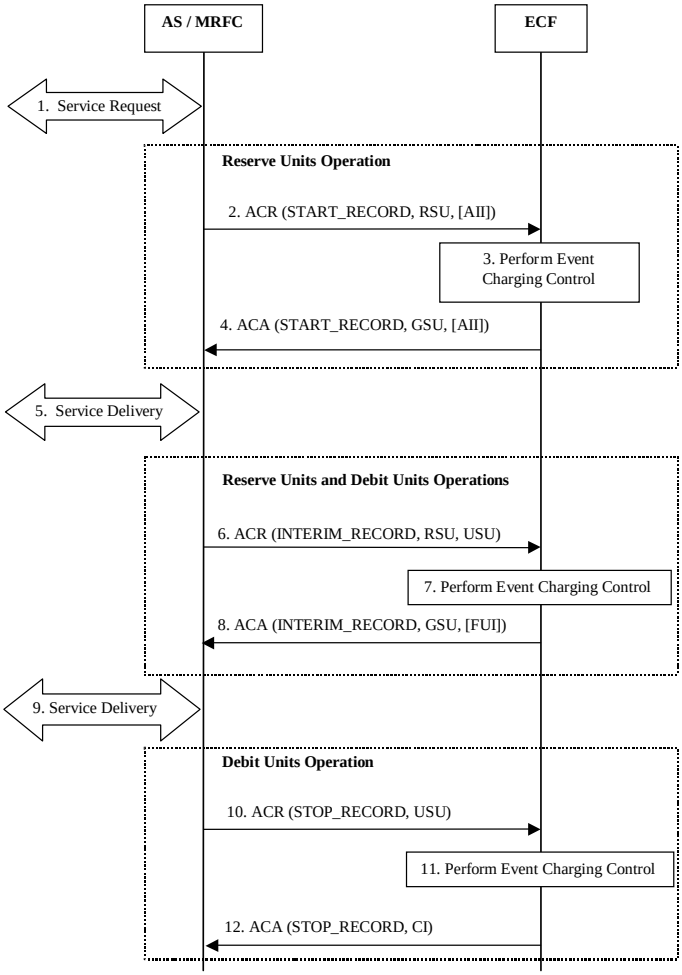

Figure 6.2: ECUR - Reserve Units and Debit Units Operations

1. The AS/MRFC receives a SIP related service request from S-CSCF. The service request may be initiated by either the user or an AS/MRFC.

The Reserve Units Operation is performed as described in TS 32.200 [2].

2. In order to perform Reserve Units operation for a number of units (monetary or non-monetary units), the AS/MRFC sends an ACR with *Accounting-Record-Type* AVP set to START_RECORD to the ECF. If known, the AS/MRFC may include *Requested-Service-Unit* (RSU) AVP (monetary or non monetary units) and *Acc-Interim-Interval* (AII) AVP in the request message.
3. If the service cost information is not received by the ECF, the ECF determines the price of the desired service according to the service specific information received by issuing a rating request to the Rating Function. If the cost of the service is included in the request, the ECF directly reserves the specified monetary amount. If the credit balance is sufficient, the ECF reserves the corresponding amount from the users account.
4. Once the reservation has been made, the ECF returns *Accounting-Answer* message with *Accounting-Record-Type* set to START_RECORD to the AS/MRFC in order to authorize the service execution (*Granted-Service-Unit* and possibly *Cost-Information* indicating the cost of the service are included in the *Accounting-Answer* message). If requested, the ECF returns the *Acc-Interim-Interval* (AII) AVP with value field set to a non-zero value.
5. Content/service delivery starts and the reserved units are concurrently controlled.

The Reserve Units and Debit Units Operations are performed as described in TS 32.200 [2].

6. During content/service delivery, in order to perform Debit Units and subsequent Reserve Units operations, the AS/MRFC sends an ACR with *Accounting-Record-Type* AVP set to INTERIM_RECORD, to report the units used and request additional units, respectively. The ACR message with *Accounting-Record-Type* AVP set to INTERIM_RECORD must be sent by the AS/MRFC between the START_RECORD and STOP_RECORD either on request of the credit control application within the interim interval or if the interim interval is elapsed. If known, the AS/MRFC may include *Requested-Service-Unit* AVP (monetary or non monetary units) in the request message. The *Used-Service-Unit* (USU) AVP is complemented in the ACR message to deduct units from both the user's account and the reserved units, respectively.
7. The ECF deducts the amount used from the account. If the service cost information is not received by the ECF, the ECF determines the price of the desired service according to the service specific information received by issuing a rating request to the Rating Function. If the cost of the service is included in the request, the ECF directly reserves the specified monetary amount. If the credit balance is sufficient, the ECF reserves the corresponding amount from the users account.
8. Once the deduction and reservation have been made, the ECF returns *Accounting-Answer* message with *Accounting-Record-Type* set to INTERIM_RECORD to the AS/MRFC, in order to allow the content/service delivery to continue (new *Granted-Service-Unit (GSU) AVP* and possibly *Cost-Information (CI) AVP* indicating the cumulative cost of the service are included in the *Accounting-Answer* message). The ECF may include in the ACA message the *Final-Unit-Indication* (FUI) AVP to indicate the final granted units.
9. Content/service delivery continues and the reserved units are concurrently controlled.

The Debit Units Operation is performed as described in TS 32.200 [2].

10. When content/service delivery is completed or the final granted units have been consumed, the AS/MRFC sends *ACR* with *Accounting-Record-Type* AVP set to STOP_RECORD to terminate the active accounting session and report the used units.
11. The ECF deducts the amount used from the account. Unused reserved units are released, if applicable.
12. The ECF acknowledges the reception of the ACR message by sending *ACA* message with *Accounting-Record-Type* AVP indicating STOP_RECORD (possibly *Cost-Information* AVP indicating the cumulative cost of the service is included in the *Accounting-Answer* message).

NOTE: The ECUR scenario is supervised by corresponding timers (e.g. accounting interval timer) that are not shown in the figure 6.2.

6.1.2.2.1.2 Support of Tariff Switch

Changes to the tariffs pertaining to the service may be handled in the following ways.

- Tariff Changes handled using Acct-Interim-Interval AVP; or
- Tariff changes handled using the Tariff Switch Time AVP.

6.1.2.2.1.2.1 Tariff Changes handled using Acct-Interim-Interval AVP

The tariff change for online charging can be achieved by setting the value of the *Acct-Interim-Interval* AVP (ECF controlled) in a manner that it matches the desired tariff switch time.

6.1.2.2.1.2.2 Tariff changes handled using the Tariff Switch Time AVP

To indicate a change of tariff to the AS/MRFC, the ECF can include the Tariff Switch Time (*Tariff-Switch-Definition* AVP), i.e. a timer value referring to the change of tariff, in the *Accounting-Answer*. The Tariff Switch Time is evaluated by the AS/MRFC relative to the time stamp of the *Accounting-Request* (*Accounting-Record-Type* START_RECORD or INTERIM_RECORD). By that it is possible to eliminate any delays of the signalling between AS/MRFC and ECF.

Together with the Tariff Switch Time the ECF also provides the granted service units. These units can be provided in one portion or in two, referring to the granted service units before and after the tariff switch.

If a Tariff Switch Time is received, the AS/MRFC starts the tariff switch timer and use the granted service units for usage metering. If both, granted service units before and after the tariff switch have been provided, the AS/MRFC uses the units granted before the tariff switch (pre-switch quota).

If the pre-switch quota is exhausted, the AS/MRFC sends an *Accounting-Request* to the ECF. The *Accounting-Request* contains the amount of service units used from the beginning of the connection only. The value of the tariff switch timer is discarded in the AS/MRFC and it is the responsibility of the ECF to provide a new Tariff Switch Time in the *Accounting-Answer*.

If the tariff switch timer expired, the AS/MRFC further continues usage metering using the post-switch quota, if provided, but no *Accounting-Request* is sent. If no specific units were granted to after tariff switch time, the AS/MRFC continues usage metering with the remaining units granted.

If the post switch quota is exhausted, the AS/MRFC sends an *Accounting-Request* to the ECF, containing the service units used before the last tariff switch, the service units used after the last tariff switch and the tariff switch time.

If the granted units - provided in one portion - are exhausted, an *Accounting-Request* is sent. If a tariff switch has occurred in this time, the *Accounting-Request* contains the service units used before the tariff switch, the service units used after the tariff switch and the time of the tariff switch. Otherwise, if no tariff switch has occurred, the *Accounting-Request* contains the overall amount of used service units.

There may be some AS/MRFCs that do no support tariff switching. In this case, the AS/MRFC ignores the AVPs associated with this feature (i.e. *Tariff-Switch-Definition* and *Unit-Value-After-Tariff-Switch* AVPs). The *Granted-Service-Unit, Unit-Value* and *Used-Service-Unit* AVPs are treated as if the Tariff Switch feature does not exist.

Figure 6.3 shows the messages exchanged on the Ro interface for ECUR for a tariff change. This scenario covers a tariff switch where the granted service units are provided in two portions, before and after the tariff switch. No additional Acc*ounting-Request* takes place, as the granted service units were not exhausted.

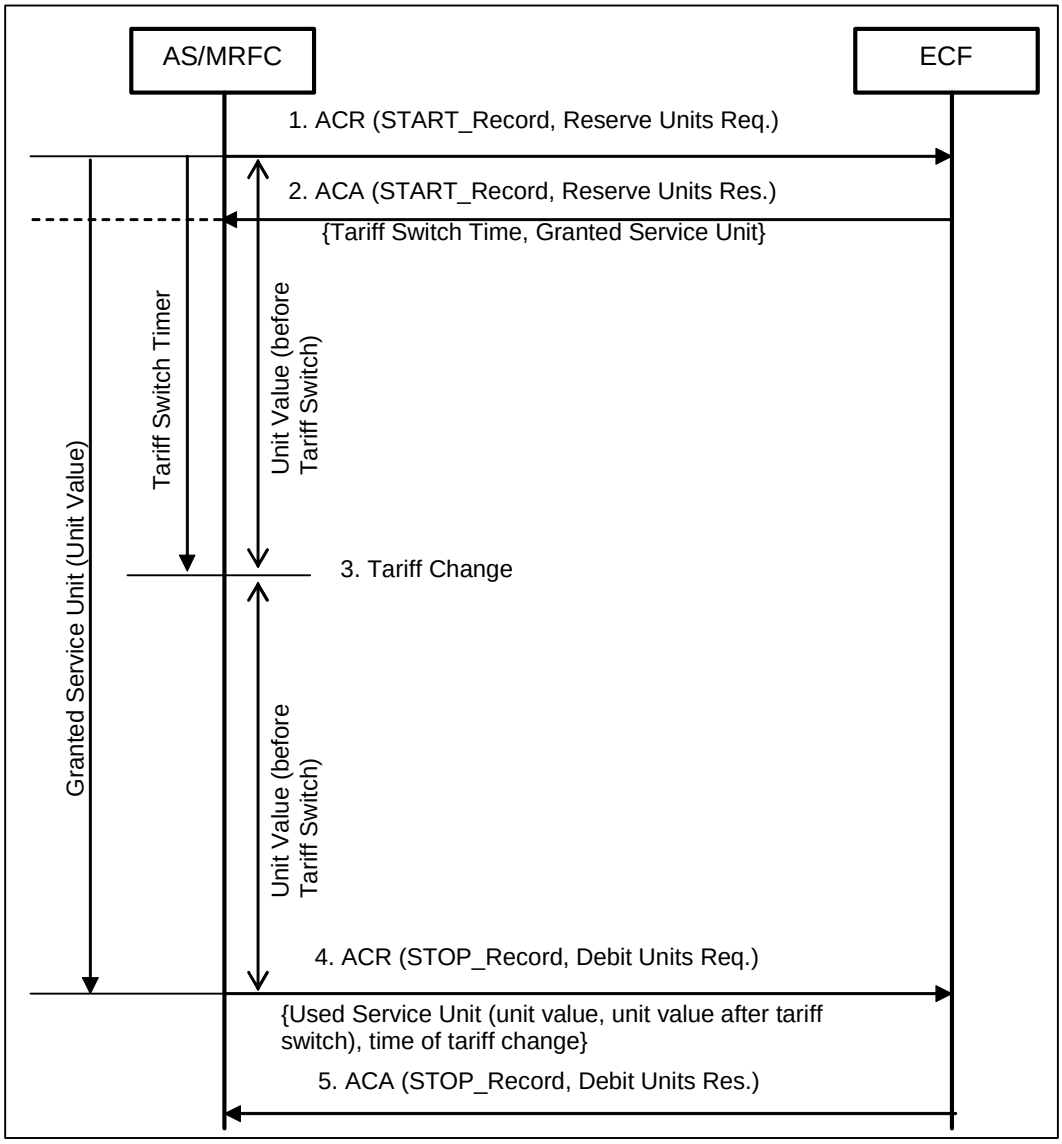

Figure 6.3: Tariff Change in the AS/MRFC

1. In order to perform credit control with reservation of an amount of units (monetary or non-monetary units) the AS/MRFC sends an ACR with *Accounting-Record-Type* set to START_RECORD to ECF. The *Requested-Action* is set to RESERVE_UNITS.
2. Once the reservation has been made, ECF returns an ACA with *Accounting-Record-Type* set to START_RECORD to the AS/MRFC in order to authorize the content/service delivery. The ACA includes the Tariff Switch Time, the service units granted before the tariff switch and the service units granted after the tariff switch.
   Upon receipt of the ACA, the AS/MRFC evaluates the tariff switch time relative to the timestamp of the ACR, starts the tariff switch timer and monitors service usage based on the service units granted before the tariff switch.
3. The Tariff Switch Timer expires. The AS/MRFC now monitors service usage based on the service units granted after the tariff switch.
4. The AS/MRFC sends ACR with *Accounting-Record-Type* set to STOP_RECORD to terminate the active accounting session. The message includes the amount of service units used before the tariff switch, the amount of service units used after the tariff switch and the time of the tariff change.
5. An *Accounting-Answer* is sent from the ECF back to the AS/MRFC as an acknowledgment of the successful debit process and to finalize the transaction.

6.1.2.2.1.3 Expiration of Reservation Validity

This subclause defines how reserved units are returned, if not used, within a reasonable time. It should be possible that both the reservation and SIP sessions are cancelled or only the reservation is cancelled without removing the SIP session. Work on this is ongoing in IETF Credit Control Draft [13]. Alignment with [13] is planned.

6.1.2.2.2 Message Flows - Error Cases and Scenarios

This subclause describes various error cases and how these should be handled.

The failure handling behaviour is locally configurable in the AS/MRFC. If *Credit-Control-Failure-Handling* AVP is not used, the locally configured values are used instead.

6.1.2.2.2.1 Reception of SIP Error Messages

If SIP errors occur during service delivery, as defined in [5] and [12], it is up to the AS/MRFC to determine to what extent the service was delivered before the error occurred and act appropriately with respect to charging. This may imply that no units at all (or no more units) are reserved or debited.

6.1.2.2.2.2 Reserve Units and Debit Units Operation Failure

This case comprises of ECF connection failure, and/or receiving error responses from the ECF.

The AS/MRFC detects an ECF connection failure when the timer Tx expires [13] or a transport failure is detected as defined in [3]. The ECF also has the capability to detect failures when the timer Ts [3] expires. The ECF should indicate the cause of failure by setting the appropriate result code as defined in [3] and [13]. In any case, the failure handling of AS/MRFC and ECF complies with the failure procedures for "Session Based Credit Control" scenario described in [13].

6.1.2.2.2.3 Duplicate Detection

For credit control duplicate detection is performed only for possible duplicate event requests related to IEC as mentioned in subclause 6.1.2.1.2.3,as retransmission of ECUR related accounting requests is not allowed.

6.1.3 Message Formats

6.1.3.1 Summary of Online Charging Message Formats

The existing Diameter credit control extension internet-draft [13] proposes an approach based on a series of "interrogations":

- Initial interrogation (extending the start-session accounting report message).
- Zero, one or more interim interrogations (extending the interim accounting report message).
- Final interrogation (extending the stop-session accounting report message).

In addition to a series of interrogations, also a one time event (interrogation) can be used e.g. in the case when service execution is always successful.

All of these interrogations make use of the same *Accounting-Request* and *Accounting-Answer* messages in the base Diameter protocol as for the offline charging. Additional AVPs are specified for the purposes of online charging. These additional AVPs include all the AVPs listed in [13] and the *Tariff-Switch-Definition* AVP as specified in clause 7.

The *Accounting-Request* for the "interim interrogation" and "final interrogation" reports the actual number of "units" that were used, from what was previously reserved. This determines the actual amount debited from the subscriber's account.

Such an approach has the benefit of a common basic message structure, and accounting data reporting mechanism for both offline and online charging.

Table 6.1 describes the use of these messages for online charging.

Table 6.1: Online Charging Messages Reference Table

Command-Name	Source	Destination	Abbreviation
Accounting-Request	MRFC, AS	ECF	ACR
Accounting-Answer	ECF	MRFC, AS	ACA

6.1.3.2 Structure for the Accounting Message Formats

The following is the basic structure shared by all online charging messages. This is based directly on the format of the *Accounting-Request* and *Accounting-Answer* messages defined in the base Diameter protocol specification [3] with the extensions defined in [13].

Those Diameter AVPs that are used for online charging are marked "Yes" in tables 6.2 to 6.3. Those Diameter AVPs that are not used for online charging are marked "No" in tables 6.2 to 6.3. This implies that their content can (Yes) or can not (No) be used by the ECF for charging purposes.

The following symbols are used in the tables:

- <AVP> indicates a mandatory AVP with a fixed position in the message.
- {AVP} indicates a mandatory AVP in the message.
- [AVP] indicates an optional AVP in the message.
- *AVP indicates that multiple occurrences of an AVP is possible.

6.1.3.2.1 Accounting-Request Message

Table 6.2 illustrates the basic structure of a Diameter *Accounting-Request* message as used for IMS online charging.

Table 6.2: Accounting-Request (ACR) Message Contents for Online Charging

Diameter Base Protocol AVPs	
AVP	**Used in Online ACR**
<Diameter Header: 271, REQ, PXY>	Yes
<Session-Id>	Yes
{Origin-Host}	Yes
{Origin-Realm}	Yes
{Destination-Realm }	Yes
{Accounting-Record-Type}	Yes
{Accounting-Record-Number}	Yes
[Acct-Application-Id]	No
[Vendor-Specific-Application-Id]	Yes
[User-Name]	Yes
[Accounting-Sub-Session-Id]	No
[Accounting-RADIUS-Session-Id]	No
[Acct-Multi-Session-Id]	No
[Acct-Interim-Interval]	Yes
[Accounting-Realtime-Required]	No
[Origin-State-Id]	Yes
[Event-Timestamp]	Yes
* [Proxy-Info]	No
* [Route-Record]	No
*[AVP]	No
Diameter Credit Control AVPs	
[Subscription-Id]	Yes
[Requested-Action]	Yes
*[Requested-Service-Unit]	Yes
*[Used-Service-Unit]	Yes
[Tariff-Switch-Definition]	Yes
*[Service-Parameter-Info]	Yes
[Abnormal-Termination-Reason]	Yes
*[Accounting-Correlation-Id]	No
[Credit-Control-Failure-Handling]	Yes
[Direct-Debiting-Failure-Handling]	Yes
3GPP Diameter accounting AVPs	
[Event-Type]	Yes
[Role-of-node]	Yes
[User-Session-ID]	Yes
[Calling-Party-Address]	Yes
[Called-Party-Address]	Yes
[Time-stamps]	Yes
*[Application-Server]	No
*[Application-Provided-Called-Party-Address]	Yes
*[Inter-Operator-Identifier]	Yes
[IMS-Charging-Identifier]	Yes
*[SDP-Session-Description]	Yes
*[SDP-Media-Component]	Yes
[GGSN-Address]	Yes
[Served-Party-IP-Address]	No
[Authorised QoS]	No
[Server-Capabilities]	No
[Trunk-Group-ID]	No
[Bearer-Service]	No
[Service-Id]	Yes
[UUS-Data]	Yes
[Cause]	Yes

The detailed use of the AVPs for MRFC/AS and for each ACR record type (start/interim/stop/event) is specified in subclause 6.1.3.3.

6.1.3.2.2 Accounting-Answer Message

Table 6.3 illustrates the basic structure of a Diameter *Accounting-Answer* message as used for IMS charging. This message is always used by the ECF as specified below, independent of the receiving IMS node and the ACR record type that is being replied to.

Table 6.3: Accounting Answer (ACA) Message Contents for Online Charging

Diameter base protocol AVPs	
AVP	**Used in online ACA**
<Diameter Header: 271, PXY>	Yes
<Session-Id>	Yes
{Result-Code}	Yes
{Origin-Host}	Yes
{Origin-Realm}	Yes
{Accounting-Record-Type}	Yes
{Accounting-Record-Number}	Yes
[Acct-Application-Id]	No
[Vendor-Specific-Application-Id]	Yes
[User-Name]	Yes
[Accounting-Sub-Session-Id]	Yes
[Accounting-RADIUS-Session-Id]	No
[Acct-Multi-Session-Id]	No
[Error-Reporting-Host]	No
[Acct-Interim-Interval]	Yes
[Accounting-Realtime-Required]	No
[Origin-State-Id]	Yes
[Event-Timestamp]	Yes
* [Proxy-Info]	No
*[AVP]	No
Diameter Credit Control AVPs	
[Subscription-Id]	Yes
*[Granted-Service-Unit]	Yes
[Tariff-Switch-Definition]	Yes
[Cost-Information]	Yes
[Final-Unit-Indication]	Yes
[Check-Balance-Result]	Yes
[Credit-Control-Failure-Handling]	Yes

6.1.3.3 Detailed Message Formats

Following the protocol specifications, the following "types" of accounting data may be sent:

- Start session accounting data.
- Interim session accounting data.
- Stop session accounting data.
- Event accounting data.

ACR types start, interim and stop are used for accounting data related to successful SIP sessions. In contrast, event accounting data is used for session-unrelated accounting data, such as a simple registration or interrogation, and for accounting data related to unsuccessful SIP session establishment attempts.

The following table specifies per ACR type the accounting data that are sent by MRFC and AS.

Tables 6.4 and 6.5 are the basic structure for online charging messages via Ro Interface. This is based directly on the *Accounting-Request* and *Accounting-Answer* messages defined in the Diameter protocol specifications [3] and [13].

Table 6.4: Detailed Diameter ACR Message Contents for online Charging

AVP name	Node Type	MRFC	AS
	Supported ACRs	S/I/S/E	S/I/S/E
AVPs from Diameter Base Protocol			
<Session-ID>		SISE	SISE
{Origin-Host}		SISE	SISE
{Origin-Realm}		SISE	SISE
{Destination-Realm}		SISE	SISE
{Accounting-Record-Type}		SISE	SISE
{Accounting-Record-Number}		SISE	SISE
[Acct-Application-ID]		-	-
[Vendor-Specific-Application-ID]		SISE	SISE
[User-Name]		SISE	SISE
[Accounting-Sub-Session-ID]		-	-
[Accounting-RADIUS-Session-ID]		-	-
[Acct-Multi-Session-ID]		-	-
[Acct-Interim-Interval]		SIS-	SIS-
[Accounting-Realtime-Required]		-	-
[Origin-State-ID]		SISE	SISE
[Event-Timestamp]		SISE	SISE
*[Proxy-Info]		-	-
*[Route-Record]		-	-
*[AVP]		-	-
Diameter Credit-Control AVP			
[Subscription-Id]		SISE	SISE
[Requested-Action]		SISE	SISE
*[Requested-Service-Unit]		SISE	SISE
*[Used-Service-Unit]		SISE	SISE
[Tariff-Switch-Definition]		SISE	SISE
*[Service-Parameter-Info]		SISE	SISE
[Abnormal-Termination-Reason]		SISE	SISE
*[Accounting-Correlation-Id]		SISE	SISE
[Credit-Control-Failure-Handling]		SISE	SISE
[Direct-Debiting-Failure-Handling]		SISE	SISE
*[Granted-Service-Unit]		-	-
[Cost-Information]		-	-
[Final-Unit-Indication]		-	-
[Check-Balance-Result]		-	-
3GPP Diameter Accounting AVPs			
[Event-Type]		SISE	SISE
[Role-of-Node]		SISE	SISE
[User-Session-ID]		SISE	SISE
[Calling-Party-Address]		SISE	SISE
[Called-Party-Address]		SISE	SISE
[Time-stamps]		SISE	SISE
[Application-server]		-	-
[Application-provided-called-party-address]		-	-
[Inter-Operator-Identifiers]		SISE	SISE
[IMS-Charging-Identifier]		SISE	SISE
*[SDP-Session-Description]		SI-E	SI-E
*[SDP-Media-component]		SI-E	SI-E
[SDP-Media-Name]		SI-E	SI-E
[GGSN-Address]		SI-E	SI-E
GPRS-Charging-Id]		SI-E	SI-E
[Served-Party-IP-Address]		-	-
[Authorized-QoS]		-	-
[Server-Capabilities]		-	-
[Trunk-Group-ID]		-	-
[Bearer-Service]		-	-
[Service-Id]		SISE	
[UUS-Data]		SISE	SISE
[Cause]		--SE	--SE

Table 6.5: Detailed Diameter ACA Message Contents for Online Charging

AVP name	Node Type	ECF
	Supported ACAs	S/I/S/E
AVPs from Diameter Base Protocol		
<Session-ID>		SISE
{Result Code}		SISE
{Origin-Host}		SISE
{Origin-Realm}		SISE
{Accounting-Record-Type}		SISE
{Accounting-Record-Number}		SISE
[Acct-Application-ID]		-
[Vendor-Specific-Application-ID]		SISE
[User-Name]		-
[Accounting-Sub-Session-ID]		-
[Accounting-RADIUS-Session-ID]		-
[Acct-Multi-Session-ID]		-
[Error-Reporting-Host]		-
[Acct-Interim-Interval]		SIS-
[Accounting-Realtime-Required]		-
[Origin-State-ID]		SISE
[Event-Timestamp]		SISE
*[Proxy-Info]		-
*[Route-Record]		-
AVPs from Diameter Credit Control		
[Subscription-Id]		SISE
[Requested-Action]		-
*[Requested-Service-Unit]		-
*[Used-Service-Unit]		-
[Tariff-Switch-Definition]		SISE
*[Service-Parameter-Info]		-
[Abnormal-Termination-Reason]		-
*[Accounting-Correlation-Id]		-
[Credit-Control-Failure-Handling]		-
[Direct-Debiting-Failure-Handling]		-
*[Granted-Service-Unit]		SISE
[Cost-Information)		SISE
[Final-Unit-Indication]		SISE
[Check-Balance-Result]		SISE
[Credit-Control-Failure-Handling]		SISE

7 AVPs Used for Offline and Online Charging

7.1 Diameter Base Protocol AVPs

The use of the Attribute Value Pairs (AVPs) that are defined in the Diameter Base Protocol [3] is specified in subclause 5.1.3 for offline charging and in subclause 6.1.3 for online charging. The information is summarized in table 7.1 with the base protocol AVPs listed in alphabetical order. Detailed specification of these AVPs is available in the base protocol specifications.

The 3GPP IMS Charging Application uses the value 10415 (3GPP) as *Vendor-Id.*

Those Diameter AVPs that are used for IMS charging are marked "Yes" in table 7.1. Those Diameter AVPs that are not used for IMS charging are marked "No" in table 7.1. This implies that their content can (Yes) or can not (No) be used by the CCF or ECF for charging purposes.

The following symbols (adopted from [3]) are used in the tables:

- <AVP> indicates a mandatory AVP with a fixed position in the message.
- {AVP} indicates a mandatory AVP in the message.
- [AVP] indicates an optional AVP in the message.
- *AVP indicates that multiple occurrences of an AVP are possible.

Table 7.1: Use Of Diameter Base Protocol AVPs in IMS

AVP name	Mechanism	Offline		Online	
	Type	ACR	ACA	ACR	ACA
	Table #	5.4	5.5	6.2	6.3
[Accounting-Multi-Session-Id]		No	No	No	No
[Accounting-RADIUS-Session-Id]		No	No	No	No
[Accounting-Realtime-Required]		No	No	No	No
{Accounting-Record-Number}		Yes	Yes	Yes	Yes
{Accounting-Record-Type}		Yes	Yes	Yes	Yes
[Accounting-Sub-Session-Id]		No	No	No	No
[Acct-Application-Id]		No	No	No	No
[Acct-Interim-Interval]		Yes	Yes	Yes	Yes
{Auth-Application-Id}		-	-	-	-
<Diameter-Header:271,REQ,PXY>		Yes	Yes	Yes	Yes
{Destination-Host}		-	-	-	-
{Destination-Realm}		Yes	-	Yes	-
[Error-Message]		-	-	-	-
[Error-Reporting-Host]		-	No	-	No
[Event-Timestamp]		Yes	Yes	Yes	Yes
*[Failed-AVP]		-	-	-	-
*[Proxy-Info]		No	No	No	No
{Origin-Host}		Yes	Yes	Yes	Yes
{Origin-Realm}		Yes	Yes	Yes	Yes
[Origin-State-Id]		Yes	Yes	Yes	Yes
*[Redirected-Host]		-	-	-	-
[Redirected-Host-Usage]		-	-	-	-
[Redirected-Max-Cache-Time]		-	-	-	-
{Result-Code}		-	Yes	-	Yes
*[Route-Record]		No	-	No	-
<Session-Id>		Yes	Yes	Yes	Yes
[User-Name]		Yes	Yes	Yes	Yes
[Vendor-Specific-Application-Id]		Yes	Yes	Yes	Yes

NOTE: *Result-Code* AVP is defined in Diameter Base Protocol [3]. However, new values are used in IMS charging applications. These additional values are defined below.

7.1.1 Acct-Application-Id AVP

The *Acct-Application-Id* AVP (AVP code 259), as part of the *Vendor-Specific-Application-Id* grouped AVP, shall contain the value of 1 i.e. the same application id as used by the Cx interface protocol as defined in [19].

7.1.2 Result-Code AVP

This subclause defines new *Result-Code* AVP (AVP code 298) values that must be supported by all Diameter implementations that conform to the present document.

The *Accounting-Answer* message includes the *Result-Code* AVP, which may indicate that an error was present in the *Accounting-Request* message. A rejected *Accounting-Request* message should cause the user's session to be terminated.

Errors that fall within the transient failures category are used to inform a peer that the request could not be satisfied at the time it was received, but MAY be able to satisfy the request in the future.

DIAMETER_END_USER_SERVICE_DENIED 4100

The ECF denies the service request due to service restrictions or limitations related to the end-user, for example the end-user's account could not cover the requested service.

DIAMETER_CREDIT_CONTROL_NOT_APPLICABLE 4102

The credit control server determines that the service can be granted to the end user but no further credit control needed for the service (e.g. service is free of charge).

Errors that fall within permanent failure category are used to inform the peer that the request failed, and should not be attempted again.

DIAMETER_END_USER_NOT_FOUND 5100

The specified end user could not be found in the CCF or ECF.

7.1.3 User-Name AVP

The *User-Name* AVP (AVP code 1) contains the Private User Identity [18], if available in the node.

7.1.4 Vendor-Id AVP

The *Vendor-Id* AVP (AVP code 266), as part of the *Vendor-Specific-Application-Id* grouped AVP, shall contain the value of 10415, which is the IANA registered value for '3GPP'.

7.2 Additional AVPs

For the purpose of IMS charging additional AVPs are used in ACR and ACA for both online and offline charging. The use of these AVPs are described in subclause 5.1.3 for offline charging and in subclause 6.1.3 for online charging. The information is summarized in table 7.2 along with the AVP flag rules.

Detailed descriptions of AVPs that are used specifically for IMS charging are provided in the subclauses below the table. However, for AVPs that are just borrowed from other applications only the reference (e.g. [13]), is provided in table 7.2 and the detailed description is not repeated.

Table 7.2: Use Of Diameter Credit Control and 3GPP accounting AVPs for IMS

AVP Name	AVP Code	Clause Defined	Value Type	AVP Flag rules				
				Must	May	Should not	Must not	May Encr.
AVPs from Diameter Credit Control								
[Subscription-Id]	200	[13]						
[Requested-Action]	201	[13]						
*[Used-Service-Unit]	202	7.2.44	Grouped					
{Unit-Type}	203	7.2.41	Enumerated					
{Unit-Value}	204	7.2.42	Float64					
{Unit-Value-After-Tariff-Switch}	205	7.3.43	Float64					
[Currency-Code]	206	[13]						
[Tariff-Switch-Definition]	207	7.2.37	OctetString					
*[Service-Parameter-Info]	208	[13]						
[Abnormal-Termination-Reason]	209	[13]						
*[Accounting-Correlation-Id]	210	[13]						
[Credit-Control-Failure-Handling]	211	[13]						
[Direct-Debiting-Failure-Handling]	212	[13]						
*[Granted-Service-Unit]	213	7.2.19	Grouped					
{Unit-Type}	214	7.2.41	Enumerated					
{Unit-Value}	215	7.2.42	Float64					
[Unit-Value-After-Tariff-Switch]	216	7.3.43	Float64					
[Currency-Code]	217	[13]						
[Cost-Information]	218	7.2.13	Grouped					
{Cost}	219	[13]						
{Currency-Code}	220	[13]						
[Final-Unit-Indication]	221	[13]						
[Check-Balance-Result]	222	[13]						
3GPP Diameter Accounting AVPs								
[Event-Type]	223	7.2.16	Grouped					
[SIP-Method]	224	7.2.34	UTF8String					
[Event]	225	7.2.15	UTF8String					
[Content-Type]	226	7.2.12	UTF8String					
[Content-Length]	227	7.2.11	UTF8String					
[Content-Disposition]	228	7.2.10	UTF8String					
[Role-of-Node]	229	7.2.27	Enumerated					
[User Session Id]	230	7.2.45	UTF8String					
[Calling-Party-Address]	231	7.2.7	UTF8String					
[Called-Party-Address]	232	7.2.6	UTF8String					
[Time-stamps]	233	7.2.39	Grouped					
[SIP-Request-Timestamp]	234	7.2.35	UTF8String					
[SIP-Response-Timestamp]	235	7.2.36	UTF8String					
[Application-server]	236	7.2.3	UTF8String					
[Application-provided-called-party-address]	237	7.2.2	UTF8String					
[Inter-Operator-Identifier]	238	7.2.22	Grouped					
[Originating-IOI]	239	7.2.25	UTF8String					
[Terminating-IOI]	240	7.2.38	UTF8String					
[IMS-Charging-Identifier]	241	7.2.20	UTF8String					
*[SDP-Session-Description]	242	7.2.31	UTF8String					
*[SDP-Media-component]	243	7.2.28	Grouped					
[SDP-Media-Name]	244	7.2.30	UTF8String					
*[SDP-Media-Description]	245	7.2.29	UTF8String					
[GPRS-Charging-Id]	246	7.2.18	UTF8String					
[GGSN-Address]	247	7.2.17	IPAddress					
[Served-Party-IP-Address]	248	7.2.32	IPAddress					
[Authorized-QoS]	249	7.2.4	UTF8String					
[Server-Capabilities]	250	[19]						
[Trunk-Group-Id]	251	7.2.40	Grouped					
[Incoming-Trunk-Group-Id]	252	7.2.21	UTF8String					
[Outgoing-Trunk-Group-Id]	253	7.2.26	UTF8String					
[Bearer-Service]	254	7.2.5	OctetString					
[Service-Id]	255	7.2. 33	UTF8String					
[UUS-Data]	256	7.2.46	Grouped					
[Amount-of-UUS-data]	257	7.2.1	UTF8String					
[Mime-type]	258	7.2.23	UTF8String					
[Direction]	259	7.2.14	Enumerated					
[Cause]	260	7.2.8	Grouped					
{Cause-Code}	261	7.2.9	Enumerated					
{Node-Functionality}	262	7.2.24	Enumerated					

7.2.1 Amount-of-UUS-Data AVP

The *Amount-Of-UUS-Data* AVP (AVP code 257) is of type UTF8String and holds the amount (in octets) of User-to-User data conveyed in the body of the SIP message with content-disposition header field equal to "render".

7.2.2 Application-Provided-Called-Party-Address AVP

The *Application-Provided-Called-Party-Address* AVP (AVP code 237) is of type UTF8String and holds the called party number (SIP URL, E.164), if it is determined by an application server.

7.2.3 Application-Server AVP

The *Application-Server* AVP (AVP code 236) is of type UTF8String and holds the SIP URL(s) of the AS(s) addressed during the session.

7.2.4 Authorised-QoS AVP

The *Authorised-QoS* AVP (AVP code 249) is of type UTF8String and holds the Authorised QoS as defined in TS 23.207 [7] / TS 29.207 [8] and applied via the Go interface.

7.2.5 Bearer-Service AVP

The *Bearer-Service* AVP (AVP code 254) is of type OctetString and holds the used bearer service for the PSTN leg.

7.2.6 Called-Party-Address AVP

The *Called-Party-Address* AVP (AVP code 232) is of type UTF8String and holds the address (Public User ID: SIP URL, E.164, etc.) of the party to whom a session is established.

7.2.7 Calling-Party-Address AVP

The *Calling-Party-Address* AVP (AVP code 231) is of type UTF8String and holds the address (Public User ID: SIP URL, E.164, etc.) of the party initiating a session.

7.2.8 Cause AVP

The *Cause* AVP (AVP code 260) is of type Grouped. The Cause AVP includes the *Cause-Code* AVP that contains the cause value and the *Node-Functionality* AVP that contains the function of the node where the cause code was generated.

Cause has the following ABNF grammar:

<Cause>::=<AVP Header: 260>

{Cause-Code}

{Node-Functionality}

7.2.9 Cause-Code AVP

The *Cause-Code* AVP (AVP code 261) is of type Enumerated and includes the cause code value from IMS node. It is used in Accounting-request[stop] and/or Accounting-request[event] messages.

Within the cause codes, values ≤ 0 are reserved for successful causes while values ≥ 1 are used for failure causes. In case of errors where the session has been terminated as a result of a specific known SIP error code, then the SIP error code is also used as the cause code.

Successful cause code values.

"Normal end of session" 0

The cause "Normal end of session" is used in Accounting-request[stop] message to indicate that an ongoing SIP session has been normally released either by the user or by the network (SIP BYE message initiated by the user or initiated by the network has been received by the IMS node after the reception of the SIP ACK message).

"Successful transaction" -1

The cause "Successful transaction" is used in Accounting-request[event] message to indicate a successful SIP transaction (e.g. REGISTER, MESSAGE, NOTIFY, SUBSCRIBE). It may also be used by an Application Server to indicate successful service event execution.

"End of SUBSCRIBE dialog" -2

The cause "End of SUBSCRIBE dialog" is used to indicate the closure of a SIP SUBSCRIBE dialog . For instance a successful SIP SUBSCRIBE transaction terminating the dialog has been detected by the IMS node (i.e. SUBSCRIBE with expire time set to 0).

"3xx Redirection" -3xx

The cause "3xx Redirection" is used when the SIP transaction is terminated due to an IMS node receiving/initiating a 3xx response [16].

Failure cause code values.

"Unspecified error" 1

The cause "Unspecified error" is used when the SIP transaction is terminated due to an unknown error.

" 4xx Request failure" 4xx

The cause "4xx Request failure" is used when the SIP transaction is terminated due to an IMS node receiving/initiating a 4xx error response [16].

"5xx Server failure" 5xx

The cause "5xx Server failure" is used when the SIP transaction is terminated due to an IMS node receiving/initiating a 5xx error response [16].

"6xx Global failure" 6xx

The cause "6xx Global failure" is used when the SIP transaction is terminated due to an IMS node receiving/initiating a 6xx error response [16].

"Unsuccessful session setup" 2

The cause "Unsuccessful session setup" is used in the Accounting-request[stop] when the SIP session has not been successfully established (i.e. Timer H expires and SIP ACK is not received or SIP BYE is received after reception of the 200OK final response and SIP ACK is not received) [14] [16].

"Internal error" 3

The cause "Internal error" is used when the SIP transaction is terminated due to an IMS node internal error (e.g. error in processing a request/response).

7.2.10 Content-Disposition AVP

The *Content-Disposition* AVP (AVP code 228) is of type UTF8String and indicates how the message body or a message body part is to be interpreted (e.g. session, render), as described in [17].

7.2.11 Content-Length AVP

The *Content-Length* AVP (AVP code 227) is of type UTF8String and holds the size of the of the message-body, as described in [17].

7.2.12 Content-Type AVP

The *Content-Type* AVP (AVP code 226) is of type UTF8String and holds the media type (e.g. application/sdp, text/html) of the message-body, as described in [17].

7.2.13 Cost-Information AVP

The *Cost-Information* AVP (AVP Code 218) is of type Grouped and is used to return the cost information of a service in the *Accounting- Answer* command. The included *Cost* AVP contains the cost of the service event and the *Currency-Code* specifies in which currency the cost was given.

When the *Requested-Action* AVP with value PRICE_ENQUIRY is included in the *Accounting-Request* command the *Cost-Information* AVP sent in the succeeding *Accounting-Answer* command contains the cost estimation of the requested service, without any reservation being made.

The *Cost-Information* AVP included in the *Accounting-Answer* command with the *Accounting-Record-Type* set to INTERIM_RECORD contains the accumulated cost for the session without taking any credit- reservation into account.

The *Cost-Information* AVP included in the *Accounting-Answer* command with the *Accounting-Record-Type* set to EVENT_RECORD or STOP_RECORD contains the total cost for the requested service. It has the following ABNF grammar.

When the Requested-Action AVP is set to RESERVE_UNITS in the *Accounting-Request* (ACR) and the Unit-Type in the *Requested-Service-Unit* AVP is set to SERVICE_CREDIT_MONEY, the *Cost-Information* AVP sent in the succeeding *Accounting Answer* (ACA) contains the requested cost information.

It has the following ABNF grammar:

<Cost-Information>: :=<AVP Header: 218>

{ Cost }

{ Currency-Code }

7.2.14 Direction AVP

The *Direction* AVP (AVP code 259) is of type Enumerated and indicates whether the UUS data travels in up-link or down-link direction. The following values are defined:

UPLINK 0

DOWNLINK 1

7.2.15 Event AVP

The *Event* AVP (AVP code 225) is of type UTF8String and holds the content of the "Event" header used in SUBSCRIBE and NOTIFY messages.

7.2.16 Event-Type AVP

The *Event-Type* AVP (AVP code 223) is of type Grouped and contains information about the type of chargeable telecommunication service/event for which the accounting-request message is generated.

It has the following ABNF grammar:

<Event-Type>::=<AVP Header: 223 >

[SIP-Method]

[Event]

[Content-Type]

[Content-Length]

[Content-Disposition]

7.2.17 GGSN-Address AVP

The *GGSN-Address* AVP (AVP code 247) is of type IPAddress and holds the IP-address of the GGSN that generated the GPRS Charging ID, as described in [2].

7.2.18 GPRS-Charging-ID AVP

The *GPRS-Charging-ID* AVP (AVP code 246) is of type UTF8String and holds a sequence number generated by the GGSN at PDP context activation, as described in [2].

7.2.19 Granted-Service-Unit AVP

If the ACA containing the *Granted-Service-Unit* AVP (AVP code 213) contains a *Tariff-Switch-Definition* AVP, *the Unit-Value-After-Tariff-Switch* AVP may be included. In this case the *Unit-Value* AVP contains the granted units before the tariff switch time and the *Unit-Value-After-Tariff-Switch* AVP gives the units granted after the tariff switch.

If the ACA containing the *Granted-Service-Unit* AVP contains a *Tariff-Switch-Definition* AVP but *no Unit-Value-After-Tariff-Switch* AVP is included, the granted *Unit-Value* is used before and after the tariff switch.

An ACA containing a *Granted-Service-Unit* AVP with *Unit-Value-After-Tariff-Switch* AVP MUST contain a *Tariff-Switch-Definition* AVP. If the *Tariff-Switch-Definition* AVP is missing, the *Unit-Value-After-Tariff-Switch* AVP is ignored and it is proceeded as without a tariff change.

It has the following ABNF grammar:

<Granted-Service-Unit>::=< AVP Header: 213 >

{ Unit-Type }

{ Unit-Value }

[Unit-Value-After-Tariff Switch]

[Currency-Code]

7.2.20 IMS-Charging-Identifier (ICID) AVP

The *IMS-Charging-Identifier* AVP (AVP code 241) is of type UTF8String and holds the IMS Charging Identifier (ICID) as generated by a IMS node for a SIP session and described in subclause 5.2.4.10.

7.2.21 Incoming-Trunk-Group-ID AVP

The *Incoming-Trunk-Group-ID* AVP (AVP code 252) is of type UTF8String and identifies the incoming PSTN leg.

7.2.22 Inter-Operator-Identifier AVP

The *Inter-Operator-Identifier* AVP (AVP code 238) is of type Grouped and holds the identification of the network neighbours (originating and terminating) as exchanged via SIP signalling and described in [15].

It has the following ABNF grammar:

<Inter-Operator-Identifier>::=< AVP Header: 238 >

[Originating-IOI]

[Terminating-IOI]

7.2.23 Mime-Type AVP

The *Mime-Type* AVP (AVP code 258) is of type UTF8String and holds the Mime type of the User-To-User data.

7.2.24 Node-Functionality AVP

The *Node-Functionality* AVP (AVP code 262) is of type Enumerated and includes the *functionality* identifier of the *node* where the cause code was generated.

The functionality identifier can be one of the following:

S-CSCF 0

P-CSCF 1

I-CSCF 2

MRFC 3

MGCF 4

BGCF 5

AS 6

UE 7

7.2.25 Originating-IOI AVP

The *Originating-IOI* AVP (AVP code 239) is of type UTF8String (alphanumeric string) and holds the Inter Operator Identifier for the originating network as generated by the S-CSCF in the home network of the originating end user [15].

7.2.26 Outgoing-Trunk-Group-ID AVP

The *Outgoing-Trunk-Group-ID* AVP (AVP code 253) is of type UTF8String and identifies the outgoing PSTN leg.

7.2.27 Role-of-Node AVP

The *Role-Of-Node* AVP (AVP code 229) is of type Enumerated and specifies the role of the AS/CSCF.

The identifier can be one of the following:

ORIGINATING_ROLE 0
The AS/CSCF is applying a originating role, serving the calling subscriber.

TERMINATING_ROLE 1
The AS/CSCF is applying a terminating role, serving the called subscriber.

PROXY ROLE 2
The AS is applying a proxy role.

B2BUA_ROLE 3
The AS is applying a B2BUA role.

7.2.28 SDP-Media-Component AVP

The *SDP- Media-Component* AVP (AVP code 243) is of type Grouped and contains information about media used for a IMS session.

It has the following ABNF grammar:

<SDP-Media-Component>::=<AVP Header: 243 >

[SDP-Media-Name]

*[SDP-Media-Description]

[GPRS-Charging-Id]

7.2.29 SDP-Media-Description AVP

The *SDP-Media-Description* AVP (AVP code 245) is of type UTF8String and holds the content of an "attribute-line" (i=, c=, b=, k=, a=, etc.) related to a media component, as described in [17]. The attributes are specifying the media described in the SDP-Media-Name AVP.

7.2.30 SDP-Media-Name AVP

The *SDP-Media-Name* AVP (AVP code 244) is of type UTF8String and holds the content of a "m=" line in the SDP data.

7.2.31 SDP-Session-Description AVP

The *SDP-Media-Description* AVP (AVP code 242) is of type UTF8String and holds the content of an "attribute-line" (i=, c=, b=, k=, a=, etc.) related to a session, as described in [17].

7.2.32 Served-Party-IP-Address AVP

The *Served-Party-IP-Address* AVP (AVP code 248) is of type IPAddress and holds the IP address of either the calling or called party, depending on whether the P-CSCF is in touch with the calling or the called party. This AVP is only provided by the P-CSCF.

7.2.33 Service-ID AVP

The *Service-ID* AVP (AVP code 255) is of type UTF8String and identifies the service the MRFC is hosting. For conferences the conference ID is used as the value of this parameter.

7.2.34 SIP-Method AVP

The *SIP-Method* AVP (AVP code 224) is of type UTF8String and holds the name of the SIP Method (INVITE, UPDATE etc.) causing an accounting request to be sent to the CCF.

7.2.35 SIP-Request-Timestamp AVP

The *SIP-Request-Timestamp* AVP (AVP code 234) is of type UTF8String and holds the time in UTC format of the initial SIP request (e.g. Invite).

7.2.36 SIP-Response-Timestamp AVP

The *SIP-Response-Timestamp AVP* (AVP code 235) is of type UTF8String and holds the time in UTC format of the response to the initial SIP request (e.g. 200 OK).

7.2.37 Tariff-Switch-Definition AVP

The *Tariff-Switch-Definition* AVP (AVP Code 207) is of type OctetString and contains the tariff switch timer.

This AVP can be included in the *Accounting Answer* which is sent as a result of the previous *Accounting Request* with *Requested-Action* AVP set to RESERVE_UNITS. The tariff switch timer is evaluated relative to the timestamp of the preceding *Accounting Request* command. When the tariff switch timer expires, the AS/MRFC uses the *Unit-Value-After-Tariff-Switch*, if provided in the ACA, as granted units.

If a tariff switch has occurred, the *Tariff-Switch-Definition* AVP should be included in the next ACR together with the units used before the tariff switch (*Unit-Value* AVP) and the units used after the tariff switch (*Unit-Value-After-Tariff-Switch* AVP).

7.2.38 Terminating-IOI AVP

The *Terminating-IOI* AVP (AVP code 240) is of type UTF8String (alphanumeric string) and holds the Inter Operator Identifier for the originating network as generated by the S-CSCF in the home network of the terminating end user [15].

7.2.39 Time-Stamps AVP

The *Time-Stamp* AVP (AVP code 233) is of type Grouped and holds the time of the initial SIP request and the time of the response to the initial SIP Request.

It has the following ABNF grammar:

<Time-Stamps>::=< AVP Header: 233 >

[SIP-Request-Timestamp]

[SIP-Response-Timestamp]

7.2.40 Trunk-Group-ID AVP

The *Trunk-Group-ID* AVP (AVP code 251) is of type Grouped and identifies the incoming and outgoing PSTN legs.

It has the following ABNF grammar:

<Trunk-Group-ID>::=<AVP Header: 251>

[Incoming-Trunk-Group-ID]

[Outgoing-Trunk-Group-ID]

7.2.41 Unit-Type AVP

The *Unit-Type* AVP is of type Enumerated (AVP Code 203) and contains the type of the unit. The unit type can be one of the following:

SERVICE_CREDIT_TIME 0

The unit is of type "time" and is given in seconds.

SERVICE_CREDIT_VOLUME 1

The unit is of type "volume" and is given in kB.

SERVICE_CREDIT_EVENT 2

The unit is of type "event" and is given as a number of events.

SERVICE_CREDIT_MONEY 3

The unit is of type "money" and is given as a monetary value, whose currency SHOULD be specified by the *Currency-Code* AVP.

SERVICE_CREDIT_SERVICE 4

The unit of type "service" and is given as a selected service.

7.2.42 Unit-Value AVP

The *Unit-Value* AVP is of type Float64 (AVP Code 204) and contains the granted or used Unit-Value. The value can be time in seconds, volume in kB, number of events or monetary amount depending on the given *Unit-Type*.

If the *Unit-Type* AVP is set to "time" in the *Accounting-Answer* command, the *Unit Value* AVP specifies the granted time in seconds (measured from the moment when the services becomes active or from the previous Answer command) until a new *Accounting-Request* MUST be sent.

If the *Unit Type* AVP is set to "time" in the *Accounting-Request* command, the *Unit-Value* AVP specifies the used time since previous report or time requested by the service element (e.g. AS/MRFC).

If the *Unit-Type* AVP is set to "volume" in the *Accounting-Answer* command, the *Unit-Value* AVP specifies the granted volume in kB (measured from the moment when the services becomes active or from the previous Answer command) until a new *Accounting-Request* MUST be sent. If the *Unit-type* AVP is set to "volume" in the *Accounting-Request* command, the *Unit-Value* AVP specifies the used volume since previous report or volume requested by service element (e.g. AS/MRFC).

If the *Unit-Type* AVP is set to "event" in the *Accounting-Answer* command, the *Unit-Value* AVP specifies the granted number of events (measured from the moment when the service becomes active or from the previous Answer command) until a new *Accounting-Request* MUST be sent. If the *Unit-type* AVP is set to "event" in the *Accounting-Request* command, the *Unit-Value* AVP specifies the used number of events since previous report or number of events requested by the service element (e.g. AS/MRFC).

If the *Unit-Type* AVP is set to "money" in the *Accounting-Answer* command, the *Unit-Value* AVP specifies the granted monetary amount, which the end user can use until a new *Accounting-Request* MUST be sent. If the *Unit-Type* AVP is set to "money" in the *Accounting-Request* command, the *Unit-Value* AVP specifies the used monetary amount since previous report or the monetary amount requested by the service element (e.g. AS/MRFC).

If the *Accounting-Answer* command contains a *Tariff-Switch-Definition* AVP and a *Unit-Value-After-Tariff-Switch* AVP, the *Unit-Value* AVP in the *Accounting-Answer* contains the amount of units granted before the tariff change. In this case, the following holds:

- If the *Unit-Type* AVP is set to "time" in the *Accounting-Answer* command, the *Unit Value* AVP specifies the granted time before the tariff switch in seconds (measured from the moment when the services becomes active or from the previous Answer command) until the tariff switch occurs or a new *Accounting-Request* MUST be sent.
- If the *Unit-Type* AVP is set to "volume" in the *Accounting-Answer* command, the *Unit-Value* AVP specifies the granted volume before the tariff switch in kB (measured from the moment when the services becomes active or from the previous Answer command) until the tariff switch occurs or a new *Accounting-Request* MUST be sent.
- If the *Unit-Type* AVP is set to "event" in the *Accounting-Answer* command, the *Unit-Value* AVP specifies the granted number of events before the tariff switch (measured from the moment when the service becomes active or from the previous Answer command) until the tariff switch occurs or a new *Accounting-Request* MUST be sent.
- If the *Unit-Type* AVP is set to "money" in the *Accounting-Answer* command, the *Unit-Value* AVP specifies the granted monetary amount before the tariff switch, which the end user can use until the tariff switch occurs or a new *Accounting-Request* MUST be sent.

If the *Accounting-Answer* command contains a *Tariff-Switch-Definition* AVP but no *Unit-Value-After-Tariff-Switch* AVP, the *Unit-Value* AVP in the Accounting-Answer contains the total amount of units granted irrespective of the tariff change.

If the *Accounting-Answer* command contains a *Tariff-Switch-Definition* AVP and a tariff switch occurred, the next *Accounting-Request* contains the *Unit-Value* AVP and the *Unit-Value-After-Tariff-Switch* AVP. The *Unit-Value* AVP contains the service units used before the tariff switch.

7.2.43 Unit-Value-After-Tariff-Switch AVP

The *Unit-Value-After-Tariff-Switch* AVP is of type Float64 (AVP Code 205) and contains the granted or used Unit-Value after a tariff switch. The value can be time in seconds, volume in kB, number of events or monetary amount depending on the given *Unit-Type*.

The *Unit-Value-After-Tariff-Switch* AVP can only occur in combination with a *Tariff-Switch-Definition* AVP.

If the *Unit-Type* AVP is set to "time" in the *Accounting-Answer* command, the *Unit-Value-After-Tariff-Switch* AVP specifies the granted time in seconds (measured from the moment when the tariff change occurs) until a new *Accounting-Request* MUST be sent.

If the *Unit Type* AVP is set to "time" in the *Accounting-Request* command, the *Unit-Value-After-Tariff-Switch* AVP specifies the used time after tariff switch.

If the *Unit-Type* AVP is set to "volume" in the *Accounting-Answer* command, the *Unit-Value-After-Tariff-Switch* AVP specifies the granted volume in kB (measured from the moment when the tariff change occurs) until a new *Accounting-Request* MUST be sent. If the *Unit-type* AVP is set to "volume" in the *Accounting-Request* command, the *Unit-Value-After-Tariff-Switch* AVP specifies the used volume after tariff switch.

If the *Unit-Type* AVP is set to "event" in the *Accounting-Answer* command, the *Unit-Value-After-Tariff-Switch* AVP specifies the granted number of events (measured from the moment when the tariff change occurs) until a new *Accounting-Request* MUST be sent. If the *Unit-type* AVP is set to "event" in the *Accounting-Request* command, the *Unit-Value-After-Tariff-Switch* AVP specifies the used number of events after tariff switch.

If the *Unit-Type* AVP is set to "money" in the *Accounting-Answer* command, the *Unit-Value-After-Tariff-Switch* AVP specifies the granted monetary amount, which the end user can use (measured from the moment when the tariff change occurs) until a new *Accounting-Request* MUST be sent. If the *Unit-Type* AVP is set to "money" in the *Accounting-Request* command, the *Unit-Value-After-Tariff-Switch* AVP specifies the used monetary amount after tariff switch.

7.2.44 Used-Service-Unit AVP

The *Used-Service-Unit* AVP is of type Grouped AVP (AVP Code 202) and contains the amount of used units since the previous *Accounting-Answer* command. The included *Unit-Type* AVP defines the type of the unit and the *Unit-Value* AVP contains the used amount. If the unit type is "money", a *Currency-Code* AVP SHOULD be included.

If the previous ACA contained a *Tariff-Switch-Definition* AVP, *the Unit-Value-After-Tariff-Switch* AVP must be included in the *Used-Service-Unit* AVP in the ACR, if the tariff switch was encountered. In this case the *Unit-Value* AVP contains the units used before the tariff switch and the *Unit-Value-After-Tariff-Switch* AVP gives the units used after the tariff switch.

It has the following ABNF grammar:

<Used-Service-Unit>::=< AVP Header: 202 >

{ Unit-Type }

{ Unit-Value }

{ Unit-Value-After-Tariff-Switch }

[Currency-Code]

7.2.45 User-Session-ID AVP

The *User-Session-Id* AVP (AVP code 230) is of type UTF8String and holds the session identifier. For a SIP session the *Session-ID* contains the SIP Call ID, as defined in [16].

7.2.46 UUS-Data AVP

The *UUS-Data* AVP (AVP Code 256) is of type Grouped AVP and holds information about the sent User-To-User data.

It has the following ABNF grammar:

<Used-Service-Unit>::=< AVP Header: 256 >

[Amount-of-UUS-Data]

[Mime-Type]

[Direction]

Annex A (Normative): Diameter Credit Control Application

The document included in this Annex is the latest available Internet-Draft at the time of writing. When the IETF issues the RFC to this Internet-Draft then a change request will be provided to replace the text in Annex A with a reference in clause 2.

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Diameter Credit Control Application

Status of this memo

This document is an Internet-Draft and is subject to all provisions of Section 10 of RFC2026.

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This document is an individual submission to the IETF. Comments should be directed to the authors.

Abstract

This document specifies a Diameter application that is used for real-time cost and credit control between a service element and a credit control server in service environment.

Diameter accounting messages with additional AVPs are used to transfer service and credit control information between the service element and the credit control server.

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1 Introduction

This Diameter application, combined with the Diameter base protocol [DIAMBASE], describes the accounting protocol that can be used for real time cost and credit control in the service environment.

The next generation wireless networks specify (e.g. 3G Charging and Billing requirements [3GPPCHARG]) more critical requirements for the accounting applications. The accounting application must be able to rate accounting information in real-time. For example, for the service environment it is vital to be able to rate service event information instantly.

There also exists a demand for the end user credit control. The accounting application must be able to check the end user's account for coverage for the requested service event charge prior to execution of that service event. All the chargeable events related to a specific account must be prevented from the end user when the credit of that account is exhausted or expired.

Also a mechanism should be provided to indicate to the end user of the charges to be levied for a chargeable event.

There are as well services such as gaming or advertising that in some situations rather refund than deduct the end user's account.

To fulfill all these needs a new type of accounting application is needed, the credit control application. This application is used for real-time delivery of service event information in the service environment from the service element to the credit control server to minimize the financial risk.

1.1. Requirements language

In this document, the key words "MAY", "MUST, "MUST NOT", "optional", "recommended", "SHOULD", and "SHOULD NOT", are to be interpreted as described in [KEYWORDS].

1.2 Terminology

AAA
Authentication, Authorization and Accounting

Accounting
The act of collection of information on resource usage for the purposes of trend analysis, auditing, billing or cost allocation.

Accounting Server
The accounting server receives accounting data from the service elements and other devices and translates it into session records. It acts as an interface to back-end rating, billing, and operations support systems.

Charging
In the telecom world charging is synonym to accounting. A function whereby information related to a chargeable event is transferred in order to make it possible to determine usage for which the charged party may be billed.

Credit Control
Credit control is a mechanism, which directly interacts in real-time with an account and controls or monitors the charges, related to the service usage. Credit control is a process of checking if credit is available, credit-reservation, reduction of credit from the end user account when service is completed and refunding of reserved credit not used.

Credit Control Server
It is located in the home environment and is accessed by service elements in real-time for purpose of price determination and credit control before the service event is delivered to the end-user. It may also interact with business support systems.

Diameter Credit Control Client
A Diameter credit control client is an entity that interacts with a credit control server.

Diameter Credit Control Server
A Diameter credit control server is an entity that handles credit control request.

Rating
The act of determining the cost of the service event.

Service
A type of task that is performed by a service element for an end user.

Service Element
A network element that provides a service to end user. A service element itself can include the application service providers or application service providers can be located in an other domain.

Service Event
Any event which creates value for the end-user.

1.3 Advertising application support

Diameter nodes conforming to this specification MAY advertise support by including the value of TBD (X) in the Acct-Application-Id AVP of the Capabilities-Exchange-Request and Capabilities-Exchange-Answer command [DIAMBASE].

2 Architecture Model

A service element provides services to end-users. When accounting is used a service element collects service event information and reports it while and/or after services are provided to an accounting server by using an accounting protocol. Alternatively the accounting server may query the service element for service event information.

The accounting protocol can for example be RADIUS accounting protocol or the Diameter base protocol with a Diameter application.

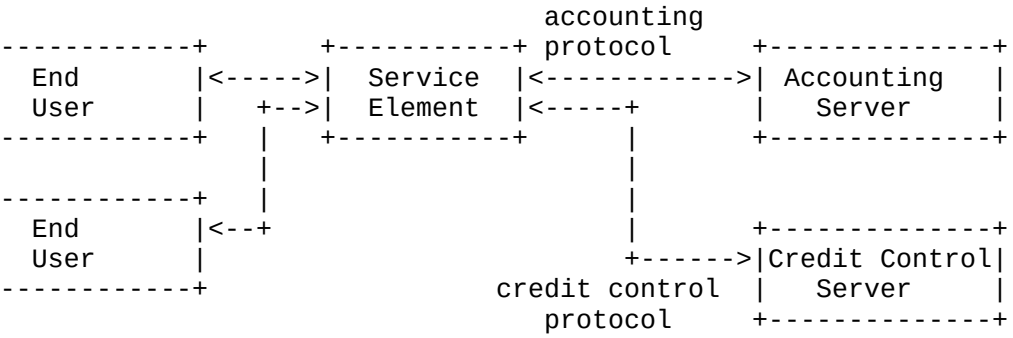
If real-time credit control is required, the service element (credit control client) contacts the credit control server with service event information included before the service is provided. The credit control server, depending on the service event information, MAY perform the rating of the service event, pricing of the service event, credit check and credit-reservation from the account. The service element monitors the service execution according to the instructions returned by the credit control server. After the service completion the credit control server deducts the money from the account.

If direct debiting/refunding is requested, the credit control server deducts/increases the end user's account, respectively. The service element can also enquire the price of the service or the account balance status from the credit control server.

In a multi-service environment it might happen that an end user with already ongoing service (e.g. voice call) issues a new service request (e.g. data service) towards same account or during an active multimedia session an additional media type is added to the session causing a new simultaneous request towards same account. Consequently this SHOULD be considered when units are granted to the services.

There MAY be multiple credit control servers in the system for reasons of redundancy and load balancing. The system MAY also contain separate rating server(s) and accounts MAY locate in a centralized database. System internal interfaces can exist to relay messages between servers and an account manager. However the detailed architecture of credit control system and its interfaces are implementation specific and are out of scope of this specification.

The credit control protocol is the Diameter base protocol with the Diameter credit control application.



The credit control server and accounting server in this architecture model are logical entities. The real configuration MAY combine them into a single host.

There MAY exist protocol transparent Diameter relays and redirect agents between credit control client and credit control server. These

agents transparently support the Diameter credit control application.

If Diameter credit control proxies exist between the credit control client and the credit control server, they MUST advertise the Diameter credit control application support.

3 Service Control

When an end user requests a service the request is forwarded to a service element in the home domain, that is the same administrative domain, in which the end user's credit control server is located. In some cases it might be possible that the service element in the visited domain can offer service event to the end user, but in that case a commercial agreement must exist between the service element in the visited domain and in the home domain.

The service element SHOULD authenticate and authorize the end user before any request is sent to the credit control server. The way how the authentication and/or authorization are performed in the service element and the authentication and/or authorization messages that are used are not defined in this application. The methods defined in other Diameter applications or other legacy authentication and authorization methods can be used.

Each credit control session MUST have globally unique Session-Id as defined in [DIAMBASE] and it MUST NOT be changed during the life time of a credit control session.

The Diameter credit control client in the service element MAY get information from the authorization server regarding the way accounting data shall be forwarded (accounting protocol, credit control protocol or both) based on its knowledge of the end user. This means that the accounting information is forwarded to the accounting server as defined in [DIAMBASE], the credit control server SHOULD be contacted before the service event is offered to the end user or both the accounting protocol and the credit control protocol MAY be used in parallel.

The authorization server MAY include the Accounting-Realtime-Required AVP to determine what to do if the sending of accounting records to the accounting server has been temporarily prevented as defined in [DIAMBASE]. The Accounting-Realtime-Required AVP is not used by this application. Instead of or in addition to the Accounting-Realtime-Required AVP the authorization server MAY include the Credit-Control-Failure-Handling AVP and Direct-Debiting-Failure-Handling AVP to determine what to do if the sending of credit control messages to the credit control server has been temporarily prevented. The usage of Credit-Control-Failure-Handling AVP and the Direct-Debiting-Failure-Handling AVP gives flexibility to have different failure handling for credit control session and one time event direct debiting. The credit control server MAY override the failure handling for credit control session by including the Credit-Control-Failure-Handling AVP in the Accounting-Answer.

The usage of separate AVPs makes it possible to have different failure handling towards accounting servers and credit control servers, in case both should be used parallel. It is recommended that the client complements the credit control failure procedures with backup accounting flow towards an accounting server. With different combinations of above AVPs different safety levels can be built. For example by choosing the Credit-Control-Failure-Handling AVP equal to CONTINUE and Accounting-Realtime-Required AVP equal to DELIVER_AND_GRANT the service can be granted to the end user even if

the connection to the credit control server is down but the accounting server is able to collect the accounting information, provided that there is information exchange taking place between the accounting server and credit control server.

If authentication and authorization is done based on Diameter application the authorization server MAY include the Acct-Interim-Interval AVP to control the operation of the device in the service element operating as a client as defined in [DIAMBASE]. If the Acct-Interim-Interval AVP is included then the interim interval MAY be present in the request message sent to the credit control server.

The Diameter credit control server MAY override the interim interval. It is up to the credit control server to determine, even independently from the requested value, the allowed interim interval to be used for consumption of the granted service units. The credit control server MAY return the interim interval in the Answer message to the credit control client. It can be included in the Answer message even in case it is not present in the Request message. Alternatively the accounting interim interval can be omitted from the Answer message. However, since interim records are also produced at the expiry of granted service units and/or for mid-session service events the omission of Acct-Interim-Interval does not mean that interim records are not produced.

During authorization, the authorization server MAY return the Accounting-Multi-Session-Id, which the Diameter credit control client MAY include in all subsequent accounting messages. The Accounting-Multi-Session-Id AVP MAY include the value of the original Session-Id. It's contents are implementation specific, but MUST be globally unique across other Accounting-Multi-Session-Id, and MUST NOT be changed during the life time of a credit control session.
There are certain applications that require multiple accounting sub-sessions. Such applications would send messages with a constant Session-Id AVP, but a different Accounting Sub-Session-Id AVP.
If several credit sub-sessions will be used, all sub-sessions MUST be closed separately before the closing the main session. The absence of this AVP implies no sub-sessions are in use.

If the credit control client wants to perform credit-reservation before granting service to the end user it MUST use several interrogations towards the credit control server. In this case the credit control server MUST maintain the accounting session state.

A one time event MAY be used when there is no need to maintain any state in the Diameter credit control server, for example enquiring the price of the service.

3.1 Session Based Credit Control

For a session based credit control several interrogations are needed: the first, intermediate (optional) and the final interrogation.

3.1.1 First Interrogation

The first interrogation MUST be sent before the Diameter credit control client in a service element allows any service event to the end user. The Accounting-Record-Type is set to the value START_RECORD in the first request message. The Subscription-Id-Data AVP SHOULD be included to identify the end-user in the credit control server.

If the Diameter credit control client knows the cost of the service event the monetary amount to be charged is included in the Requested-

Service-Unit AVP. If the Diameter credit control client does not know the cost of the service event, the Requested-Service-Unit AVP MAY contain the number of requested service events and the Service-Parameter-Info AVP SHOULD contain the service event information to be rated by the credit control server. The Service-Parameter-Info AVP always refers to the requested service units.

The Event-Timestamp AVP contains the time when the service event is requested in the service element.

The credit control server SHOULD rate the service event and make a credit-reservation from the end user's account that covers the cost of the service event. If the type of the Requested-Service-Unit AVP is money, no rating is needed but the corresponding monetary amount is reserved from end user's account.

The credit control server returns the Granted-Service-Unit AVP in the Answer message to the Diameter credit control client. The Granted-Service-Unit AVP contains the amount of service units that the Diameter credit control client can provide to the end user until a new Accounting-Request MUST be sent to the credit control server. If several unit types are sent in the Answer message the credit control client MUST handle each unit type separately. However there MUST be maximum one instance of the same unit type in one Answer message. When the granted service units for one unit type have been spent a new Accounting-Request MUST be sent to the credit control server even though there would be service units left for other units types. The type of the Granted-Service-Unit AVP can be time, volume, service specific or money depending on the type of service event. It is not allowed to change the unit type(s) within the session.

If the credit control server determines that no further control is needed for the service it MAY include the result code indicating that the credit control is not applicable (e.g. service is free of charge) and terminate the credit control session.

The Accounting-Answer message MAY also include the Final-Unit-Indication AVP to indicate that the Answer message contains the final units for the service session. After the end user has used these units, the Diameter credit control client is responsible for terminating the service session and the credit control session by sending the final interrogation to the credit control server.

3.1.2 Intermediate Interrogation

When all the granted service units for one unit type are spent by the end user or the interim interval is expired the Diameter credit control client MUST send a new Accounting-Request to the credit control server. In case the Acct-Interim-Interval is used it is always up to the Diameter credit control client to send a new request well in advance before the expiration of the previous request in order to avoiding interruption in the service element. Even if the granted service units reserved by the credit control server have not been spent upon expiration of the accounting interim interval, the Diameter credit control client MUST send a new Accounting-Request to the credit control server.

There can be also mid-session service events, which might affect the rating of the current service events. In this case a spontaneous updating (a new Accounting-Request) SHOULD be sent including information related to the service event even if all the granted service units have not been spent or the accounting interim interval has not expired.

When the used units are reported to the credit control server the credit control client will not have any units in its possession before new granted units are received from the credit control server. When the new granted units are received from the credit control server these units apply from the point where the measurement of the reported used units stopped.

The Accounting-Record-Type AVP is set to the value INTERIM_RECORD in the intermediate request message. The Subscription-Id-Data AVP SHOULD also be included in the intermediate message to identify the end user in the credit control server.

The Requested-Service-Unit AVP contains the new amount of requested service units. The Used-Service-Unit AVP contains the amount of used service units measured from the point when the service became active or, in case of interim interrogations are used during the session, from the point when the previous measurement ended. The same unit types that are used in the previous message MUST be used. If several unit types were included in the previous Answer message the used service units for each unit type MUST be reported.

The Event-Timestamp AVP contains the time of the event that triggered the sending of the new Accounting-Request.

The credit control server MUST deduct the used monetary amount from the end user's account. It MAY rate the new request and make a new credit-reservation from the end user's account that covers the cost of the requested service event.

The Accounting-Answer message with the Accounting-Record-Type AVP set to the value INTERIM_RECORD MAY include the Cost-Information AVP containing the accumulated cost estimation for the session without taking any credit-reservation into account.

There MAY be several intermediate interrogations within a session.

3.1.3 Final Interrogation

When the end user terminates the service session or when all the granted units are used after a Final-Unit-Indication AVP has been received from the credit control server, the Diameter credit control client MUST send a final Accounting-Request message to the credit control server. The Accounting-Record-Type AVP is set to the value STOP_RECORD.

The Event-Timestamp AVP MAY contain the time of the session was terminated.

The Used-Service-Unit AVP contains the amount of used service units measured from the point when the service became active or, in case of interim interrogations are used during the session, from the point when the previous measurement ended. If several unit types were included in the previous answer message the used service units for each unit type MUST be reported.

After final interrogation the credit control server MUST refund the reserved credit amount not used to the end user's account and deduct the used monetary amount from the end user's account.

The Accounting-Answer message with the Accounting-Record-Type set to the value STOP_RECORD SHOULD include the Cost-Information AVP containing the estimated total cost for the session in question.

3.1.4 Failure Procedures

Since the credit control application is based on real-time bi-directional communication between the credit control client and the credit control server alternative destinations and buffering of messages are not sufficient in the event of communication failures. Since the credit control server has to maintain a session state the credit control message stream MUST not be moved to a backup credit control server during an ongoing credit control session. However, Diameter agents MAY perform failover to an alternative agent when they detect a transport failure. As a consequence the credit control server MAY receive duplicate messages. These duplicates or out of sequence messages can be detected in the credit control server based on the credit control server session state machine (section 3.3), Session-Id AVP and Accounting-Record-Number AVP.

If a communication failure occurs during an ongoing credit control session the credit control client will terminate or continue the service depending on the value set in the Credit-Control-Failure-Handling AVP. The Credit-Control-Failure-Handling AVP MAY be sent from the authorization server and in the Accounting-Answer from the credit control server. For new credit control sessions failover to alternative credit control server SHOULD be performed, if possible.

The timer Tx (as defined in section 8) is used in the credit control client to supervise the communication with the credit control server.

If the credit control server detects a failure during an ongoing credit control session it will terminate the credit control session and return the reserved units back to the end user's account.

The supervision session timer Ts as defined in [DIAMBASE] is used in the credit control server.

3.2 One Time Event

The one time event is used when there is no need to maintain accounting session state in the credit control server.

The one time event can be used when the service element wants to know the cost of the service event without any credit-reservation or to check the account balance without any credit-reservation. It can be used also for refunding service units on the user's account or direct debiting without any credit-reservation.

3.2.1 Service Price Enquiry

Sometimes the service element needs to know the price of the service event. There might exist services offered by application service providers, whose prices are not known in the service element. End user might also want to get an estimation of the price of a service event before requesting it.

A Diameter credit control client requesting the cost information MUST set the Accounting-Record-Type AVP equal to EVENT_RECORD, include the Requested-Action AVP set to PRICE_ENQUIRY and set the requested service event information into the Service-Parameter-Info AVP in the Accounting-Request message.

The credit control server calculates the cost of the requested service event, but it does not perform any account balance check or credit-reservation from the account.

The estimated price of the requested service event is returned to the credit control client in the Cost-Information AVP in the Accounting-Answer message.

3.2.2 Balance Check

Sometimes Diameter credit control client needs only to verify that the end user's account balance covers the cost for a certain service without reserving any units from the account at the time of the enquiry. This method does not guarantee that there would be credit left when the Diameter credit control client requests the debiting of the account with a separate request.

A Diameter credit control client requesting the balance check MUST set the Accounting-Record-Type AVP equal to EVENT_RECORD, include Requested-Action AVP set to CHECK_BALANCE and include the Subscription-Id-Data to identify the End-User in the credit control server.

The credit control server makes the balance check, but it does not do any credit-reservation from the account.

The result of balance check (Credit/No Credit) is returned to the credit control client in the Check-Balance-Result AVP in the Accounting-Answer message.

3.2.3 Direct Debiting

There are certain one time events for which service execution is always successful in the service environment. Sometimes the delay between the service invocation and the actual service delivery to the end user can be so long that the use of the session based credit control would lead to unreasonable long credit control sessions. In these cases the Diameter credit control client can use the one time event scenario for direct debiting. The Diameter credit control client SHOULD be sure that the requested service event execution will be successful, when this scenario is used.

The Accounting-Record-Type is set to the value EVENT_RECORD and the Requested-Action AVP set to DIRECT_DEBITING in the Accounting-Request message. The Subscription-Id-Data AVP SHOULD be included to identify the End-User in the credit control server. The Event-Timestamp AVP contains the time when the service event is requested in the service element.

The Diameter credit control client MAY include the monetary amount to be charged in the Request-Service-Unit AVP, if it knows the cost of the service event. If the Diameter credit control client does not know the cost of the service event, then the Service-Parameter-Info AVP SHOULD contain the service event information to be rated by the credit control server. The Service-Parameter-Info AVP always refers to the requested service unit.

The credit control server SHOULD rate the service event and deduct the corresponding monetary amount from end user's account. If the type of the Requested-Service-Unit AVP is money, no rating is needed but the corresponding monetary amount is deducted from the End User's account.

The credit control server returns the Granted-Service-Unit AVP in the Answer message to the Diameter credit control client. The Granted-Service-Unit AVP contains the amount of service units that the

Diameter credit control client can provide to the end user. The type of the Granted-Service-Unit can be time, volume, service specific or money depending on the type of service event.

If the credit control server determines that no credit control is needed for the service it MAY include the result code indicating that the credit control is not applicable (e.g. service is free of charge).

For informative purposes, the Accounting-Answer message SHOULD also include the Cost-Information AVP containing the estimated total cost of the requested service.

3.2.4 Refund

There MAY be a need to refund service units on the end user's account, for example gaming services.

The credit control client MUST set Accounting-Record-Type AVP to the value EVENT_RECORD and the Requested-Action AVP to REFUND in the Accounting-Request message. The Subscription-Id-Data AVP SHOULD be included to identify the End-User in the credit control server.

The Diameter credit control client MAY include the monetary amount to be refunded in the Request-Service-Unit AVP, if it knows the cost of the service event. If the Diameter credit control client does not know the cost of the service event, then the Service-Parameter-Info AVP SHOULD contain the service event information to be rated by the credit control server. The Service-Parameter-Info AVP always refers to the requested service unit.

For informative purposes, the Accounting-Answer message MAY also include the Cost-Information AVP containing the estimated monetary amount of refunded unit.

3.2.5 Failure Procedure

There MAY exist protocol transparent Diameter relays and redirect agents or Diameter credit control proxies between credit control client and credit control server. These agents MAY perform failover procedures if they detect transport failure as described in [DIAMBASE].

When the credit control client detects a communication failure to the credit control server its behavior depends on the requested action. The timer Tx (as defined in section 8) is used in the credit control client to supervise the communication with the credit control server.

In case the requested action is Service Price Enquiry or Balance Check and communication failure is detected the credit control client MAY forward the request messages to an alternative credit control server, if possible.

If the requested action is DIRECT_DEBITING and the Direct-Debiting-Failure-Handling AVP is set to TERMINATE_OR_BUFFER the credit control client SHOULD terminate the service if it can determine from the result code or error code in the answer message that units have not been debited. Otherwise the credit control client SHOULD grant the service to the end user and store the record in the credit control application level non-volatile storage. The credit control client MUST mark these request messages as possible duplicate by setting the T-flag in the command header as described in [DIAMBASE] section 3. If the Direct-Debiting-Failure-Handling AVP is set to CONTINUE the

service SHOULD be granted even if credit control messages can't be delivered. If the timer Tx expires the credit control client MUST continue the service and eventually buffer the request according to the value of the Direct-Debiting-Failure-Handling AVP.

The Accounting-Request with requested action REFUND should always be stored in the credit control application level non-volatile storage in case of temporary failure. The credit control client MUST mark the re-transmitted request message as possible duplicate by setting the T-flag in the command header as described in [DIAMBASE] section 3.

The implementation MAY choose to limit the number of re-transmission attempts and define a re-transmission interval.

Because there can appear duplicate request for various reason the credit control server is therefore responsible for the real time duplicate detection. Implementation issues for duplicate detection are discussed in [DIAMBASE] Appendix C. When the credit control client re-sends messages from its application level non-volatile storage it MUST mark these request messages as possible duplicate by setting the T-flag in the command headers as described in [DIAMBASE] section 3.

Only one place in the credit control system SHOULD be responsible for duplicate detection. If there is only one credit control server within the given realm the credit control server MAY perform duplicate detection. In case when more than one credit control server are supporting the credit control application the accounting manager controlling the account database MAY be responsible for duplicate detection.

3.3 Credit Control Session State Machine

The following state machines MUST be supported for credit control applications.

The first two state machines are to be observed by credit control clients. The first one describes the session based credit control and the second one event based credit control. The third state machine describes the credit control session from a credit control server perspective.

Any event not listed in the state machines MUST be considered as an error condition, and a corresponding answer, if applicable, MUST be returned to the originator of the message.

In the state table, the event 'Failure to send' means that the Diameter credit control client is unable to communicate with the desired destination (i.e. the answer message is not received within the validity time of the request). This could be due to the peer being down, or due to a physical link failure in the path to/from the credit control server.

The event 'Temporary error' means that the Diameter credit control client received a transient failure notification in the Accounting Answer command (i.e. the peer sending back a transient failure or temporary protocol error notification DIAMETER_TOO_BUSY, or DIAMETER_LOOP_DETECTED in the Result-Code AVP).

The event 'Failed answer' means that the Diameter credit control client received non-transient failure (permanent failure) notification in the Accounting Answer command.

The action 'store record' means that a record is stored in the credit control application level non-volatile storage.

The event 'Not successfully processed' means that the credit control server could not process the message, e.g. due to unknown end user, account being empty or due to errors defined in [DIAMBASE].

The states PendingS, PendingI, PendingL PendingE and PendingB stand for pending states to wait for an answer to an accounting request related to a Start, Interim, Stop, Event or Buffered record respectively.

CLIENT, SESSION BASED

State	Event	Action	New State
Idle	Client or device requests access	Send accounting start req., start Tx.	PendingS
PendingS	Successful accounting start answer received	Stop Tx	Open
PendingS	Failure to send, or temporary error and credit control fault handling equal to CONTINUE	Grant service to end user	Idle
PendingS	Failure to send, or temporary error and credit control fault handling equal to TERMINATE	Disconnect user/dev	Idle
PendingS	Tx expired and credit Control fault handling equal to TERMINATE	Disconnect user/dev	Idle
PendingS	Tx expired and credit control fault handling equal to CONTINUE	Grant service to end user	Idle
PendingS	Accounting start answer received with result code SERVICE_ DENIED or USER_NOT_FOUND	Disconnect user/dev	Idle
PendingS	Accounting start answer received with result code equal to credit control N/A	Grant service to end user	Idle
PendingS	Failed accounting start answer received and credit control fault handling equal to CONTINUE	Grant Service to end user	Idle
PendingS	Failed accounting start answer received and credit control failure handling equal to TERMINATE	Disconnect user/dev	Idle
PendingS	User service terminated	Queue termination event	PendingS

PendingS	Change in rating condition	Queue changed rating condition event	PendingS
Open	Granted unit elapses and no final unit indication received	Send accounting interim req., start Tx.	PendingI
Open	Granted unit elapses and final unit indication received	Disconnect send accounting stop req., start Tx.	PendingL
Open	Change in rating condition in queue	Send accounting interim req., Start Tx.	PendingI
Open	Service terminated in queue	Send accounting stop req., start Tx	PendingL
Open	Change in rating condition or interim interval elapses	Send accounting interim req., Start Tx.	PendingI
Open	User service terminated	Send accounting stop req., start Tx	PendingL
PendingI	Successful accounting interim answer received	Stop Tx	Open
PendingI	Failure to send, or temporary error and credit control fault handling equal to CONTINUE	Grant service to end user	Idle
PendingI	Failure to send, or temporary error and credit control fault handling equal to TERMINATE	Disconnect user/dev	Idle
PendingI	Tx expired and credit control fault handling equal to TERMINATE	Disconnect user/dev	Idle
PendingI	Tx expired and credit control fault handling equal to CONTINUE	Grant service to end user.	Idle
PendingI	Accounting interim answer received with result code SERVICE_DENIED	Disconnect user/dev	Idle

PendingI	Accounting interim answer received with result code equal to credit control N/A	Grant service to end user	Idle
PendingI	Failed accounting interim answer received and credit control fault handling equal to CONTINUE	Grant service to end user.	Idle
PendingI	Failed accounting interim answer received and credit control fault handling equal to TERMINATE	Disconnect user/dev	Idle
PendingI	User service terminated	Queue termination event	PendingI
PendingI	Change in rating condition	Queue changed rating condition event	PendingI
PendingL	Successful accounting stop answer received		Idle
PendingL	Tx expired		Idle
PendingL	Failure to send, or temporary error or failed answer		Idle
PendingL	Change in rating condition		PendingL

CLIENT, EVENT BASED

State	Event	Action	New State
Idle	Client or device requests a one-time service	Send accounting event req., Start Tx.	PendingE
Idle	Records in storage	Send stored records	PendingB
PendingE	Successful accounting event answer received		Idle
PendingE	Failure to send, temporary error or failed accounting event answer received, or Tx expired, requested action GET_BALANCE or PRICE_ENQUIRY	Indicate service error	Idle
PendingE	Accounting event answer received with result code SERVICE_ DENIED or USER_NOT_FOUND	Disconnect user/dev	Idle

PendingE	Accounting event answer received with result code credit control N/A, requested action DIRECT_DEBITING	Grant service to end user	Idle
PendingE	Failure to send, temporary error or failed accounting event answer received, or Tx expired, requested action DIRECT_DEBITING and fault handling equal to CONTINUE	Grant service to end user	Idle
PendingE	Failed accounting event answer received, requested action DIRECT_DEBITING and fault handling equal to TERMINATE_OR_BUFFER	Disconnect user/dev	Idle
PendingE	Failure to send or Tx expired, requested action DIRECT_DEBITING and fault handling equal to TERMINATE_OR_BUFFER	Grant service to end user and store record with T-flag	Idle
PendingE	Temporary error, requested action DIRECT_DEBITING and fault handling equal to TERMINATE_OR_BUFFER	Disconnect user/dev	Idle
PendingE	Failed accounting event answer received, requested action REFUND	Indicate service error and delete record	Idle
PendingE	Failure to send or Tx expired, requested action REFUND	Store record with T-flag	Idle
PendingE	Temporary error and requested action REFUND	Store record	Idle
PendingB	Successful accounting answer received	Delete record	Idle
PendingB	Failed accounting answer received	Delete record	Idle
PendingB	Failure to send or temporary error		Idle

SERVER, SESSION AND EVENT BASED

State	Event	Action	New State
Idle	Accounting start request received and successfully processed.	Send accounting start answer,	Open

		reserve units, start Ts	
Idle	Accounting start request received, but not successfully processed.	Send accounting start Answer with Result-Code != SUCCESS	Idle
Idle	Accounting event request received and successfully processed.	Send accounting event answer, debit units	Idle
Idle	Accounting event request received, but not successfully processed.	Send accounting event Answer with Result-Code != SUCCESS	Idle
Open	Accounting Interim request received and successfully processed	Send accounting answer, debit used units and reserve new units, Restart Ts	Open
Open	Accounting interim request received, but not successfully processed.	Send accounting interim Answer with Result-Code != SUCCESS, debit used units	Idle
Open	Accounting stop request received, and successfully processed	Send accounting stop answer, Stop Ts, debit used units	Idle
Open	Accounting stop request received, but not successfully processed.	Send accounting stop Answer with Result-Code != SUCCESS, debit used units	Idle
Open	Session supervision timer Ts expired	Stop Ts, release reserved units	Idle

4 Accounting AVPs

This section defines the accounting AVPs that are specific to Diameter Credit Control Application and MAY be included in the Diameter accounting messages [DIAMBASE].

Accounting-Request command MAY include the following additional AVPS:

```
  [ Subscription-Id ]
  [ Requested-Action ]
 *[ Requested-Service Unit ]
 *[ Used-Service-Unit ]
 *[ Service-Parameter-Info ]
  [ Abnormal-Termination-Reason]
 *[ Accounting-Correlation-Id ]
  [ Credit-Control-Failure-Handling ]
```

Accounting-Answer command MAY include a following additional AVPS:

```
  [ Subscription-Id ]
 *[ Granted-Service-Unit ]
  [ Cost-Information]
  [ Final-Unit-Indication ]
  [ Check-Balance-Result ]
  [ Credit-Control-Failure-Handling ]
```

The following table describes the Diameter AVPs defined in Credit Control application, their AVP Code values, types, possible flag values and whether the AVP MAY be encrypted.

				AVP Flag rules				
Attribute Name	AVP Code	Section Defined	Data Type	MUST	MAY	SHLD NOT	MUST NOT	MAY Encr
Abnormal-Termination-Reason	XXX	4.1	Enumerated	M	P		V	Y
Accounting-Correlation-Id	XXX	4.2	OctetString	M	P		V	Y
Check-Balance-Result	XXX	4.3	Enumerated	M	P		V	Y
Cost-Information	XXX	4.5	Grouped	M	P		V	Y
Credit-Control-Failure-Handling	XXX	4.6	Enumerated	M	P		V	Y
Direct-Debiting Failure-Handling	XXX	4.8	Enumerated	M	P		V	Y
Final-Unit-Indicator	XXX	4.9	Unsigned32	M	P		V	Y
Granted-Service-Unit	XXX	4.10	Grouped	M	P		V	Y
Requested-Action	XXX	4.11	Enumerated	M	P		V	Y
Requested-Service Unit	XXX	4.12	Grouped	M	P		V	Y
Service-Parameter Info	XXX	4.14	Grouped	M	P		V	Y
Subscription-Id	XXX	4.17	Grouped	M	P		V	Y
Used-Service-Unit	XXX	4.22	Grouped	M	P		V	Y

4.1 Abnormal-Termination-Reason AVP

The Abnormal-Termination-Reason AVP (AVP Code TBD) is of type Enumerated and contains information about the reason for an abnormal service termination in a service element.

The following reasons are defined:

SERVICE_ELEMENT_TERMINATION 0
An error occurred in the service element.

CONNECTION_TO_END-USER_BROKEN 1
The connection to the end-user is broken.

4.2 Accounting-Correlation-Id AVP

The Accounting-Correlation-Id AVP (AVP Code TBD) is type of OctetString and contains information to correlate accounting data generated for different components of the service, e.g. transport and service level.

4.3 Check-Balance-Result AVP

The Check Balance Result AVP (AVP code TBD) is of type Enumerated and contains the result of the balance check. This AVP is applicable only when the Requested-Action AVP indicates CHECK_BALANCE in the Accounting-Request command.

The following values are defined for the Check-Balance-Result AVP.

ENOUGH_CREDIT 0
There is enough credit in the account to cover the requested service.

NO_CREDIT 1
There isnÆt enough credit in the account to cover the requested service.

4.4 Cost-Information AVP

The Cost-Information AVP (AVP Code TBD) is of type Grouped and is used to return the cost information of a service in the Accounting-Answer command. The included Unit-Value AVP contains the cost estimate (always type of money) of the service in case of price enquiry or the accumulated cost estimation in the case of credit control session.
The Currency-Code specifies in which currency the cost was given.

When the Requested-Action AVP with value PRICE_ENQUIRY is included in the Accounting-Request command the Cost-Information AVP sent in the succeeding Accounting-Answer command contains the cost estimation of the requested service, without any reservation being made.

The Cost-Information AVP included in the Accounting-Answer command with the Accounting-Record-Type set to INTERIM_RECORD contains the accumulated cost estimation for the session without taking any credit-reservation into account.

The Cost-Information AVP included in the Accounting-Answer command with the Accounting-Record-Type set to EVENT_RECORD or STOP_RECORD contains the estimated total cost for the requested service.

It has the following ABNF grammar:

```
<Cost-Information>::=< AVP Header: TBD >
                    { Unit-Value }
                     { Currency-Code }
```

4.5 Credit-Control-Failure-Handling AVP

The Credit-Control-Failure-Handling AVP (AVP Code TBD) is of type Enumerated. The credit control client uses information in this AVP to decide what to do if the sending of credit control messages to the credit control server has been for instance temporarily prevented due to a network problem.

TERMINATE 0
When the Credit-Control-Failure-Handling AVP is set to TERMINATE the service MUST only be granted as long as there is a connection to the credit control server. If the credit control client does not receive any Accounting-Answer message within the Tx timer (as defined in section 8) the credit control request is regarded failed. The moving of already started credit control session to alternative server is not allowed.

This is the default behaviour if the AVP isn't included in the reply from the authorization or credit control server.

CONTINUE 1
When the Credit-Control-Failure-Handling AVP is set to CONTINUE the service SHOULD be granted even if credit control messages can't be delivered.

4.6 Currency-Code AVP

The Currency-Code AVP (AVP Code TBD) is of type Unsigned32 and contains a currency code that specifies in which currency the values of AVPs containing monetary units were given. It is specified using the numeric values defined in the ISO 4217 standard.

4.7 Direct-Debiting-Failure-Handling AVP

The Direct-Debiting-Failure-Handling AVP (AVP Code TBD) is of type Enumerated. The credit control client uses information in this AVP to decide what to do if the sending of credit control messages (Requested-Action AVP set to Direct Debiting) to the credit control server has been for instance temporarily prevented due to a network problem.

TERMINATE_OR_BUFFER 0
When the Direct-Debiting-Failure-Handling AVP is set to TERMINATE_OR_BUFFER the service MUST be granted as long as there is a connection to the credit control server. If the credit control client does not receive any Accounting-Answer message within the Tx timer (as defined in section 8) the credit control request is regarded failed. The client SHOULD terminate the service if it can determine from the failed answer that units have not been debited. Otherwise the credit control client SHOULD grant the service, store the request to application level non-volatile storage and try to re-send the request. These requests MUST be marked as possible duplicate by setting the T-flag in the command header as described in [DIAMBASE] section 3.

This is the default behaviour if the AVP isn't included in the reply from the authorization server.

CONTINUE 1
When the Direct-Debiting-Failure-Handling AVP is set to CONTINUE the service SHOULD be granted even if credit control messages can't be delivered.

4.8 Exponent AVP

Exponent AVP is of type Integer32 (AVP code TBD) and contains the exponent value to be applied for the Value-Digit AVP within the Unit-Value AVP.

4.9 Final-Unit-Indication AVP

The Final-Unit-Indication AVP (AVP Code TBD) is of type Unsigned32 and indicates that the Granted-Service-Unit AVP in the accounting command contains the final units for the service. After these units have expired, the Diameter credit control client in a service element is responsible for terminating the service and sending the STOP_RECORD to the credit control server.
If more than one unit types are received in the Accounting-Answer, the Unit type which first expired SHOULD cause the termination.
If included in a command, the value of this AVP is always 1.

4.10 Granted-Service-Unit AVP

Granted-Service-Unit AVP (AVP Code TBD) is of type Grouped and contains the amount of units that the Diameter credit control client can provide to the end user until the service must be released or the new Accounting-Request must be sent. The Unit-Value AVP contains the granted units and the Unit-Type AVP defines the type of the unit.

If the Unit-Type AVP is set to time in the Accounting-Answer command, the Unit Value AVP specifies the granted time in seconds.

If the Unit-Type AVP is set to volume in the Accounting-Answer command, the Unit-Value AVP specifies the granted volume in bytes.

If the Unit-Type AVP is set to service specific in the Accounting-Answer command, the Unit-Value AVP specifies the granted number of service specific units (e.g. number of events, points) given in a selected service.

If the Unit-Type AVP is set to money in the Accounting-Answer command, the Unit-Value AVP specifies the granted monetary amount in the given currency. If the unit type is money, a Currency-Code AVP SHOULD be included.

It has the following ABNF grammar:

```
<Granted-Service-Unit>::=< AVP Header: TBD >
                          { Unit-Type }
                          { Unit-Value }
                          [ Currency-Code ]
```

4.11 Requested-Action AVP

The Requested-Action AVP (AVP Code TBD) is type of Enumerated and contains the requested action being sent by Accounting-Request command where the Accounting-Record-Type is set to EVENT_RECORD. The following values are defined for the Requested-Action AVP:

DIRECT DEBITING 0
Direct debiting indicates that the request is to decrease the end user's account according to information specified in the Requested-Service-Unit AVP and/or Service-Parameter-Info AVP. The Granted-Service Unit AVP in the Accounting-Answer command contains the debited units.

REFUND ACCOUNT 1
Refund account indicates that the request is to increase the end

user's account according to information specified in the Requested-Service-Unit AVP and/or Service-Parameter-Info AVP. The Granted-Service Unit AVP in the Accounting-Answer command contains the refunded units.

CHECK_BALANCE 2
Check balance indicates that the request is a balance check request. In this case the checking of the account balance is done without any credit reservation from the account. The Check-Balance-Result AVP in the Accounting-Answer command contains the result of the Balance Check.

PRICE_ENQUIRY 3
Price Enquiry indicates that the request is a price enquiry request. In this case neither checking of the account balance nor reservation from the account will be done, only the price of the service will be returned in the Cost-Information AVP in the Accounting-Answer Command.

4.12 Requested-Service-Unit AVP

The Requested-Service-Unit AVP (AVP Code TBD) is of type Grouped and contains the amount of requested units specified by the Diameter credit control client. The included Unit-Value AVP contains the requested Unit-Value and the Unit-Type AVP defines the type of the unit.

If the Unit Type AVP is set to time in the Accounting-Request command, the Unit-Value AVP specifies the requested time in seconds.

If the Unit-type AVP is set to volume in the Accounting-Request command, the Unit-Value AVP specifies the requested volume in bytes.

If the Unit-type AVP is set to service specific in the Accounting-Request command, the Unit-Value AVP specifies the used number of service specific units (e.g. number of events) given in a selected service.

If the Unit-Type AVP is set to money in the Accounting-Request command, the Unit-Value AVP specifies the monetary amount in the given currency. If the unit type is money, a Currency-Code AVP SHOULD be included.

It has the following ABNF grammar:

```
<Requested-Service-Unit>::=< AVP Header: TBD >
                           { Unit-Type }
                           { Unit-Value }
                           [ Currency-Code ]
```

4.13 Service-Parameter-Info AVP

The Service-Parameter-Info AVP (AVP Code TBD) is of type Grouped and contains a service specific information used for price calculation or rating. The Service-Parameter-Type AVP defines the service parameter type and the Service-Parameter-Value AVP contains the parameter value. Alternatively it MAY also contain IANA registered standard AVPs or vendor specific AVPs. The actual contents of these AVPs are not within the scope of this document and SHOULD be defined in another Diameter application, standards written by other standardization bodies, or service specific documentation.

In case of unknown service request (e.g. unknown AVP or Service-Parameter-Type), the corresponding answer message MUST contain error code DIAMETER_AVP_UNSUPPORTED or DIAMETER_INVALID_AVP_VALUE. An Accounting Answer message with these errors MUST contain one or more FAILED-AVP AVPs containing the AVPs that caused the failure.

It has the following ABNF grammar:

```
<Service-Parameter-Info>::=< AVP Header: TBD >
                           [ Service-Parameter-Type ]
                           [ Service-Parameter-Value ]
                           [ AVP ]
```

4.14 Service-Parameter-Type AVP

The Service-Parameter-Type AVP is of type Unsigned32 (AVP Code TBD) and defines the type of the service event specific parameter (e.g. it can be end-user location, service name). The different parameters and their types are service specific and the meanings of these parameters are not defined in this document. The Service-Parameter-Value AVP contains the service parameter type.

4.15 Service-Parameter-Value AVP

The Service-Parameter-Value AVP is of type UTF8String (AVP Code TBD) and contains the value of the service parameter type.

4.16 Subscription-Id AVP

The Subscription-Id AVP (AVP Code TBD) is used to identify the end userÆs subscription and is of type Grouped. The Subscription-Id AVP includes a Subscription-Id-Data AVP that hold the identifier and a Subscription-Id-Type AVP that defines the identifier type.

It has the following ABNF grammar:

```
<Subscription-Id>::=< AVP Header: TBD >
                    { Subscription-Id-Data }
                    { Subscription-Id-Type }
```

4.17 Subscription-Id-Data AVP

The Subscription-Id-Data AVP (AVP Code TBD) is used to identify the end-user and is of type UTF8String. The Subscription-Id-Type AVP defines which type of identifier is used.

4.18 Subscription-Id-Type AVP

The Subscription-Id-Type AVP (AVP Code TBD) is of type Enumerated and it is used to determine which type of identifier that is carried by the Subscription-Id AVP.

The identifier can be one of the following:

END_USER_MSISDN 0
The identifier is in international MSISDN format, according to the ITU-T E.164 numbering plan as defined in [E164] and [CE164].

END_USER_IMSI 1
The identifier is in international IMSI format, according to the ITU-T E.212 numbering plan as defined in [E121] and [CE121].

END_USER_SIP_URL 2
The identifier is in the form of a SIP URL as defined in [SIP].

END_USER_NAI 3
The identifier is in the form of a Network Access Identifier as defined in [NAI].

END_USER_PRIVATE 4
The Identifier is a credit control server private identifier.

4.19 Unit-Type AVP

The Unit-Type AVP is of type Enumerated (AVP Code TBD) and contains the type of the unit.
The unit type can be one of the following:

CREDIT_TYPE_TIME 0
The unit is of type time, given in seconds.

CREDIT_TYPE_VOLUME 1
The unit is of type volume, given in bvtes.

CREDIT_TYPE_SERVICE_SPECIFIC 2
The unit is service specific (e.g. number of events, points, chips, services etc), given in a selected service.

CREDIT_TYPE_MONEY 3
The unit is of type money, given as a monetary value, whose currency SHOULD be specified by the Currency-Code AVP.

4.20 Unit-Value AVP

Unit-Value AVP is of type Grouped (AVP Code TBD). The value can be time in seconds, volume in bytes, number of service specific units or monetary amount depending on the given unit type. The Unit-Value is a value together with an exponent, i.e. Unit-Value = Value-Digits AVP * 10^Exponent. This representation avoids unwanted rounding off. For example the value of 2,3 is represented as Value-Digits = 23 and Exponent = -1. The absence of exponent part MUST be interpreted as exponent being equal to zero.

It has the following ABNF grammar:

```
<Unit-Value>::=< AVP Header: TBD >
              { Value-Digits }
              [ Exponent ]
```

4.21 Used-Service-Unit AVP

The Used-Service-Unit AVP is of type Grouped AVP (AVP Code TBD) and contains the amount of used units measured from the point when the service became active or, in case of interim interrogations are used during the session, from the point when the previous measurement ended. The included Unit-Type AVP defines the type of the unit and the Unit-Value AVP contains the used amount.

If the Unit Type AVP is set to time in the Accounting-Request command, the Unit-Value AVP specifies the used time in seconds.

If the Unit-Type AVP is set to volume in the Accounting-Request command, the Unit-Value AVP specifies the used volume in bytes.

If the Unit-type AVP is set to service specific in the Accounting-Request command, the Unit-Value AVP specifies the used number of service specific units (e.g. number of events) given in a selected service.

If the Unit-Type AVP is set to money in the Accounting-Request command, the Unit-Value AVP specifies the used monetary amount in the given currency. If the unit type is money, a Currency-Code AVP SHOULD be included.

It has the following ABNF grammar:

```
<Used-Service-Unit>::=< AVP Header: TBD >
                       { Unit-Type }
                       { Unit-Value }
                       [ Currency-Code ]
```

4.22 Value-Digits AVP

The Value-Digits AVP is of type Unsigned64 (AVP code TBD) and contains the number of seconds, volume in bytes, number of service specific units or monetary amount depending on the given Unit-Type AVP. If decimal values are needed to present the units, the scaling MUST be indicated with the related Exponent AVP. For example for the monetary amount $ 0,05 the value of Value-Digits AVP MUST be set to 5 and the scaling MUST be indicated with the Exponent AVP set to û2.

5 Result Code AVP values

This section defines new Result-Code AVP [DIAMBASE] values that must be supported by all Diameter implementations that conform to this specification.

The Accounting-Answer message includes the Result-Code AVP, which MAY indicate that an error was present in the Accounting-Request message. A rejected Accounting-Request message SHOULD cause the userÆs session to be terminated.

5.1 Transient Failure

Errors that fall within the transient failures category are used to inform a peer that the request could not be satisfied at the time it was received, but MAY be able to satisfy the request in the future.

DIAMETER_END_USER_SERVICE_DENIED 40XX
The credit control server denies the service request due to service restrictions or limitations related to the end-user, for example the end-user's account could not cover the requested service.

DIAMETER_CREDIT_CONTROL_NOT_APPLICABLE 40XX
The credit control server determines that the service can be granted to the end user but no further credit control is needed for the service (e.g. service is free of charge).

5.2 Permanent Failures

Errors that fall within permanent failure category are used to inform the peer that the request failed, and should not be attempted again.

DIAMETER_USER_UNKNOWN 50XX
The specified end user is unknown in the credit control server.

6 AVP Occurrence Table

The following table presents the AVPs defined in this document, and specifies in which Diameter messages they MAY, or MAY NOT be present. Note that AVPs that can only be present within a Grouped AVP are not represented in this table.

The table uses the following symbols:

0	The AVP MUST NOT be present in the message.
0+	Zero or more instances of the AVP MAY be present in the message.
0-1	Zero or one instance of the AVP MAY be present in the message. It is considered an error if there are more than once instance of the AVP.
1	One instance of the AVP MUST be present in the message.
1+	At least one instance of the AVP MUST be present in the message.

6.1 Accounting AVP Table

The table in this section is used to represent which Credit Control applications specific AVPs defined in this document are to be present in the accounting messages.

Attribute Name	Command Code ACR	Command Code ACA
Abnormal-Termination-Reason	0-1	0
Accounting-Correlation-Id	0-1	0
Credit-Control-Failure-Handling	0-1	0-1
Check-Balance-Result	0	0-1
Cost-Information	0	0-1
Direct-Debiting-Failure-Handling AVP	0	0
Final-Unit-Indication	0	0-1
Granted-Service-Unit	0	0+
Requested-Action	0-1	0
Requested-Service-Unit	0-1	0
Service-Parameter-Info	0+	0
Subscription-Id	0-1	0-1
Used-Service-Unit	0+	0

7 IANA Considerations

This section contains the namespaces that have either been created in this specification, or the values assigned to existing namespaces managed by IANA.

7.1 Application Identifier

This specification assigns the value TBD to the Application Identifier namespace defined in [DIAMBASE]. See section 1.3 for more information.

7.2 Command Codes

This specification uses the value 271 from the Command code namespace

defined in [DIAMBASE].

7.3 AVP Codes

This specification assigns the values TBD - TBD from the AVP code namespace defined in [DIAMBASE] See section 4.0 for the assignment of the namespace in this specification.

7.4 Result-Code AVP Values

This specification assigns the values 40XX and 50XX from the Result-Code AVP (AVP Code 268) value namespace defined in [DIAMBASE]. See section 5.0 for the assignment of the namespace in this specification.

7.5 Abnormal-Termination-Reason AVP

As defined in Section 4.1, the Abnormal-Termination-Reason AVP (AVP Code TBD) defines the values 0-1. All remaining values are available for assignment via Designated Expert [IANA].

7.6 Check-Balance-Result AVP

As defined in Section 4.3, the Check-Balance-Result AVP (AVP Code TBD) defines the values 0-1. All remaining values are available for assignment via Designated Expert [IANA].

7.7 Credit-Control-Failure-Handling AVP

As defined in Section 4.6, the Credit-Control-Failure-Handling AVP (AVP Code TBD) defines the values 0-1. All remaining values are available for assignment via Designated Expert [IANA].

7.8 Direct-Debiting-Failure-Handling AVP

As defined in Section 4.8, the Direct-Debiting-Failure-Handling AVP (AVP Code TBD) defines the values 0-1. All remaining values are available for assignment via Designated Expert [IANA].

7.9 Requested-Action AVP

As defined in Section 4.11, the Requested-Action AVP (AVP Code TBD) defines the values 0-3. All remaining values are available for assignment via Designated Expert [IANA].

7.10 Subscription-Id-Type AVP

As defined in Section 4.17, the Subscription-Id-Type AVP (AVP Code TBD) defines the values 0-4. All remaining values are available for assignment via Designated Expert [IANA].

7.11 Unit-Type AVP

As defined in Section 4.20, the Unit-Type AVP (AVP Code TBD) defines the values 0-3. All remaining values are available for assignment via Designated Expert [IANA].

8 Credit Control Application related parameter

Tx timer
When real-time credit control is required, the credit control client contacts the credit control server before and during the service is provided to an end user. Due to real-time nature of

application the communication delays SHOULD be minimized, e.g. to avoid too long service set up time experienced by the end user. The Tx timer is introduced to control the waiting time in the client in the PENDING state.

The recommended value is 10 seconds.

9 Security Considerations

The security models as defined in the Diameter base protocol [DIAMBASE] applies to this application too.

10 References

10.1 Normative

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10.2 Non-Normative

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Annex B (informative): Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
Mar 2002	S_15	SP-020033	--	--	Submitted to TSG SA #15 for Information	1.0.0	
Jun 2002	S_16	SP-020327	--	--	Submitted to TSG SA #16 for the 2nd time for Information	1.5.0	
Sep 2002	S_17	SP-020453	--	--	Submitted to TSG SA #17 for Approval	2.0.0	5.0.0
Dec 2002	S_18	SP-020739	001	--	Remove ambiguity of the CCF Session State	5.0.0	5.1.0
Dec 2002	S_18	SP-020739	002	--	Addition of Application Server (AS) acting as a Voice Mail Server	5.0.0	5.1.0
Dec 2002	S_18	SP-020739	003	--	Corrections of definitions and ambiguity	5.0.0	5.1.0
Mar 2003	S_19	SP-030057	004	--	Alignment of Immediate Event Charging (IEC) description with the latest draft IEFT Credit-Control specification	5.1.0	5.2.0
Mar 2003	S_19	SP-030057	005	--	Correction of the IMS Charging Identifier (ICID) definition	5.1.0	5.2.0
Mar 2003	S_19	SP-030057	006	--	Correction of IMS-CDR definitions	5.1.0	5.2.0
Mar 2003	S_19	SP-030057	007	--	Inclusion of IETF draft 'Hakala-diameter-credit-control' specification version 05	5.1.0	5.2.0
Mar 2003	S_19	SP-030057	008	--	Removal of Re-Transmission Attribute Value Pair (AVP) in order to align duplicate detection procedure with the Diameter Base protocol	5.1.0	5.2.0
Mar 2003	S_19	SP-030057	009	--	Correction of the accounting session supervision (Offline) - alignment with the Diameter Base protocol	5.1.0	5.2.0
Mar 2003	S_19	SP-030057	010	--	Correction of the accounting session supervision (Online) - alignment with the Diameter Base protocol	5.1.0	5.2.0
Mar 2003	S_19	SP-030057	011	--	Correction of the support of local file storage and use of FTP for transfer of Accounting Information	5.1.0	5.2.0
Mar 2003	S_19	SP-030057	012	--	Correction of abnormal session termination procedure	5.1.0	5.2.0
Mar 2003	S_19	SP-030057	013	--	Correction of network initiated session release procedure - alignment with SIP (IETF RFC 3261)	5.1.0	5.2.0
Mar 2003	S_19	SP-030057	014	--	Correction of media modification procedures - add the UPDATE SIP method	5.1.0	5.2.0
Jun 2003	S_20	SP-030271	015	--	Corrections to align 'Event Charging with Unit Reservation' (ECUR) with IETF Credit Control Application	5.2.0	5.3.0
Jun 2003	S_20	SP-030271	016	--	Correction of usage of Application-Provided-Called-Party-Address AVP	5.2.0	5.3.0
Jun 2003	S_20	SP-030271	017	--	Correction of 'Cause' and 'Service-ID'AVP	5.2.0	5.3.0
Jun 2003	S_20	SP-030271	018	--	Correction to some AVP definitions	5.2.0	5.3.0
Jun 2003	S_20	SP-030271	019	--	Correction on ICID definition	5.2.0	5.3.0
Dec 2003	S_22	SP-030622	020	--	Correction of MRFC-CDR content definition for multi-party-call establishment	5.3.0	5.4.0
Dec 2003	S_22	SP-030622	021	--	Correction on ICID definition	5.3.0	5.4.0
Dec 2003	S_22	SP-030622	022	--	Removal of ASR and ASA	5.3.0	5.4.0
Mar 2004	S_23	SP-040143	023	--	Correction of AVP Codes and Diameter protocol specific details	5.4.0	5.5.0
Mar 2004	S_23	SP-040143	024	--	Corrections on the Session Description Protocol (SDP) parameters	5.4.0	5.5.0
Mar 2004	S_23	SP-040143	025	--	Correction of reference to diameter base protocol	5.4.0	5.5.0

History

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