PacketCable™ 2.0

Accounting Specification

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Key to Document Status Codes:

Work in Progress An incomplete document, designed to guide discussion and generate feedback that may include several alternative requirements for consideration.

Draft A document in specification format considered largely complete, but lacking review by Members and vendors. Drafts are susceptible to substantial change during the review process.

Issued A stable document, which has undergone rigorous member and vendor review and is suitable for product design and development, cross-vendor interoperability, and for certification testing.

Closed A static document, reviewed, tested, validated, and closed to further engineering change requests to the specification through CableLabs.

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1 SCOPE

1.1 Introduction and Purpose

The purpose of this specification is to define the requirements and functionality needed to support Accounting within this release of the PacketCable Architecture. PacketCable is a CableLabs specification effort designed to extend cable's real-time IP communication service architecture and to accelerate the convergence of voice, video, data, and mobility technologies.

The primary focus of this document is to define how the collection of usage data is done to ensure that the required billing functions can be supported, though usage data may also be used for other purposes (e.g., network or service trend analysis, network planning, and traffic engineering).

In addition to defining how the collection of usage data is done, this specification details the various accounting events and their associated attributes.

An Accounting Event message is a data record containing information about network usage and activities. A single Accounting Event may contain a complete set of data regarding usage or it may only contain part of the total usage information. When correlated by the Charging Data Function (CDF), information contained in multiple Accounting Events provides a complete record of the service. This complete record of the service is often referred to as a Call Detail Record (CDR). Accounting Events or CDRs may be sent to one or more back office applications such as a billing system, fraud detection system, or pre-paid services processor.

The structure of an Accounting Event Message data record is designed to be flexible and extensible in order to carry information about network usage for a wide variety of services.

Finally, the PacketCable Accounting architecture needs to support the correlation of accounting events generated in the session and bearer domains. Given that the bearer domain is based on PacketCable Multimedia, which defines its own accounting architecture, PacketCable needs to extend the IMS accounting architecture to seamlessly interwork with this cable-specific access network. Fortunately, IMS provides for extension points in both the session establishment and accounting protocols to accommodate access network specific accounting needs.

1.2 Requirements

Throughout this document, the words that are used to define the significance of particular requirements are capitalized. These words are:

"MUST"	This word means that the item is an absolute requirement of this specification.
"MUST NOT"	This phrase means that the item is an absolute prohibition of this specification.
"SHOULD"	This word means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighed before choosing a different course.
"SHOULD NOT"	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
"MAY"	This word means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.

2 REFERENCES

2.1 Normative References

In order to claim compliance with this specification, it is necessary to conform to the following standards and other works as indicated, in addition to the other requirements of this specification. Notwithstanding, intellectual property rights may be required to use or implement such normative references.

[PKT 24.229] PacketCable SIP and SDP Stage 3 Specification 3GPP TS 24.229, PKT-SP-24.229-I04-080425, April 25, 2008, Cable Television Laboratories, Inc.

[RFC 3588] IETF Reference 3588, Diameter Base Protocol, September 2003.

[TS 32.240] 3GPP TS 32.240, Charging Architecture and Principles, Release 7, V7.2.0, March 2007.

[TS 32.260] 3GPP TS 32.260, IP Multimedia Subsystem (IMS) charging, Release 7, V7.4.0, October 2007.

[TS 32.299] 3GPP TS 32.299, DIAMETER charging applications, Release 7, V7.7.0, October 2007.

2.2 Informative References

This specification uses the following informative references.

[CMSS] PacketCable 1.5 CMS to CMS Signaling Specification, PKT-SP-CMSS1.5-I04-070412, April 12, 2007, Cable Television Laboratories, Inc.

[EM] PacketCable 1.5 Event Messages Specification, PKT-SP-EM1.5-I03-070412, April 12, 2007, Cable Television Laboratories, Inc.

[IANA] AAA Parameters per RFC 3588, IANA, September 2005. http://www.iana.org/assignments/aaa-parameters

[PCMM] PacketCable Multimedia Specification, PKT-SP-MM-I03-051221, December 21, 2005, Cable Television Laboratories, Inc.

[QoS] PacketCable 2.0 Quality of Service Specification, PKT-SP-QoS-I02-080425, April 25, 2008, Cable Television Laboratories, Inc.

[RFC 3455] IETF RFC 3455, Private Header (P-Header) Extensions to the Session Initiation Protocol (SIP) for the 3rd-Generation Partnership Project (3GPP), January 2003.

[TS 23.228] 3GPP TS 23.228, IP Multimedia Subsystem (IMS) Stage 2, Release 7, V7.10.0, December 2007.

[TS 32.298] 3GPP TS 32.298, Charging Data Record (CDR) parameter description, Release 7, V7.4.0, October 2007.

2.3 Reference Acquisition

- Cable Television Laboratories, Inc., 858 Coal Creek Circle, Louisville, CO 80027;
  Phone +1-303-661-9100; Fax +1-303-661-9199; Internet: http://www.cablelabs.com/
- Internet Engineering Task Force (IETF), Internet: http://www.ietf.org
- Third Generation Partnership Project (3GPP), Internet: http://www.3gpp.org
- Internet Assigned Number Authority (IANA), http://www.iana.org

3 TERMS AND DEFINITIONS

The terms and definitions defined in the 3GPP Technical Specification TS 32.260 [TS 32.260] are generally applicable; please refer to section 3 of [TS 32.260]. In addition, this specification uses the following terms:

Accounting	The process of collecting usage data.
Billing Correlation ID (BCID)	A Billing Correlation ID (BCID) is a PacketCable defined term created for the multi-media session, which uniquely identifies the session within the PacketCable Multimedia billing domain.
DIAMETER	The DIAMETER protocol provides an Authentication, Authorization and Accounting (AAA) framework for applications such as network access or IP mobility.
Charging	The process of applying rating to usage data for a given session for the generation of a subscriber's bill.
HFC Access Network	The Hybrid-Fiber Coax Network, which provides physical transport of video and high speed data services via DOCSIS.
Usage Data	A collection of data representing the usage of network resources for a given session.

4 ABBREVIATIONS AND ACRONYMS

This specification uses the following abbreviations:

3GPP	Third Generation Partnership Project
BCID	Billing Correlation ID
BSS	Business Support Systems
CCF	Charging Collection Function
CDF	Charging Data Function
CDR	Call Detail Record
CGF	Charging Gateway Function
CM	Cable Modem
CMS	Call Management Server
CMTS	Cable Modem Termination System
CSCF	Call Session Control Function
EM	Event Messages
E-MTA	Embedded Multimedia Terminal Adaptor
GPRS	General Packet Radio Service
ICID	IMS Charging ID
IMS	IP Multimedia Subsystem
IOI	Inter-Operator Identifier
IP	Internet Protocol
IP-CAN	IP Connectivity Access Network
PAM	PacketCable Application Manager
P-CSCF	Proxy-CSCF
PS	Policy Server
RADIUS	Remote Authentication Dial-In User Service
RKS	Record Keeping Server
S-CSCF	Serving-CSCF
UE	User Equipment

5 TECHNICAL OVERVIEW

The IMS architecture, as defined and standardized by the Third Generation Partnership Project (3GPP) can be found in [TS 23.228]. This section provides an overview of the IMS Charging Architecture, how it enables the PacketCable Accounting Architecture, and defines any needed extensions to the IMS. In this section, information is also provided on how this Accounting architecture relates to PacketCable Multimedia Event Messages and, to a lesser extent, PacketCable Event Messages specifications.

The general 3GPP Charging Architecture and Principles are defined in [TS 32.240], and the IMS Charging Subsystem is specified in [TS 32.260].

PacketCable network elements involved in the IMS Charging Architecture are required to implement the 3GPP requirements defined in [TS 32.240] and [TS 32.260]. Additional PacketCable requirements are also defined in this document to allow for better integration of the PacketCable accounting model with the existing PacketCable Multimedia specification. The PacketCable charging requirements for IMS are covered in Section 5.2.1, and fully defined in subsequent sections. Note that the IMS Online Charging is currently out of scope for PacketCable.

5.1 IMS Charging Architecture

GSM and UMTS networks provide functions that implement various charging mechanisms based on three levels: bearer usage (e.g., GPRS packet services), service usage (e.g., SMS and MMS), or a service subsystem (e.g., IMS). 3GPP IMS provides the means to implement offline and/or online charging mechanisms on these levels. In order to support these charging mechanisms, the network performs real-time monitoring of resource usage on the above three levels in order to detect the relevant chargeable events.

The IMS also defines intra- and inter-domain charging operations. In particular, IMS defines mechanisms for identifying the originating and terminating networks.

In addition to defining the charging mechanisms for the bearer, subsystem and service levels, the IMS also defines an extensible mechanism for correlating charging events from the bearer and subsystem. This is accomplished through the use of the Access-Network-Charging-Info parameter in the P-Charging-Vector SIP header. Such an approach allows the IMS to support non-GPRS based access networks with their own charging architecture as long as they generate a unique billing correlation identifier.

The following sections describe the various IMS charging concepts.

5.1.1 Offline Charging

As defined by 3GPP, offline charging is a mechanism where charging occurs after the usage collection is complete: the usage information does not affect, in real-time, the service rendered. The final result of this charging mechanism is the forwarding of Call Detail Records (CDR) files to the Billing Domain.

The offline charging functionality relies 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 Accounting Requests (ACR) using the IETF DIAMETER protocol from the IMS network elements to the Charging Data Function (CDF), which correlates the accounting events and provides CDRs to the billing applications.

Information used for IMS charging is passed between IMS nodes in the SIP P-Charging-Vector header. [PKT 24.229] describes the IMS control messages in detail, including the use of the P-Charging-Vector SIP header [RFC 3455]. This header contains the following information parameters:

- The IMS Charging Identity (`ICID`), mandatory parameter. (`icid-value`)
  The ICID is the primary information element used to correlate records across the various IMS elements. The details of how correlation is done based on ICID are covered in [TS 32.260]. The ICID provides a similar function to the Billing Correlation Identifier (BCID) used in PacketCable Event Messaging.
- The Inter-Operator Identifier (IOI) parameters (`orig-ioi and term-ioi`)
  The IOI parameters may include the originating and/or terminating interoperator identifiers that are used to

correlate charging records between different operators. IOI parameters identify the networks handling the IMS session

- The Access Network Charging Information parameter (`access-network-charging-info`)
  The access-network-charging-info parameter is an instance of generic-param from the current charge-params component of P-Charging-Vector header and is defined in [PKT 24.229] section 7.2A.5. This parameter contains access-network-specific information that allows IP-CAN accounting records to be correlated with the IMS Subsystem billing records. The existing IMS architecture defines this information in detail for GPRS access networks. PacketCable defines additional values for the IP-CAN data for the Cable HFC Access Network. In particular, it is used to convey the PacketCable Multimedia Billing Correlation ID (BCID) as described in Section 5.2 of this document.

In the SIP signaling session, the offline charging function address is encoded in the SIP P-Charging-Function-Addresses header [RFC 3455], which is also described in [PKT 24.229]. For Offline Charging, the P-Charging-Function-Addresses header contains addressing information for the Charging Collection Function (CCF). The CCF is the same as the CDF (Charging Data Function) in IMS Offline Charging.

5.1.2 Online Charging

Online Charging is a mechanism defined in 3GPP where the collected usage data information can affect, in real-time, the service rendered. It requires a more direct interaction between the charging mechanism and the bearer, session, and service control via the use of Application Servers and the Media Resource Function Controller. The mechanism comprises the execution of credit control and subscriber account balance management on the Online Charging System. Note that for PacketCable, online charging is currently out of scope.

5.1.3 Inter-domain Charging

IMS defines an Inter-Operator Identifier (IOI) that is used to identify the originating and terminating network operators involved in an IMS SIP dialog or transaction outside a dialog. The IOI is passed between IMS nodes in the SIP signaling in the P-Charging-Vector SIP header. The originator of a session passes the orig-ioi to the terminating side in the SIP requests, and the terminating side fills in the term-ioi in SIP responses.

There are three types of IOI records defined in IMS:

1. Type 1 IOIs identify the visited and home networks in roaming situations;
2. Type 2 IOIs identify the originating and terminating parties in an IMS session;
3. Type 3 IOIs identify the home network and the service provider.

Thus, this identifier is used for inter-domain billing purposes in three critical ways. It is used to identify the home and visiting network when the user is accessing services away from the home network. It is used to identify the originating and terminating network for a user session. And it is used to identify the home network and the service provider when these two entities are separate.

In each of these cases, the two networks may use the IOI for exchanging charging records or doing inter-operator settlements.

5.2 PacketCable Accounting Architecture

PacketCable Accounting takes the approach that the Cable HFC Access Network along with the PacketCable Multimedia Subsystem defines a new type of IP-CAN for incorporation into the overall IMS architecture.

5.2.1 Design Goals

The PacketCable network accounting and usage design goals include:

- to enable the ability to account for network usage and service activities in Real-Time;
  - In this case, Real-Time is relative to when the events are sent to the central repository and does not imply when the final bill may be available to the customer nor that events are sent to indicate incremental usage of network resources;
- to allow for multiple network elements to generate events that can be correlated to a given session or subscriber;

- to support the correlation of accounting events across the signaling and bearer planes;
- to facilitate the rapid introduction of features and services by minimizing the impact to other network elements and their need to signal feature and service related information.

5.2.2 Scope

PacketCable network elements involved in the PacketCable Accounting Architecture or the 3GPP Charging Architecture are required to support all the 3GPP requirements for offline charging. Additionally, the PacketCable event reporting definition is limited to the Rf interface, a DIAMETER-based protocol interface between the IMS nodes (SIP CSCFs and AS) and the Charging Data Function and specifically, the definition of additional accounting record fields to meet the high-level design goals stated above.

Online charging is currently left out of the scope for PacketCable.

The 3GPP Ga and Bx interfaces are considered out of scope in PacketCable, so extensions to CDR formats are left unspecified.

5.2.3 Accounting Reference Points

Figure 1 shows the main PacketCable components involved with Accounting, and the interfaces between each of the components.

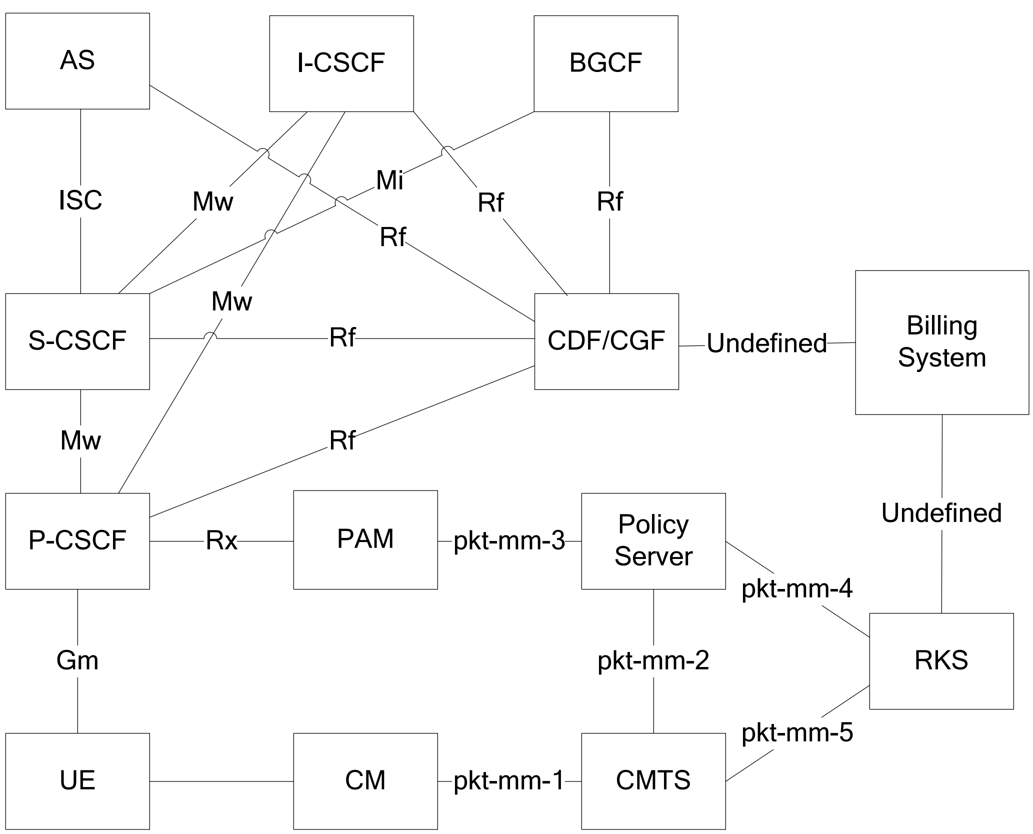

Figure 1 – PacketCable Accounting Reference Points

The reference points shown in Figure 1 are described in Table 1.

Table 1 – Accounting Reference Point Descriptions

Reference Point	PacketCable Network Components	Reference Point Description
Gm	UE – P-CSCF	SIP-based interface from the User Endpoint to the P-CSCF. All registration and session related signaling to the user application is done over this interface.
Mw	P-CSCF – S-CSCF, I-CSCF– S-CSCF, P-CSCF– I-CSCF	SIP-based interface from the P-CSCF to the S-CSCF, the I-CSCF to the S-CSCF, and the P-CSCF to the I-CSCF.
Mi	BGCF – S-CSCF	SIP-based interface from the BGCF to the S-CSCF.
ISC	S-CSCF – AS	IMS Service Control Interface from the S-CSCF and the Application Server (AS).
Rf	P-CSCF, I-CSCF, S-CSCF, AS, BGCF – CDF/CGF	DIAMETER-based interface from between the IMS nodes (P-CSCF, I-CSCF, S-CSCF, BGCF, and AS) to the Charging Data Function (CDF)/Charging Gateway Function (CGF).
Rx	P-CSCF – PacketCable Application Manager	A DIAMETER-based interface between the P-CSCF and Application Manager. This interface provides the mechanism for the P-CSCF to request QoS on behalf of the UE. See [QoS].
pkt-mm-1	CMTS – CM	DOCSIS interface between the CMTS and the CM. The CMTS instructs the CM to setup, teardown or change a DOCSIS service flow in order to satisfy a QoS request via DSX signaling. See [PCMM].
pkt-mm-2	Policy Server – CMTS	COPS-based interface between the PacketCable Multimedia Policy Server (PS) and the CMTS. It is used to control policy decisions on providing QoS to a UE session. See [PCMM].
pkt-mm-3	PacketCable Application Manager – Policy Server	COPS-based interface between the Application Manager and the PS to trigger the PS to control the policy decisions for a UE session. See [PCMM].
pkt-mm-4, pkt-mm-5	Policy Server, CMTS – RKS	RADIUS-based interface between the PacketCable Multimedia nodes (CMTS and PS) and the Record Keeping Server (RKS) as defined in [PCMM].

The UE communicates through the CM using the IP protocol (and in fact, the IMS-Gm traffic is carried over the IP protocol). In PacketCable Multimedia, the interface between the RKS and the Business Support Systems (BSS) is undefined. Since each MSO has CDR requirements unique to their service offerings and billing systems, PacketCable similarly leaves this interface as undefined. In practice CDRs over both interfaces are commonly batched and sent to the BSS over a batch interface using file transfer protocols such as FTP.

5.3 Relationship to PacketCable Multimedia Event Messages

The PacketCable Multimedia subsystem is an IP-CAN to the IMS. PacketCable Multimedia provides the foundation for QoS resource management on cable networks, such as QoS reservation, activation, and release. The PacketCable Multimedia architecture also defines an accounting framework and specific Event Messages to track the status and usage data related to QoS policy decisions (requests, updates, deletions). Since this release of PacketCable relies on PacketCable Multimedia, it is critical for service operators to be able to correlate the various streams of accounting data related to a given session. This includes both the IMS-related accounting data based on the SIP sessions and the bearer-related accounting data based on the PacketCable Multimedia sessions.

The Rx interface is used by the P-CSCF to request access network resources for a given session. The protocol exchanges between the P-CSCF and the PacketCable Application Manager (PAM) include the charging data needed to correlate accounting data between the two domains.

The Rx interface and theory of operation for QoS operations are defined in details in the PacketCable 2.0 Quality of Services Specification [QoS]. When initiating a session on behalf of a UE, the P-CSCF passes the IMS ICID identifier assigned to the session via the Rx interface to the PAM. The PAM provides the Access Network Charging Information to the P-CSCF in the message response: it consists of the BCID. The BCID is also sent in PacketCable Multimedia Event Messages from the PS and CMTS to the PacketCable Multimedia Record Keeping Server (RKS).

The PacketCable Multimedia BCID is defined to be unique within a PacketCable Service Provider's domain. Since the correlation of the PacketCable session-related information and the PacketCable Multimedia QoS accounting records is done within the boundaries of an operator's domain, the BCID is the only PacketCable Multimedia data item needed to perform the correlation.

Refer to [PCMM] for a detailed description of the format and value ranges for the BCID.

5.4 Relationship to PacketCable Event Messages

Like PacketCable Accounting, PacketCable Event Messages (EM) defines an event-based accounting architecture. This architecture is documented in [EM] and defines the complete accounting record format and associated network element triggers. It is expected that CSCFs will need to interwork directly with CMS to allow communication between E-MTAs and UEs and to allow the sharing of PSTN facilities. A critical capability that must be preserved is the ability to correlate accounting events for sessions that may traverse the two network elements.

Given the strong desire to leverage as much of the existing IMS work as possible, the PacketCable accounting operation will not change. Rather, interworking between CMSes and CSCFs will be treated in one of the following ways:

1. CMSes and CSCFs are co-existent in the same operators network and thus the signaling is intra-domain;
2. CMSes and CSCFs are separate and in different operators networks and thus the signaling is inter-domain.

The advantage of this approach is that IMS has clearly defined procedures for both of these cases. It also allows the CMS to look like a CSCF from a signaling perspective.

While the two accounting frameworks are similar, the PacketCable EM accounting specifications are different in how the accounting data is conveyed inside SIP sessions, and some slight change in operation is required.

1. Correlation IDs are transferred in the SIP P-DCS-Billing-Info header in CMSS [CMSS], as opposed to the P-Charging-Vector in PacketCable Accounting as defined in this document, and
2. PacketCable EM requires both the originating and terminating network elements to generate and exchange correlation IDs.

These two differences are easily accommodated by placing a few additional operational requirements on the CMS interfacing with a CSCF. Please refer to [CMSS] for the detailed operational requirements placed on the CMS.

6 PACKETCABLE EXTENSIONS TO IMS CHARGING

Since PacketCable Accounting adopts the IMS Charging Subsystem, and given the operator requirements to correlate accounting events between PacketCable Multimedia QoS and SIP sessions, some extensions are needed to support interactions between the PacketCable IMS systems and the PacketCable Multimedia IP-CAN. This section identifies the required extensions to IMS, and also defines what functionality within the existing IMS Release 6 specifications is required in a PacketCable implementation.

6.1 Required Subset of IMS Charging

The IMS Charging Subsystem defines the interfaces necessary to deliver accounting information from the IMS network elements up to the Billing System. It also defines both offline and online charging mechanisms. PacketCable Accounting relies on the use of the offline charging and the associated requirements of the Rf interface from the IMS components to the CDF. The mechanism for delivering charging information from the CDF to the billing system is left unspecified. PacketCable Network Elements MUST implement the Rf interface as defined in [TS 32.240], [TS 32.260], and [TS 32.299]. PacketCable Network Elements MUST support the P-Charging-Vector and P-Charging-Function-Address header requirements as defined in [PKT 24.229].

To support PacketCable service offerings, the MSOs will need to ensure that the BSS has enough information associated with each basic session legs to perform session-based charging. In general, all information needed for basic session accounting is derived from the existing required accounting data described in [TS 32.260] and [TS 32.299].

The PacketCable accounting model enables both session-based and event-based charging. Session-based charging uses ACRs of type Start, Interim, and Stop, while event-based charging uses Event ACRs. PacketCable accounting uses all of these ACR types.

In a normal session set-up, the P-CSCF and S-CSCF will generate ACR Starts (with an AS also generating a Start if it is involved in session establishment). Interim ACRs may be generated by any of the elements. At the end of a session, there will be ACR Stops from both the P-CSCF and the S-CSCF. If all nodes are in a single service provider domain, there will therefore be two sets of ACR Starts and Stops sent to the CDF.

On the terminating side of a PacketCable session, an I-CSCF may also generate accounting records. In this case, the accounting records will be ACR Event records.

Throughout this section, we assume that the PacketCable nodes are configured to generate all of the ACRs that are required to be supported. These capabilities should be configurable for deployments where not all of the messages are needed. For example, an operator may decide that only the S-CSCF needs to generate the ACR Starts and Stops for PacketCable sessions originating and terminating in their network, in which case the P-CSCF can be configured not to issue ACR messages. Configuration of these messages according to an operator's needs is allowed and in some cases will enable more efficient implementations and facilitate correlation within the CDF or the Billing Systems.

Several of the AVPs defined in IMS are critical to PacketCable accounting. Some of the critical AVPs are found in the Diameter Base data defined in [RFC 3588]. The rest are grouped in the IMS-Information AVP (ID 876) within the Service-Information AVP (ID 873), and defined in [TS 32.299]. Note that Diameter Base AVPs have IMS names that differ from the names in RFC 3588. This document uses the IMS name for initial reference of such AVPs, and includes the base name in parentheses along with the AVP ID. After the initial reference, only the IMS name is used.

Required AVPs for PacketCable are defined in this document. AVPs that are optional, and for which there is no appropriate value for the context in which the ACR is generated, MUST be omitted from the ACR (AVPs with NULL values are not to be included in ACRs).

6.1.1 On-Net to On-Net Session Configuration

This section defines accounting for a basic on-net session initiation and termination. First, the originating side of the session is described, followed by the requirements specific to the termination side.

6.1.1.1 Data Available at Session Origination

Figure 2 shows a basic session establishment and release for the originating side of an on-net PacketCable session. In this flow, there is nothing specific to the PacketCable service; it is based on the flows documented in [TS 32.260]. In the basic originating case, the only elements guaranteed to be sending accounting records are the P-CSCF and S-CSCF. These PacketCable nodes could either be in the same service provider domain, or separate service provider domains (in the case of mobile origination).

Critical accounting data is obtained from:

- Message 3 – ACR Start from the S-CSCF
- Message 5 – ACR Start from the P-CSCF
- Message 7 – ACR Stop from the P-CSCF
- Message 9 – ACR Stop from the S- CSCF

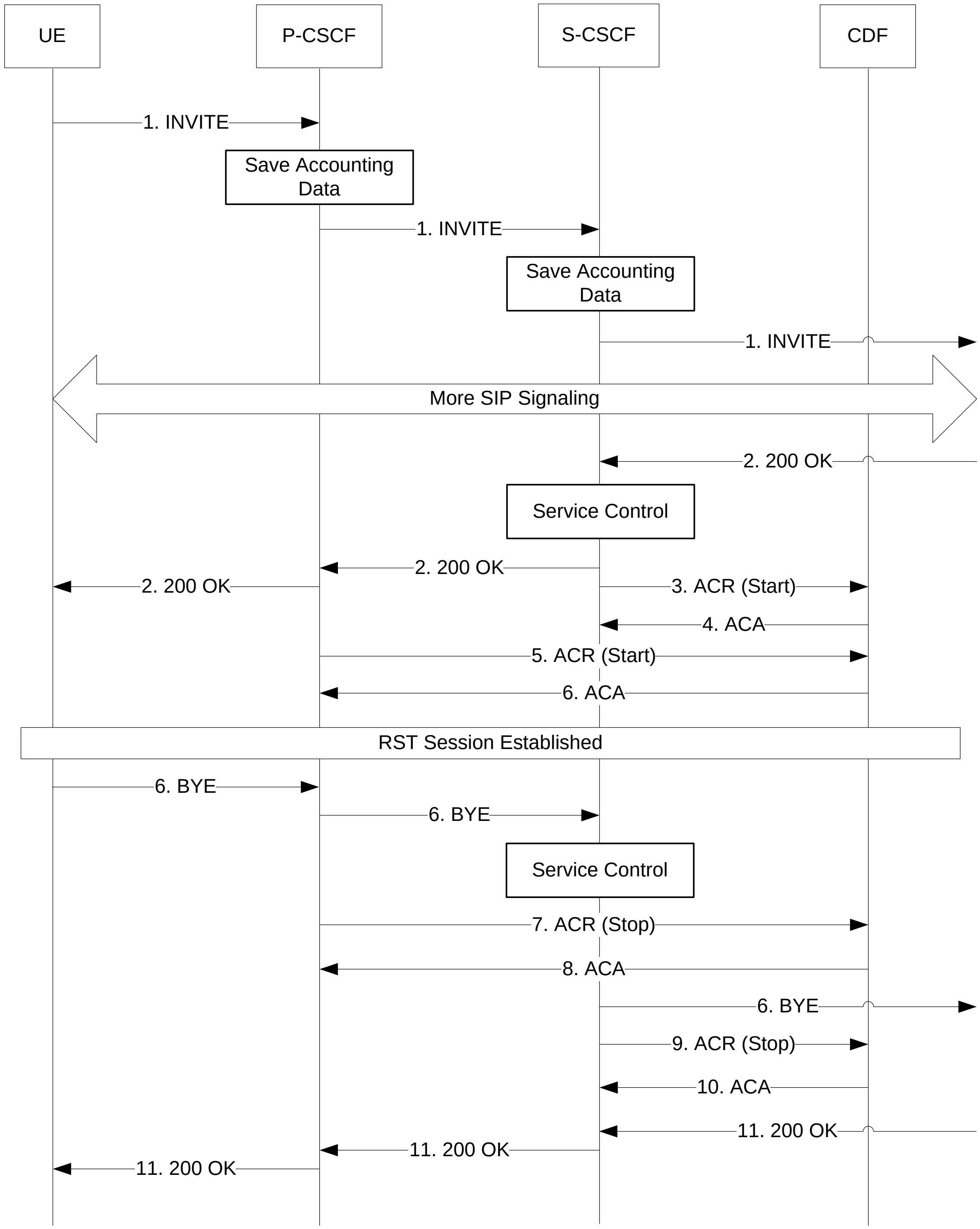

Figure 2 – On-net Call Origination

6.1.1.1.1 Originating AVPs for basic accounting use

The following AVPs available in all the ACR messages are critical for PacketCable accounting. The originating P-CSCF and originating S-CSCF MUST include the following AVPs in the ACR Start, Stop, and Interim messages related to a PacketCable session. Additionally, the originating P-CSCF and originating S-CSCF MUST set the values as indicated:

- IMS-Charging-ID (AVP 841): Used by the CDF for correlation. On the originating side, the IMS-Charging-ID (ICID) is generated by the P-CSCF and passed on in SIP signaling in the P_Charging_Vector.
- Operation Type (Accounting-Record-Type AVP 480) from the Diameter Base Data: Designates if the message is an ACR Start, Interim, Stop, or Event. This will help the CDF determine the context of the message.
- Node-Functionality (AVP 862): Identifies the type of the node that sent the accounting message (P-CSCF, S-CSCF). This will help the CDF determine the context of the message. The P-CSCF sets the Node-Functionality to P-CSCF. The S-CSCF sets the Node-Functionality to S-CSCF.
- Originator Host (Origin-Host AVP 264) and Originator Domain (Origin-Realm AVP 296) in the Diameter Base data: Uniquely identify the node that sent the accounting message. The P-CSCF and S-CSCF set the Originator Host and Originator Domain as configured.
- Operation Number (Accounting-Record-Number AVP 485) from the Diameter Base Data: Provides a sequence number for ordering the accounting messages.
- Role-of-Node (AVP 829): Designates whether the element is originator, terminator, proxy, or B2BUA. This will enable the CDF/Billing System to determine whether it is receiving accounting messages for the originating or terminating side of a session.

There are additional AVPs that are critical to the basic accounting functionality but only appear in relevant ACR messages.

The Inter-Operator-Identifier (AVP 838) is a grouped AVP that contains the Originating-IOI (AVP 839) and Terminating-IOI (AVP 840) wherever operator boundaries are crossed. This data is used for settlements with interconnect operators. [PKT 24.229] describes when the IOI is available to an IMS node. Whenever an originating IMS node sends or receives inter-operator information in IMS signaling, it MUST include the IOI AVP in the ACR Start and Event messages, and MAY include it in the ACR Interim and Stop messages.

The Cause-Code (AVP 861) indicates the termination status when a session is torn down. The originating P-CSCF and originating S-CSCF MUST include this AVP in ACR Stop messages.

6.1.1.1.2 Originating Subscriber Identification

In IMS, all information concerning the calling and called subscribers in a session are sent in the following AVPs:

- Calling-Party-Address (AVP 831): Information about the calling party derived from the P-Asserted-Identity header when present. If the P-Asserted-Identity header is not present, then the P-Preferred-Identity header (if present) is used. If both the P-Asserted-Identity and P-Preferred-Identity headers are not present, the From header is used. Refer to [PKT 24.229] for additional information about when these different sources of public identity will be available.
- Called-Party-Address (AVP 832): Information about the called party derived from the Request URI.

The Calling-Party-Address provides the CDF/Billing System the public identity information passed from the originating UE to the terminating UE. Since the public identity headers can contain a Tel URI or a SIP URI or both, CDFs/Billing Systems are expected to be able to handle both TEL URI and SIP URI to identify the originator.

When generating ACR Start messages, the originating P-CSCF and originating S-CSCF MUST include the Calling-Party-Address AVP containing the entire contents of the P-Asserted-Identity header of the originator if present. If the P-Asserted-Identity header is not present, then the originating P-CSCF and originating S-CSCF MUST include the entire contents of the P-Preferred-Identity header if present. If both the P-Asserted-Identity and P-Preferred-Identity headers are not present, then the originating P-CSCF and originating S-CSCF MUST include the entire contents of the From header.

The Called-Party-Address provides the CDF/Billing System all the information passed from the originating UE to the terminating UE in the Request URI. The Request URI can undergo modifications during the signaling for a session.

In the initial INVITE for an PacketCable session through the P-CSCF, the Request URI will either be a Tel URI or a SIP URI identifying the destination from the perspective of the UE. It can also be a dial-string for a Vertical Service

Code (VSC). Since the Request URI can be either a Tel or SIP URI, CDFs/Billing Systems are expected to be able to handle both formats to identify the termination of an PacketCable session.

Note that in IMS, the actual user input may not be derivable from the Request URI, since the UE can translate user input into the URI format. Information like international country codes will be derived from the Tel URI format when available.

When generating ACR start messages, the originating P-CSCF MUST include the Called-Party-Address AVP containing the entire contents of the Request URI of the terminator as provided by the originating UE.

The S-CSCF commonly performs AS and ENUM/DNS queries on the initial INVITE. For example, the S-CSCF will do the translation of 800 numbers. The reported value of the Called-Party-Address from the S-CSCF should be the globally routable address in the modified Request URI.

When generating ACR start messages, the originating S-CSCF MUST include the Called-Party-Address AVP containing the entire contents of the Request URI of the terminator after applying all of the translations needed for initial routing of the INVITE.

6.1.1.1.3 Originating Timestamps

For PacketCable usage-based billing, it is important to ensure that the meaning of the timestamps included in the ACRs is well defined. The following AVPs contain important timestamps:

- Origination Timestamp (Event-Timestamp AVP 55) from the Diameter Base Data: This is defined as the time that the "operation is requested", which generally means when the DIAMETER message is sent.
- SIP-Request-Timestamp (AVP 834): This AVP is used for the time at which a SIP request message was sent.
- SIP-Response-Timestamp (AVP 835): This AVP is used for the time at which a SIP response was received.

SIP-Request-Timestamp and SIP-Response-Timestamp are grouped under Time-Stamps (AVP 833).

In IMS, timestamps are always in UTC. It will be up to the CDF/Billing System to determine if a particular time-zone translation needs to be applied.

For PacketCable accounting, it is likely that the SIP-Response-Timestamp for the 200-OK response to the initial INVITE (as reported by the S-CSCF) be used as the session start time. This will be the most reliable indicator at the originating side of when the active session was initiated. When generating an ACR Start, the originating P-CSCF and originating S-CSCF nodes MUST include the SIP-Response-Timestamp containing the time at which it received the 200 OK to the INVITE message.

The SIP-Request-Timestamp of the BYE message reported by the S-CSCF will likely be used for the session termination time. When generating an ACR Stop, the originating P-CSCF and originating S-CSCF nodes MUST include the SIP-Request-Timestamp containing the time at which the BYE message was sent or received.

ACR Interim records can be generated for SIP re-INVITEs and UPDATEs for such things as changes to the service. They are also used as a mechanism of periodic updates for long-duration sessions to support partial billing and support for reliability. When generating ACR Interim records as a result of SIP signaling activity, the originating P-CSCF and originating S-CSCF MUST include the SIP-Response-Timestamp containing the time at which the 200 OK response was received for the re-INVITE or UPDATE. When generating ACR Interim records as a result of periodic time-outs and non-signaling-related events, the originating P-CSCF and originating S-CSCF MUST include the Origination Timestamp containing the time at which the operation is requested, and MUST NOT include the SIP-Request-Timestamp, the SIP-Response-Timestamp, or the grouped Time-Stamps AVPs.

In general, the service-related ACRs may also have requirements for timestamps, and those requirements will be specified in the requirements for the service.

6.1.1.1.4 Originating Number Portability

To support PacketCable requirements for Number Portability (NP), PacketCable defines 3 new NP-related AVPs:

- Location-Routing-Number: Contains the E.164 format ported-to Location

- Routing Number (LRN) of the terminating side of a PacketCable session.

- LRN-Source-Indicator: Specifies where the LRN was obtained (e.g., DB Dip, Provisioned Data, Signaling).
- LRN-Query-Status: Specifies the status of doing a query for the LRN.

The detailed definitions of these new AVPs are in Section 6.6.1, and are defined to be consistent with the CDR-level representation in [TS 32.298]. These new AVPs are grouped under the IMS-Information AVP within a new Number-Portability AVP.

When the originating S-CSCF determines that the destination is a ported number and does the NP translation, the S-CSCF MUST send the following in the ACR Start message: Location-Routing-Number AVP with the resulting ported-to routing number, LRN-Source-Indicator AVP specifying how the LRN was obtained, and the LRN-Query-Status-Indicator AVP with the status/result of performing an LRN query.

6.1.1.1.5 Originating Related Session Information

When the originating access network is a PacketCable HFC network, additional information will be available from the PacketCable Multimedia Subsystem, and will be available to the Access Provider's Billing system for correlation with the IMS-based accounting data. This includes the detailed QoS information sent by the CMTS in QoS_Reserve, QoS_Commit, and QoS_Release messages. See Section 5.3 for more details on correlation with PacketCable Multimedia.

6.1.1.2 Data Available at Call Termination

Figure 3 shows a basic session establishment and release for the terminating side of an on-net PacketCable session. This flow is similar to the originating flow, with the addition of the I-CSCF node.

Critical accounting data is obtained from:

- Message 2 – ACR Event from the I-CSCF
- Message 5 – ACR Start from the P-CSCF
- Message 7 – ACR Start from the S-CSCF
- Message 10 – ACR Stop from the S- CSCF
- Message 12 – ACR Stop from the P- CSCF

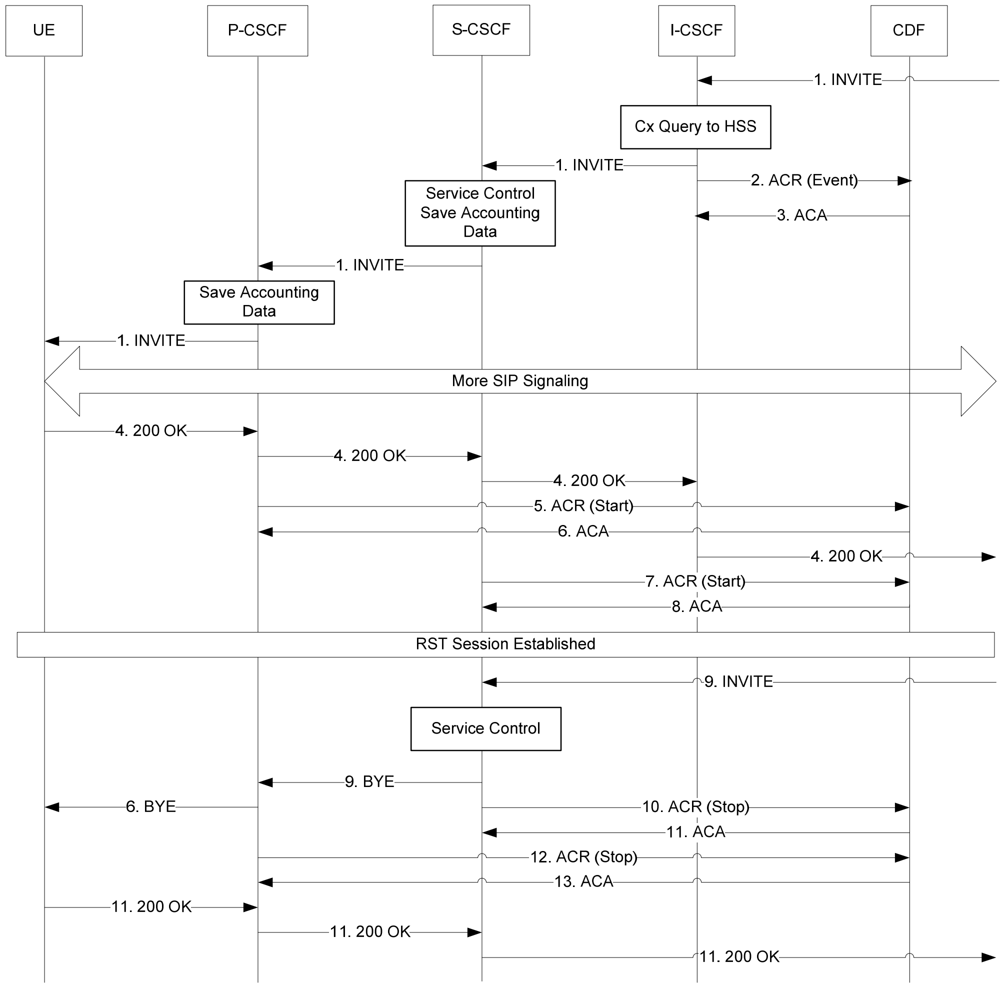

Figure 3 – On-net Call Termination

6.1.1.2.1 Terminating AVPs for basic accounting use

The same basic AVPs described in Section 6.1.1.1.1 apply on the terminating side as on the originating side. The terminating P-CSCF and terminating S-CSCF MUST include the following AVPs in the ACR Start, Stop, and Interim messages related to an PacketCable session. The terminating I-CSCF MUST include the following AVPs in the initial ACR Event message related to an PacketCable session. Additionally, the terminating P-CSCF, I-CSCF, and S-CSCF MUST set the values as indicated:

- IMS-Charging-ID (AVP 841): Used by the CDF for correlation. On the terminating side, the IMS-Charging-ID (ICID) is either passed in SIP signaling in the P_Charging_Vector (when the originator is in the same domain), or generated by the PacketCable node in the terminating domain.
- Operation Type (Accounting-Record-Type AVP 480) from the Diameter Base Data: Designates if the message is an ACR Start, Interim, Stop, or Event. This will help the CDF determine the context of the message.
- Node-Functionality (AVP 862): Identifies the type of the node that sent the accounting message (P-CSCF, S-CSCF, I-CSCF, AS). This will help the CDF determine the context of the message. The P-CSCF sets the Node-Functionality to P-CSCF. The S-CSCF sets the Node-Functionality to S-CSCF. The I-CSCF sets the Node-Functionality to I-CSCF.

- Originator Host (Origin-Host AVP 264) and Originator Domain (Origin-Realm AVP 296) in the Diameter Base data: Uniquely identify the node that sent the accounting message. The P-CSCF, S-CSCF, and I-CSCF set the Originator Host and Originator Domain as configured.
- Operation Number (Accounting-Record-Number AVP 485) from the Diameter Base Data: Provides a sequence number for ordering the accounting messages.
- Role-of-Node (AVP 829): Designates whether the element is originator, terminator, proxy, or B2BUA. This will enable the CDF/Billing System to determine whether it is receiving accounting messages for the originating or terminating side of a session.

The Inter-Operator-Identifier (AVP 838) is a grouped AVP that contains the Originating-IOI (AVP 839) and Terminating-IOI (AVP 840) wherever operator boundaries are crossed. This data will be used for settlements with interconnect operators. [PKT 24.229] describes when the IOI is available to an IMS node. Whenever a terminating IMS node receives or sends inter-operator information in IMS signaling, it MUST include the IOI AVP in the ACR Start and Event messages, and MAY include it in the ACR Interim and Stop messages.

The Cause-Code (AVP 861) indicates the termination status when a session is torn down. The terminating P-CSCF and terminating S-CSCF MUST include this AVP in ACR Stop messages.

6.1.1.2.2 Terminating Subscriber Identification

On the terminating side, the same AVPs described in Section 6.1.1.1.2 (Calling-Party-Address and Called-Party Address) are used to identify the subscribers as on the Originating side. These are populated from the public identity headers and Request URI respectively, as on the originating side.

When generating ACR Start messages, the terminating P-CSCF and terminating S-CSCF MUST include the Calling-Party-Address AVP containing the entire contents of the P-Asserted-Identity header of the originator if present. If the P-Asserted-Identity header is not present, then the terminating P-CSCF and terminating S-CSCF MUST include the entire contents of the P-Preferred-Identity header if present. If both the P-Asserted-Identity and P-Preferred-Identity headers are not present, then the terminating P-CSCF and terminating S-CSCF MUST include the entire contents of the From header.

When generating ACR Event messages, the terminating I-CSCF MUST include the Calling-Party-Address AVP containing the entire contents of the P-Asserted-Identity header of the originator if present. If the P-Asserted-Identity header is not present, then the terminating I-CSCF MUST include the entire contents of the P-Preferred-Identity header if present. If both the P-Asserted-Identity and P-Preferred-Identity headers are not present, then the terminating I-CSCF MUST include the entire contents of the From header.

As on the originating side, the terminating S-CSCF commonly performs translations on the request URI through interactions with ASs. The reported value of the Called-Party-Address from the S-CSCF should be the address in the modified Request URI after all translations have been completed.

When generating ACR start messages, the terminating S-CSCF MUST include the Called-Party-Address AVP containing the entire contents of the Request URI of the terminator after applying all of the translations needed on the incoming INVITE.

When generating ACR start messages, the terminating P-CSCF MUST include the Called-Party-Address AVP containing the entire contents of the Request URI of the terminator as provided by the terminating S-CSCF.

When generating ACR Event messages, the terminating I-CSCF MUST include the Called-Party-Address AVP containing the entire contents of the Request URI of the terminator.

6.1.1.2.3 Terminating Timestamps

The same timestamp-related AVPs described in Section 6.1.1.1.3 apply on the terminating side as the originating side.

When generating an ACR Event, the terminating I-CSCF node MUST include the SIP-Request-Timestamp containing the time at which it received the INVITE message.

When generating an ACR Start, the terminating P-CSCF and terminating S-CSCF nodes MUST include the SIP-Response-Timestamp containing the time at which it received the 200 OK to the INVITE message.

When generating an ACR Stop, the terminating P-CSCF and terminating S-CSCF nodes MUST include the SIP-Request-Timestamp containing the time at which the BYE message was received.

ACR Interim records can be generated for SIP re-INVITEs and UPDATEs for such things as changes to the service. They are also used as a mechanism of periodic updates for long-duration sessions to support partial billing and support for reliability. When generating ACR Interim records as a result of SIP signaling activity, the terminating P-CSCF and terminating S-CSCF MUST include the SIP-Response-Timestamp containing the time at which the 200 OK response was received for the re-INVITE or UPDATE. When generating ACR Interim records as a result of periodic time-outs and non-signaling-related events, the terminating P-CSCF and terminating S-CSCF MUST include the Origination Timestamp containing the time at which the operation is requested, and MUST NOT include the SIP-Request-Timestamp, the SIP-Response-Timestamp, or the grouped Time-Stamps AVPs.

6.1.1.2.4 Terminating Number Portability

There are no NP-related requirements currently in scope for the terminating side of an on-net PacketCable session.

6.1.1.2.5 Terminating Related Session Information

The related session information covered in Section 6.1.1.1.5 also applies to the terminating side.

6.1.2 On-net to Off-net and Off-net to On-net Session Configuration (interaction with the PSTN)

A PacketCable CSCF will route traffic to and from the PSTN through other PacketCable call control entities. The signaling point is from a CSCF node to a Call Management Server (CMS) or Media Gateway Controller (MGC). The [CMSS] specification defines this interface.

To signal an on-net to off-net session within a trust domain, the ICID is passed to the CMS/MGC, and it is up to the CMS/MGC to report both the ICID and the BCID to the accounting subsystem for correlation. To signal an off-net to on-net session, the CMS/MGC will generate the ICID, and pass it to the CSCF.

When routing of PSTN traffic crosses trust domains, the IOI is used to identify the originating and terminating network.

This approach to interconnecting to the PSTN introduces no special requirements on the CSCF. See [CMSS] for more details on how information is exchanged between CSCFs and MGCs.

6.2 Charging identification information in the Rx interface

This section provides a high-level description of the roles played by the P-CSCF and PacketCable Application Manager in the charging flows. The complete requirements can be found in [PKT 24.229] and [QoS].

The originating P-CSCF is responsible for generating the IMS ICID, and the PAM is responsible for generating the PacketCable Multimedia BCID. Both the ICID and BCID are exchanged between these elements allowing for their values to be recorded in their respective accounting events.

The P-CSCF generates an ICID upon receipt of a dialog initiating INVITE from a UE and includes this in the first resource request made to the PAM for that session. Upon receipt of a resource request with an ICID, the PAM stores and associates this ICID value with the session identified by the DIAMETER session identifier (SessionId). The PAM is then responsible for generating a unique BCID for all of the PacketCable Multimedia sessions (gates) associated with each leg of the call and include this BCID in an Event Generation Info object sent to the Policy Server over the pkt-mm-3 interface.

If the resource request is successful, the PAM returns the generated BCID to the P-CSCF in the response to the resource request.

Likewise, the P-CSCF may receive a dialog initiating invite for a UE from an S-CSCF with an ICID already present. In this case, the P-CSCF includes the provided ICID in the first resource request made to the PAM for that session. The PAM operation is unchanged in this case.

6.3 Extensions to the SIP P-Charging-Vector Header

Extensions to support transmitting the PacketCable Multimedia BCID in SIP signaling between IMS nodes are being incorporated in [PKT 24.229]. IMS nodes that report charging information over the Rf interface extract these data items from the P-Charging-Vector Header in the SIP signaling messages. PacketCable Network Elements MUST support the P-Charging-Vector as defined in [PKT 24.229].

6.4 Support for reporting of BCID

The PacketCable Multimedia BCID obtained from the Rx interface (as described in Section 6.2) uniquely identifies the PacketCable Multimedia session for the purposes correlating IMS charging records with the accounting records generated by the PacketCable Multimedia IP-CAN. The BCID is sent grouped with the SDP-Media-Component (AVP 843) in Access-Network-Charging-Identifier-Value (AVP 503).

A PacketCable P-CSCF MUST include the Access-Network-Charging-Identifier-Value AVP in accounting records once the data has been made available in the Rx interface (also contained within the Access-Network-Charging-Identifier-Value AVP). Accounting data may also be passed from the P-CSCF to other IMS nodes in SIP signaling. The other PacketCable Network Elements MUST include the Access-Network-Charging-Identifier-Value AVP in Charging Records when the data has been received in the P-Charging-Vector header in a SIP message.

The Access-Network-Charging-Identifier-Value AVP is of type OctetString. In its binary format, the BCID contains 4 bytes of NTP timestamp, 8 bytes of the unique identifier of the network element that generated the ID, 8 bytes giving the time zone, and 4 bytes of monotonically increasing sequence number at that network element. For representation in an OctetString, the BCID is encoded as a hexadecimal string of up to 48 characters as passed in the P-Charging-Vector specified in [PKT 24.229].

6.5 Extensions for REFER Method

The REFER method is used to effect call transfers and potentially other services. To ensure that the BSS can correlate the calls generated as a result of a REFER, the following procedures apply to the P-CSCF and the S-CSCF.

The P-CSCF and the S-CSCF MUST create an ACR Event (if configured to create ACR Events for REFER Methods) when it receives a 202 Accepted or an error response for the REFER that has been forwarded to the UE. The ACR Event for the REFER MUST include the following AVPs with the values set as specified: the Role-of-Node set to origination, the SIP-Response-Timestamp set to the time the 202 response (or error) was transmitted. The ACR Event MUST also include the following additional AVPs with the values set as specified: the Target AVP set to the value of the Target header field (if the Target header is present in the REFER), and the Refer-To AVP set to the value of the Refer-To header.

In the case where an error is returned, the P-CSCF and S-CSCF MUST include the Cause-Code (AVP 861) indicating the response code received in the error response.

Note: For a call transfer, the Target header identifies the call that is being transferred and the Refer-to header provides information to identify the transfer call, when it is established. This allows a CDF / Billing System to correlate the two calls.

Note: If the REFER is sent within an existing dialog, the target of the REFER is the existing dialog and there is no Target header in the REFER.

6.6 Extensions for IMS Charging Reporting

This section covers PacketCable extensions to IMS Charging. PacketCable Network Elements MUST support the extensions defined within this section.

6.6.1 Extensions to the DIAMETER ACRs (Rf Interface)

IMS Charging data is delivered from IMS Nodes to the CDF using DIAMETER Accounting Request (ACR) messages, and the CDF responds to the IMS Nodes with Accounting Answer (ACA) messages. Data is communicated in DIAMETER Messages via Attribute-Value Pairs (AVPs). 3GPP has defined a set of parameters specific to IMS, and these parameters are AVPs that are grouped under the DIAMETER *Service-Information* AVP. See [TS 32.299] for the full definition of these AVPs. PacketCable defines:

- additional AVPs for Number Portability as defined in Section 6.1.1.1.4.
- additional AVPs for the REFER Method.

Table 2 shows the additional AVPs for PacketCable as represented in Table 7.2 (3GPP specific AVPs) in [TS 32.299]. The following AVPs are assigned from the CableLabs Vendor ID space of 4491 and MUST be formatted as defined.

Table 2 – Additional 3GPP-specific AVPs for PacketCable

AVP Name	AVP Code	Used in				Value Type	AVP Flag rules				
		ACR	ACA	CCR	CCA		Must	May	Should not	Must not	May Encr.
Location-Routing-Number	215	X	-	-	-	UTF8String	V,M	P			N
LRN-Source-Indicator	216	X		-	-	Integer32	V,M	P			N
LRN-Query-Status	217	X		-	-	Integer32	V,M	P			N
NP-Data	220	X	-	-	-	Grouped	V, M	P			N
Refer-To	223	X	-	-	-	UTF8String	V, M	P			N
Target	230	X	-	-	-	UTF8String	V, M	P			N

The *Service-Information* AVP (AVP code 873), as defined in [TS 32.299], groups all of the 3GPP service-specific information, and includes the IMS-Information AVP (AVP code 876).

Number Portability data is grouped under a new NP-Data AVP within IMS-Information while the Target and Refer-To AVPs are part of the IMS-Information AVP Group:

```
IMS-Information :: =        < AVP Header: 876>
                              [ Event-Type ]
                              [ Role-Of-Node ]
                              { Node-Functionality }
                              [ User-Session-ID ]
                              [ Calling-Party-Address ]
                              [ Called-Party-Address ]
                              [ Time-Stamps ]
                              * [ Application-Server-Information ]
                              * [ Inter-Operator-Identifier ]
                              [ IMS-Charging-Identifier ]
                              * [ SDP-Session-Description ]
                              * [ SDP-Media-Component ]
                              [ Served-Party-IP-Address ]
                              [ Server-Capabilities ]
                              [ Trunk-Group-ID ]
                              [ Bearer-Service ]
                              [ Service-Id ]
                              [ Service-Specific-Data ]
                              * [ Message-Body ]
                              [ Cause-Code ]
                              [ NP-Data ]
                              [ Target ]
                              [ Refer-To ]
```

The following sections define these AVPs in detail.

6.6.1.1 Location-Routing-Number

The Location-Routing-Number AVP (AVP code 215) is of type UTF8String, and holds the E.164 format ported-to Location Routing Number (LRN).

6.6.1.2 LRN-Source-Indicator

The LRN-Source-Indicator AVP (AVP code 216) is of type Integer32, and identifies the source of where the LRN was obtained.

It can be one of the following values:

1. LRN NP Database;
2. Switching System Data;
3. Incoming Signaling;
9. Unknown.

6.6.1.3 LRN-Query-Status

The LRN-Query-Status AVP (AVP code 217) is of type Integer32, and identifies the result of obtaining LRN data.

It can be one of the following values:

1. Number Portability Data Base (NPDB) returns LRN or NULL response (free of any error);
2. No response was received to the query; the query timed out;
4. Protocol error in received response message;
5. Error detected in response data;
6. Query rejected; *Note: This value is incorrectly specified as "5" in 32.298. We have assumed that "6" is the intended value;
9. No query performed;
99. Query unsuccessful, reason unknown.

It is populated if an NP query was performed.

6.6.1.4 NP-Data

The NP-Data AVP (AVP code 220) is of type Grouped, and holds the Number Portability information.

It has the following ABNF grammar:

```
NP-Data :: =     < AVP Header: 220>
                     [ Location-Routing-Number ]
                     [ LRN-Source-Indicator ]
                     [ LRN-Query-Status ]
```

6.6.1.5 Refer-To

The Refer-To AVP (AVP code 223) is of type UTF8String and contains the value of the SIP Refer-to header field.

6.6.1.6 Target

The Target AVP (AVP code 230) is of type UTF8String and contains the value of the SIP Target header field.

Appendix I PacketCable Accounting Functionality Example

In this section, a simple set of flows are presented that show how the interaction with the PacketCable Multimedia Subsystem impacts the flows. By extension, these impacts can be applied to all the flow scenarios covered in [TS 32.260].

Figure 4 shows the PacketCable Charging components with the flow of messages needed to establish a session.

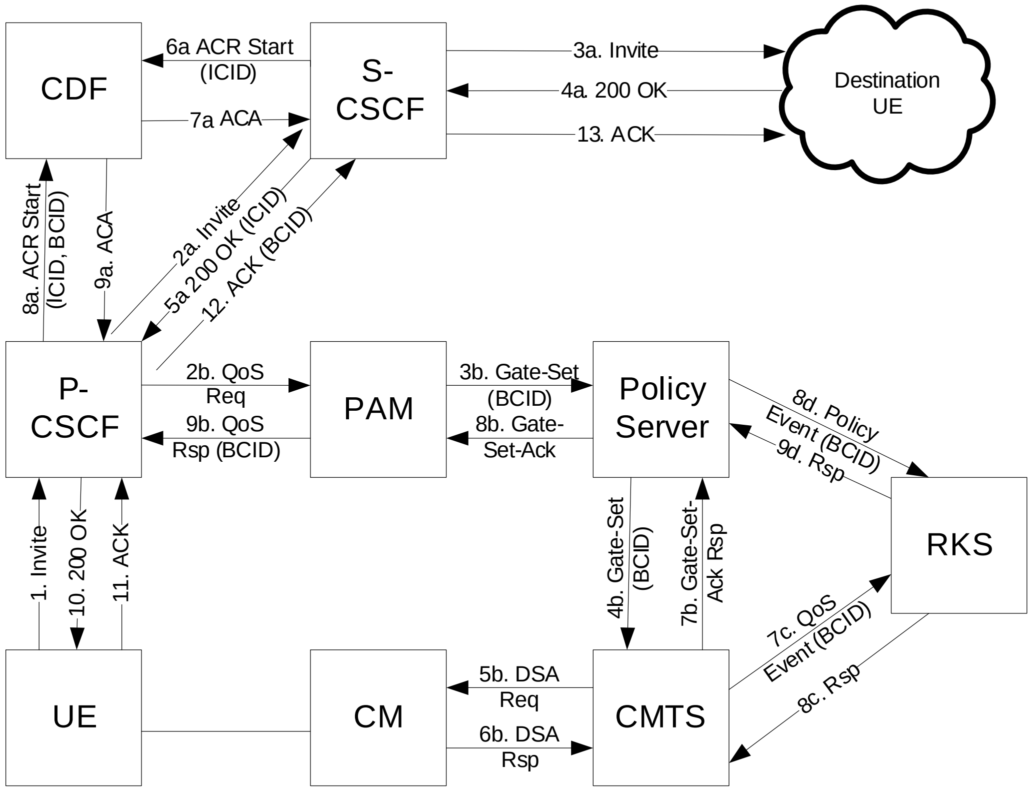

Figure 4 – PacketCable Offline Charging High-level flow

Message 1 is the initial invite from the UE to the P-CSCF. Messages 2a through 5a are the IMS Session Establishment messages. Messages 6a and 6b are the session start charging messages from the S-CSCF.

Messages 2b through 9b are the PacketCable Multimedia QoS Set-up messages. This activity can be done in parallel or series with the IMS session set-up. The Application Manager generates the BCID, and passes that on to all components that generate accounting messages. Messages 7c/8c and 8d/9d are the PacketCable Multimedia Event Messages sent to the PacketCable Record Keeping Server in parallel with the other signaling activity.

Once the P-CSCF has received response from both the S-CSCF and the PacketCable Multimedia subsystem, it sends the 200 OK response to the UE (message 10), and the IMS charging record to the CDF (messages 8a and 9a). Note that the charging message sent in this step contains both the IMS ICID and the PacketCable Multimedia BCID (sent in the Access-Network-Charging-Identifier-Value AVP).

Upon receipt of the 200 OK, the UE sends an ACK to the P-CSCF (message 11) which then adds the BCID to the P-Charging-Vector header as part of the access-network-charging-info parameter and forwards to the S-CSCF (message 12). At this point, the S-CSCF will be in possession of the BCID, which can be placed is subsequent accounting events generated by the S-CSCF.

Figure 5 shows a call-flow corresponding to the messages shown in Figure 4.

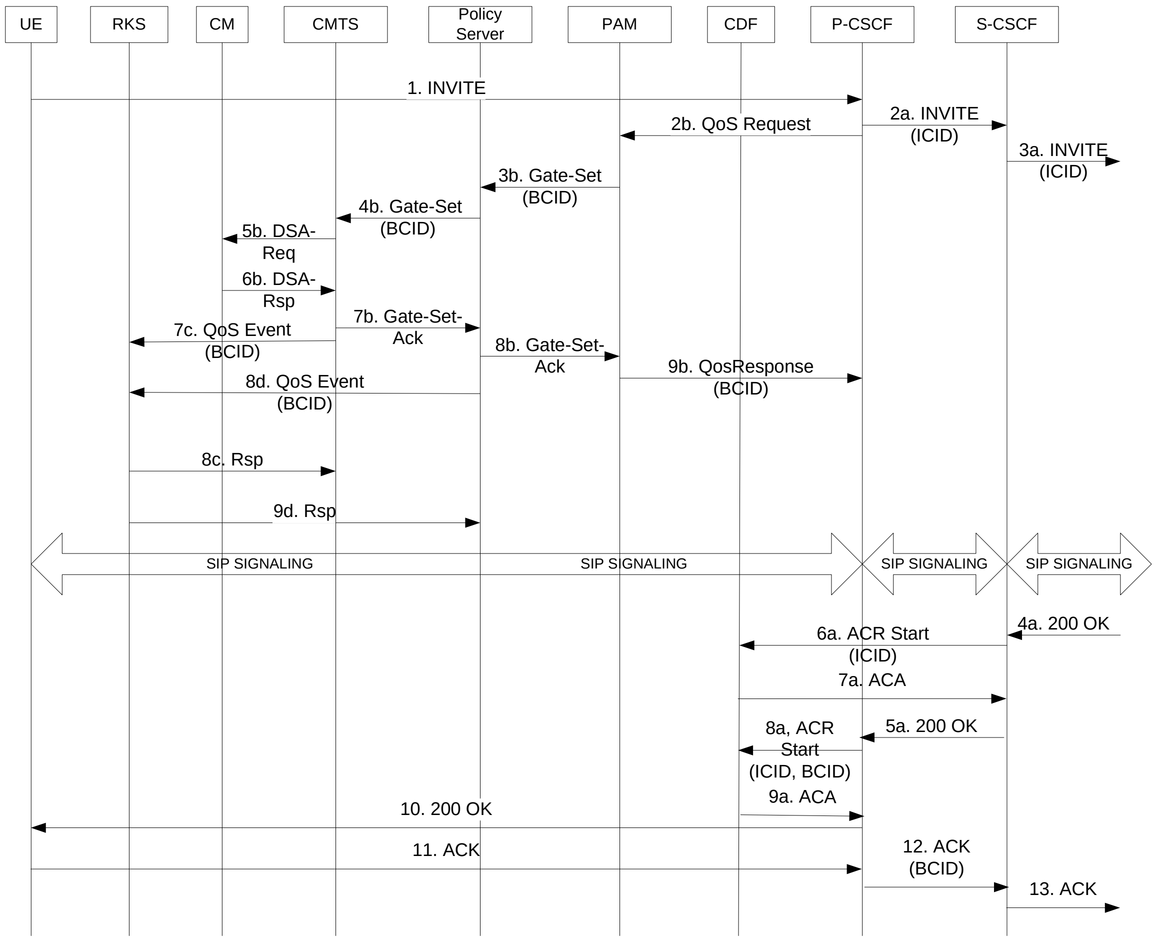

Figure 5 – PacketCable Offline Charging Call Flow Example

1. The UE sends an INVITE to the P-CSCF to initiate a session.

2a. The P-CSCF, using standard procedures, creates an ICID and inserts it into the P-Charging-Vector header and sends the INVITE to the S-CSCF.

3a. The S-CSCF proceeds with normal session initiation.

2b. At the same time that the P-CSCF forwards the INVITE in step 2a, the P-CSCF begins to reserve QoS resources for the session and sends a QoS Request to the PAM. The QoS Request contains the ICID to allow the PacketCable Multimedia system to correlate usage events with IMS charging events.

3b. The PAM creates a unique BCID that is contained in all usage events for this session. The PAM then sends a Gate-Set to the PacketCable Multimedia Policy Server to request the necessary QoS resources. This Gate-Set message includes the PAM generated BCID.

4b – 9b, 7c, 8c, 8d, 9d. The PacketCable Multimedia system does normal processing

8b. The Policy Server returns a Gate-Set Ack message to the PAM when completed.

9b. The PAM sends a QoS response back to the P-CSCF indicating that the QoS resources have been reserved and includes the BCID, which uniquely identifies this session for use in usage and charging events.

While this is occurring, other SIP signaling is being done to setup the session.

4a. When the other side is ready, it sends a 200 OK message to the S-CSCF.

5a. The S-CSCF forwards this to the P-CSCF and

6a. The S-CSCF sends an ACR Start message to the CDF with the ICID that it received from the P-CSCF in step 2a. The ICID is the unique session identifier in IMS for charging events associated with this session. The CDF will respond with an ACA in message 7a.

8a. When the P-CSCF has received both the 200 OK and the QoS response from the PAM, it sends an ACR Start message to the CDF. It includes both the ICID and the BCID (sent in the Access-Network-Charging-Identifier-Value AVP) in the message. This will allow the downstream usage and charging systems to correlate the PacketCable Multimedia and IMS events for this session. The CDF will respond with an ACA in message 9a.

10. The P-CSCF forwards the 200 OK to the UE, and

11. The UE responds with an ACK.

12. The P-CSCF includes the BCID in the P-Charging-Vector header in the ACK message to the S-CSCF. Subsequent Accounting Events from the S-CSCF will now contain both the ICID and BCID.

13. The S-CSCF forwards the ACK towards the terminating UE. Note that it does not include the BCID in the forwarded message, as the access network charging information only has local significance and is not exchanged with the terminating half of the network.

This completes the session setup. The key to correlating the PacketCable Multimedia access network usage events with the IMS charging events is the ACR from the P-CSCF in step 10e. This is the single message that includes both the ICID and the BCID in events that are sent to the usage and charging systems.

Appendix II Acknowledgements

We wish to thank the vendor participants contributing directly to this document:

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Appendix III Revision History

The following ECN has been incorporated in PKT-SP-ACCT-I02-061013.

ECN	Date Accepted	Summary
ACCT-N-06.0336-6	9/11/06	Add basic ACR requirements to PacketCable Accounting Specification

The following ECNs have been incorporated in PKT-SP-ACCT-I03-070925.

ECN	Date Accepted	Summary
ACCT-N-07.0417-1	5/29/07	Editorial Corrections
ACCT-N-07.0418-2	5/29/07	Update the Reference Architecture
ACCT-N-07.0419-2	6/18/07	Align the Accounting spec with 3GPP Release 7
ACCT-N-07.0484-2	8/20/07	Align Accounting Spec with new PacketCable 2.0 QoS spec

The following ECN has been incorporated in PKT-SP-ACCT-I04-080425.

ECN	Date Accepted	Summary
ACCT-N-08.0500-1	3/17/08	Reference Updates