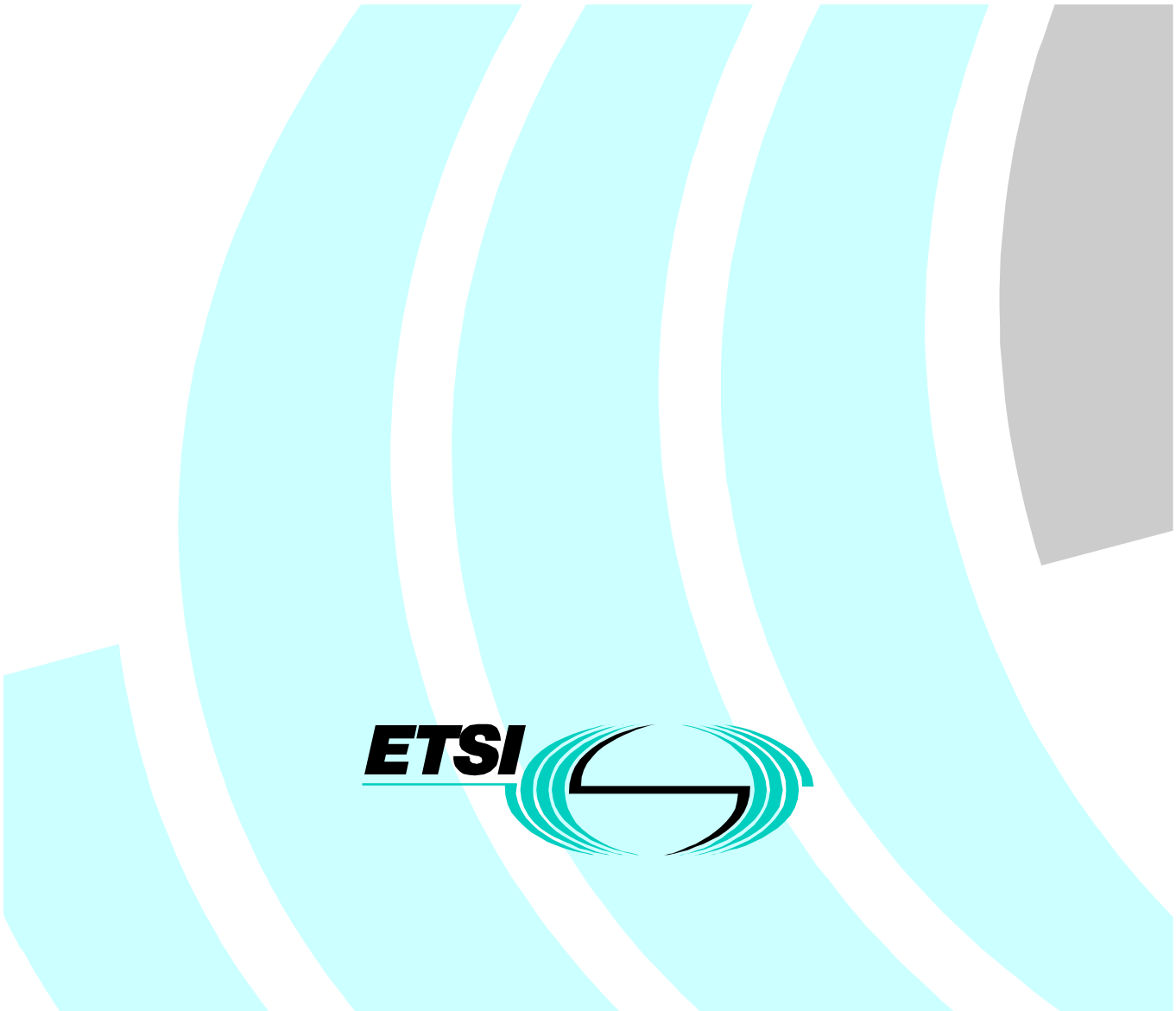
ETSI TS 101 909-10 V1.1.1 (2001-06)

Technical Specification

Access and Terminals (AT);
Digital Broadband Cable Access to the Public Telecommunications Network;
IP Multimedia Time Critical Services;
Part 10: Event Message Requirements for the Provision of Real Time Services over Cable Television Networks using Cable Modems



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Contents

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Access and Terminals (AT).

The present document is part 10 of a multi-part deliverable supporting real-time multimedia services, as identified below:

Part 1: "General";

Part 2: "Architectural framework for the delivery of time critical services over cable Television networks using cable modems";

Part 3: "Audio Codec Requirements for the Provision of Bi-Directional Audio Service over Cable Television Networks using Cable Modems";

Part 4: "Network Call signalling Protocol";

Part 5: "Dynamic Quality of Service for the Provision of Real Time Services over Cable Television Networks using Cable Modems";

Part 6: "Media Terminal Adapter (MTA) device provisioning";

Part 7: "Management Information Base (MIB) Framework";

Part 8: "Media Terminal Adapter (MTA) Management Information Base (MIB)";

Part 9: "Network Call Signalling (NCS) MIB Requirements";

Part 10: "Event Message Requirements for the Provision of Real Time Services over Cable Television Networks using Cable Modems";

Part 11: "Security";

Part 12: "Internet Signalling Transport Protocol";

Part 13: "Trunking Gateway Control Protocol";

Part 14: "Operation System Support".

NOTE 1: The above list is complete for the first version of this Technical Specification (TS) (V1.1.1 2001-06). Additional parts are being proposed and these will be added to the list in future versions".

The present part is part 10 of the above mentioned series of ETSI deliverables and describes the concept of Event Messages used to collect usage for the purposes of billing within the IPCablecom architecture. It details a transport protocol independent Event Message attribute TLV format, an Event Message file format, mandatory and optional transport protocols, the various Event Messages, lists the attributes each Event Message contains, and lists the required and optional Event Messages associated with each type of end-user service supported. In order to support vendor interoperability, implementations must minimally support RADIUS as a transport protocol.

NOTE 2: The choice of a multi-part format for this deliverable is to facilitate maintenance and future enhancements.

NOTE 3: The term **MUST** or **MUST NOT** is used as a convention in the present document part to denote an absolutely mandatory aspect of the specification.

Introduction

The cable industry in Europe and across other Global regions have already deployed broadband cable television hybrid fibre coax (HFC) data networks running the Cable Modem Protocol. The cable industry is in the rapid stages of deploying IP Voice and other time critical multimedia services over these broadband cable television networks.

The cable industry has recognized the urgent need to develop ETSI Technical Specifications aimed at developing interoperable interface specifications and mechanisms for the delivery of end-to-end advanced real time IP multimedia time critical services over bi-directional broadband cable networks.

IPCablecom is a set of protocols and associated element functional requirements developed to deliver Quality of service (QoS) enhanced secure IP multimedia time critical communications services using packetized data transmission technology to a consumer's home over the broadband cable television Hybrid Fibre/Coaxial (HFC) data network running the Cable Modem protocol. IPCablecom utilizes a network superstructure that overlays the two-way data-ready cable television network. While the initial service offerings in the IPCablecom product line are anticipated to be Packet Voice, the long-term project vision encompasses packet video and a large family of other packet-based services.

The cable industry is a global market and therefore the ETSI standards are developed to align with standards either already developed or under development in other regions. The ETSI Specifications are consistent with the CableLabs/PacketCable set of specifications as published by the SCTE. An agreement has been established between ETSI and SCTE in the US to ensure, where appropriate, that the release of PacketCable and IPCablecom set of specifications are aligned and to avoid unnecessary duplication. The set of IPCablecom ETSI specifications also refers to ITU-SG9 draft and published recommendations relating to IP Cable Communication.

The whole set of multi-part ETSI deliverables to which the present document belongs specify a Cable Communication Service for the delivery of IP Multimedia Time Critical Services over a HFC Broadband Cable Network to the consumers home cable telecom terminal. "IPCablecom" also refers to the ETSI working group program that shall define and develop these ETSI deliverables.

1 Scope

The present document specifies IPCablecom, a set of protocols and associated element functional requirements. These have been developed to deliver Quality of service (QoS), enhanced secure IP multimedia time critical communication services, using packetized data transmission technology to a consumer's home over a cable television Hybrid Fibre/Coaxial (HFC) data network.

NOTE 1: IPCablecom set of documents utilize a network superstructure that overlays the two-way data-ready cable television network, e.g. as specified within ES 201 488 and ES 200 800.

While the initial service offerings in the IPCablecom product line are anticipated to be Packet Voice and Packet Video, the long-term project vision encompasses a large family of packet-based services. This may require in the future, not only careful maintenance control, but also an extension of the present set of documents.

NOTE 2: The present set of documents aims for global acceptance and applicability. It is therefore developed in alignment with standards either already existing or under development in other regions and in International Telecommunications Union (ITU).

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 and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

ETSI TS 101 909-4: "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 4: Network Call signalling Protocol".

ETSI TS 101 909-11: "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 11: Security".

ITU-T Recommendation J.112: "Transmission systems for interactive cable television services".

ETSI TS 101 909-5: "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 5: Dynamic Quality Of Service For The Provision Of Real Time Services Over Cable Television Networks Using Cable Modems".

RFC 2138: "Remote Authentication Dial In User Service (RADIUS)".

RFC 2139: "RADIUS Accounting".

ITU-T Recommendation X.682 (1997): "Information technology - Abstract Syntax Notation One (ASN.1): Constraint specification".

ETSI ES 201 488: "Data-Over-Cable Service Interface Specifications; Radio Frequency Interface Specification".

ETSI ES 200 800: "Digital Video Broadcasting (DVB); DVB interaction channel for Cable TV distribution systems (CATV)".

ETSI TS 101 909-2: "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 2: Architectural framework for the delivery of time critical services over cable Television networks using cable modems".

ITU-T Recommendation E.164: "The international public telecommunication numbering plan".

3 Definitions and abbreviations

3.1 Definitions

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

Access Node: layer two termination device that terminates the network end of the ITU-T Recommendation J.112 connection

NOTE 1: It is technology specific. In ITU-T Recommendation J.112 annex A it is called the INA while in annex B it is the CMTS.

Cable Modem: layer two termination device that terminates the customer end of the J.112 connection

Call: instance of user-initiated voice communication capabilities

NOTE 2: In traditional telephony, a call is generally considered as the establishment of connectivity directly between two points: originating party and terminating party. In the IPCablecom context, as noted above, the communication between the parties is "connectionless" in the traditional sense.

Event Message Attribute: predefined data element described by an attribute definition and attribute type

Event Message: set of data, representative of an event in the IPCablecom architecture that could be indicative of usage of one or more billable IPCablecom capabilities

NOTE 3: An Event Message by itself may not be fully indicative of a customer's billable activities, but an Event Message correlated with other Event Messages builds the basis of a billable Usage Detail Record.

IPCablecom: ETSI working group project that includes an architecture and a series of specification that enable the delivery of real-time services over the cable television networks using cable modems

IPCablecom Transaction: collection of events on the IPCablecom network when delivering a service to a subscriber

NOTE 4: Event Messages for the same transaction are identified by one unique Billing Correlation ID (as described in table 32). For some services, multiple transactions may be required to provide information that is necessary to collect the total usage for the service. Multiple Event Messages may be required to track resources for each individual service used. A Transaction may persist over time.

Service: individual or package of communications features a subscriber may select

NOTE 5: A service is identified by a set of one or more "calls" or transactions that deliver the desired functionality to the subscriber. Examples of a service include: a voice communication between two local IPCablecom subscribers, a 3-way call, pay-per-view movie, and a web surfing session. A service may be instantaneous or persist over time.

3.2 Abbreviations

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

AMA	Automated Message Accounting
AN	Access Node
CDR	Call Detail Record
CM	Cable Modem
CMS	Call Management Server
C7	Signalling System Number 7
F ID	Flow IDentifier
HFC	Hybrid Fibre Coax
IP	Internet Protocol
MGC	Media Gateway Controller
MTA	Media Terminal Adapter
OSS	Operations Support System
QoS	Quality of Service

PSTN	Public Switched Telephone Network
RKS	Record Keeping Server

4 Void

5 Introduction

5.1 IPCablecom overview

IPCablecom is identifying and defining Specifications for delivery of enhanced communications services using packetized data transmission technology over the cable television hybrid fibre coax (HFC) data network running the J.112 protocol. IPCablecom specifies a network superstructure that overlays the two-way data-ready broadband cable access network.

While IPCablecom is initially focused on packet voice over cable, IPCablecom will ultimately encompass additional voice services as well as other services such as data, video, and other real-time multimedia.

5.2 IPCablecom Event Messages

An Event Message is a data record containing information about network usage and activities. A single Event Message may contain a complete set of data regarding usage or it may only contain part of the total usage information. When correlated by the Record Keeping System (RKS), information contained in multiple Event Messages provides a complete record of the service. This complete record of the service is often referred to as a Call Detail Record (CDR). Event Messages 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 the 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. Examples of these services include IPCablecom voice, video and other multimedia services, such as Video-On-Demand, Pay-Per-View and J.112 high-speed data services.

This IPCablecom Event Messages Specification defines a transport protocol independent Event Message attribute TLV format, an Event Message file format, as well as the mandatory RADIUS protocol and the optional FTP transport protocol. Although the scope of this Event Message Specification is limited to defining Event Messages for simple voice communications activities, it is expected that the present document will be expanded to support additional IPCablecom services as well as high-speed data services.

5.3 IPCablecom reference architecture

Figure 1 shows the reference architecture for the IPCablecom Network. Refer to the IPCablecom architecture document TS 101 909-2 for more detailed information on this reference architecture.

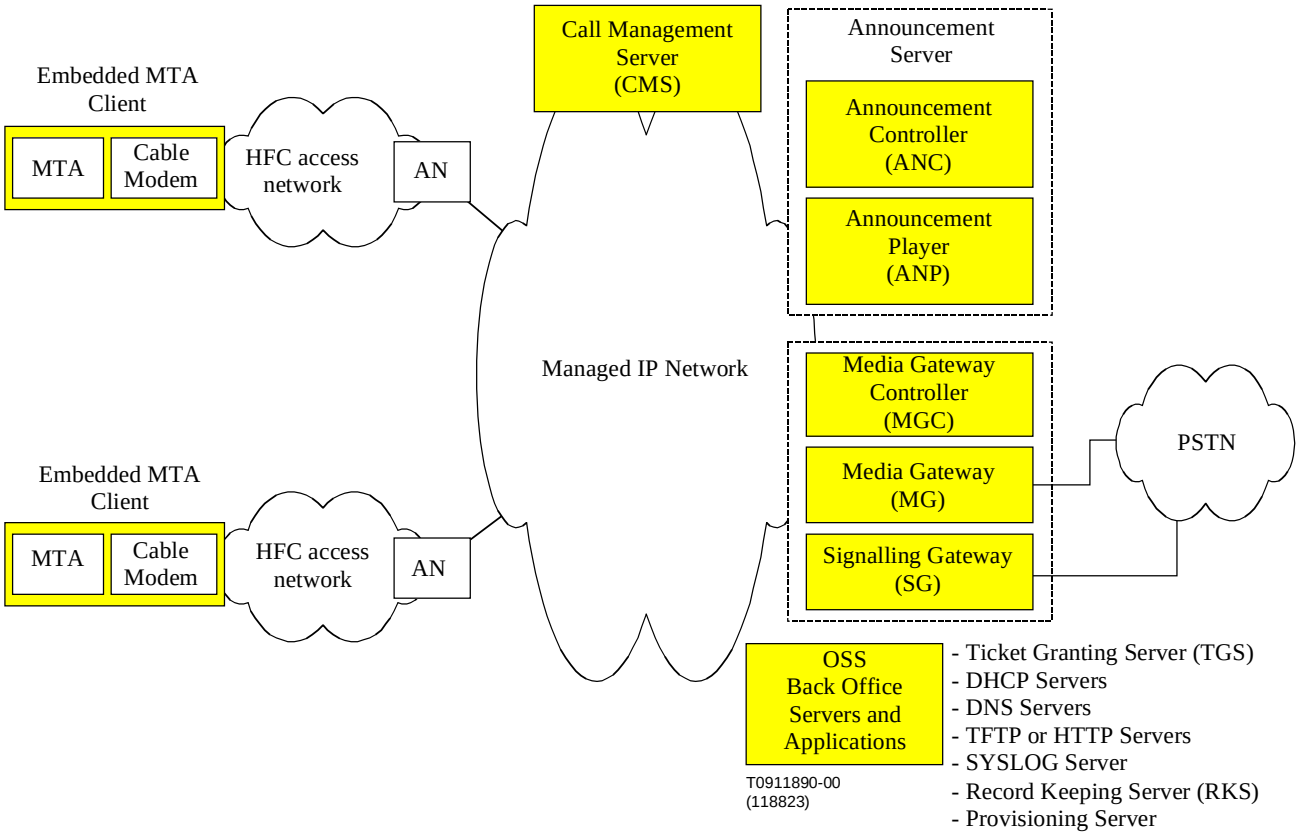


Figure 1: IPCablecom network component reference model (partial)

5.4 IPCablecom, Voice over IP over Cable

Cable operators are deploying high-speed data communications systems and offering voice, video, and data services based on bidirectional transfer of Internet protocol (IP) traffic. The transfer takes place between the cable system headend and customer locations, over an all-coaxial or hybrid-coax/coax (HFC) cable network, defined by ITU-T Recommendation J.112. This is shown in simplified form in figure 2.

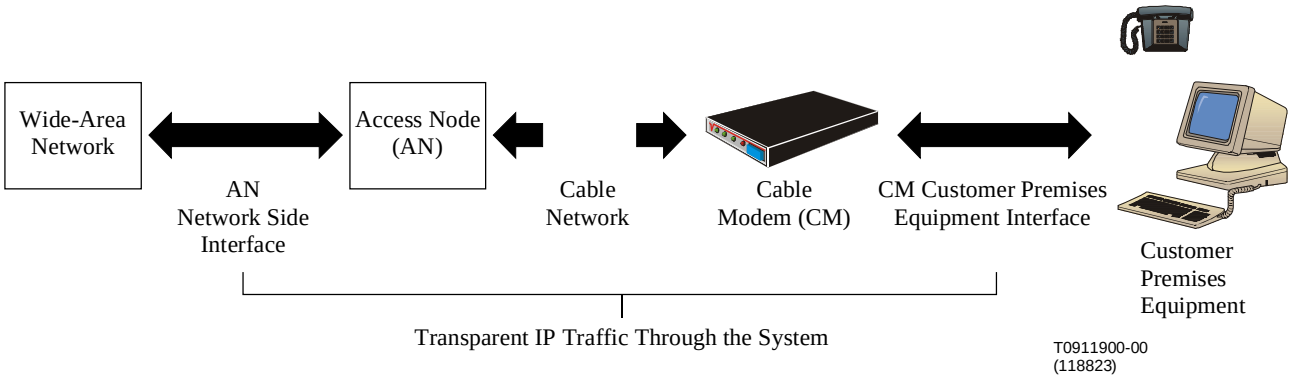


Figure 2: Transparent IP Traffic through the Data-Over-Cable System

The transmission path over the cable system is realized at the headend by an Access Node and at each customer location by a CM. The intent is for operators to transfer IP traffic transparently between these interfaces.

One critical Operations Support System (OSS) function required to operate such a system is the capturing of usage on a call-by-call basis for each subscriber. Such functionality is critical in allowing the operators to bill for services provided on a usage-sensitive basis, but also plays an important role in areas such as network usage monitoring and fraud management. The usage collection concept lies in requiring network elements involved in key portions of each call to notify a centralized Record Keeping Server (RKS) with what are termed Event Messages detailing the relevant data pertaining to the portion of the call handled by that given network element. This Event Message concept, and the architecture, which underlies it are described in greater detail in the present document.

6 Background

6.1 Traditional Telephony Billing Formats

The telephony industry has traditionally recorded call detail transactions on telephone switches utilizing various standard and proprietary billing formats such as Automated Message Accounting (AMA). The switches generate multiple transactions based upon the type of call the customer placed. These transactions are correlated and packaged into a single Call Detail Record (CDR) at the end of the service instance for billing purposes. In this traditional telephony model, services and awareness of "call state" is usually maintained in one or at most two nodes of the network, which makes such correlation relatively straightforward. The CDR is then delivered to the billing system for the purpose of placing a charge on the customer's account.

6.2 Motivation for Event Based Billing

The event-based approach to capturing information to be used for billing is necessary to accommodate the distributed architecture of IPCablecom. "Call state awareness" no longer resides in one or two network elements, but is instead spread out among many. Each network element MUST be responsible for generating Event Messages for the portion of the communication pertaining to them.

The primary motivating factor behind articulating the structure and details of these various Event Messages is to support multi-vendor interoperability between network elements and record keeping servers. The present defines the Event Message syntax and in addition it describes a recommended transport protocol.

Event based billing has the added advantage that it enables IPCablecom services to be billed in real-time, making the information about billable communications available as the network equipment processes them. This allows the system as a whole to be more responsive, allowing, for example, fraudulent behaviour to be detected sooner, saving revenue for the provider. It also allows a more fully integrated solution, as it becomes possible for the billing system and the network equipment to exchange information about the availability of a service as the customer is requesting that service.

With respect to the Event Message format, there are a large number of formats in use today. The most widely used formats carry the legacy of the traditional CDR, which is generated at the end of the call. While these formats capture much of the information content needed to bill for IPCablecom services, bringing along their full structure would make it difficult to support the real-time nature of certain enhanced IPCablecom services. The present document leverages the value of the information content from the existing billing formats, augmenting that with the distributed nature of the IPCablecom architecture.

6.3 Real-Time Billing

The billing system can be regarded as a functional block of the back office Operations Support System (OSS). The inputs to the billing system are the billing events and the outputs are the account balance and invoice. The billing system relates the billing events to the account balance by rating the events according to the pricing structure and other business logic.

Real-Time Billing Systems relate the billing events to the account balance as events occur. As the billing system receives these real-time billing events, its rating engine rates the events and immediately posts balances. Real-time Billing Systems may be required to support advanced IPCablecom features such as pre-paid calling card, real-time fraud prevention, and real-time credit enforcement.

The IPCablecom Event Message architecture can be used to support both real-time and batch billing systems.

6.4 Real-Time and Batch Event Message Delivery

Event Messages may be delivered to the RKS in real time as they are created. This enables support for a growing number of services that require purchase limits such as prepaid calling cards.

As an alternative, Event Messages may be stored for some period of time and batched together before being sent to the RKS. This approach provides a more efficient use of network resources.

6.5 Terminology and Concepts

This clause defines terminology associated with usage data as it relates to IPCablecom Services. The concept of a "call" is well understood and used within the telecommunications marketplace today. A traditional telephony "call" involves establishing a dedicated, circuit-switched path between the calling and called parties. Packet-switched architectures, including IPCablecom, do not establish any such dedicated paths. To the contrary, the IPCablecom architecture assumes a shared medium between the head-end and the customer, as compared to the dedicated loop plant in traditional telephony; and during a traditional telephone call, as noted above, a circuit-switched "connection" is established between the parties, whereas packet switching is inherently "connectionless." All that said, the term "call" is sufficiently well entrenched that it will be used in the present document to refer to packet-mode voice communications between two parties over an IPCablecom network, even though in technical terms (as will be seen) there is little resemblance to a traditional telephone "call." It is envisioned that many new voice, video, data and other multimedia services will be developed to take advantage of the inherent extensibility of the IPCablecom architecture. These new services, which likely will not be derived from traditional telephony principals, will be based on the term transaction, which is more indicative of the data flows across the IPCablecom network. The Event Message structure is designed to be flexible and enable the addition of new IPCablecom services and features while maintaining backward compatibility with existing applications. Event Messages MAY support information required for billing of CM data services, video services, and the encapsulation of vendor specific proprietary data.

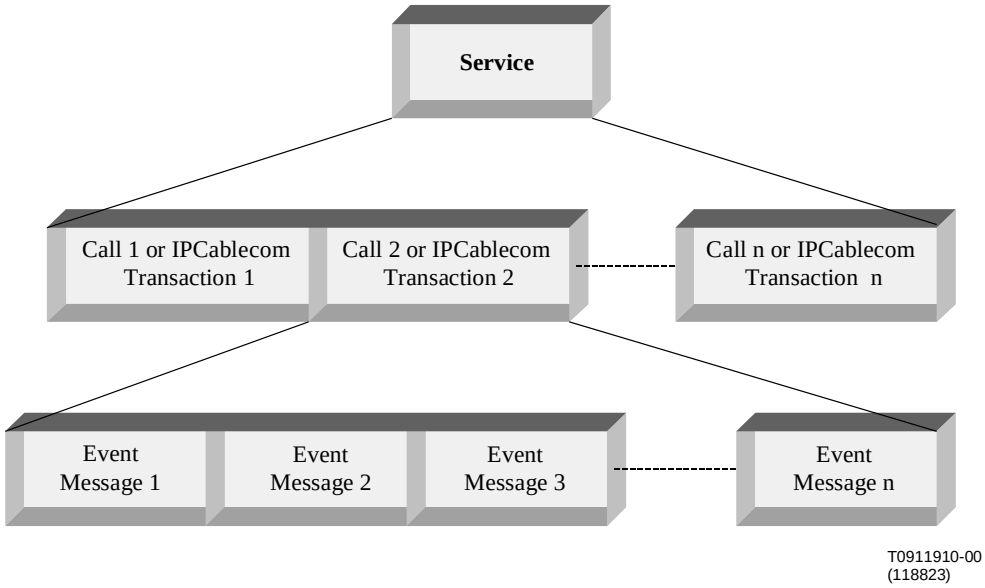


Figure 3: IPCablecom terminology

7 IPCablecom objectives

7.1 IPCablecom required services and capabilities

IPCablecom provides basic voice capabilities and therefore MUST support Event Messages for the following services. These services are described in more detail in clause 9 of the present document.

- Interconnection with circuit-switched PSTN.
- Support for Emergency Services.
- Short Code Services.
- Freephone Services.
- Operator Services.
- Call Block Service.
- Call Waiting Service.
- Call Forwarding/Call Redirection Services.
- Return Call Service.
- Repeat Call Service.
- Voicemail Service.
- Message Waiting Indicator Service (E-mail/Voicemail notification).

7.2 IPCablecom + Supported Services and Capabilities

The following represents a list of possible additional IPCablecom services that MAY be supported. The list, though meant as a rough guideline, is not comprehensive, and it is expected that as the scope of services grows, so too will this list. A detailed definition of these services is not defined in the present document.

- 3-way Communication.
- Call Transfer.
- Speed Dialling.
- Caller Name and Number.
- Caller Name and Number Privacy.
- Selective Screening Services.
- Pay-Per-Communication Services.
- Distinctive Notification (to identify callee in a multiple-party household).
- Priority Notification (to prioritize incoming communications).
- Customer Originated Trace.
- Selective Forwarding.
- Rejection (activate and deactivate).
- Teletype Translation Services.
- Multi-line Hunt Group Services.
- Virtual second line (Multiple lines).
- Alternate billing methods (collect, third number billed, credit card, pre-paid services, etc.).

7.3 Assumptions

The following assumptions have been made which apply to the entire document:

- IPCablecom does NOT support distributed call signalling (DCS), slated for later IPCablecom releases.
- IPCablecom assumes proprietary signalling for CMS-CMS or CMS-MGC signalling. These interfaces will be defined in future IPCablecom releases.
- IPCablecom does not specify the interface between an RKS and a billing system.
- All IP based Intelligent Peripherals (these include Announcement Servers, for example) will be connected to the originating CMS or MGC.
- IPCablecom does NOT support Line Information Database (LIDB) queries. Calls requiring LIDB determination, such as calling card personal identification number validation, are sent directly to the PSTN.
- IPCablecom supports local number portability (LNP).
- Non-IPCablecom network elements, such as those residing in the public switched telephone network (PSTN) to which an IPCablecom system may interconnect with, will NOT generate and send Event Messages to the RKS.
- PSTN Intelligent Peripheral Event Messages are generated by the originating CMS.

- IPCablecom Event Messages currently only support messages for actual billable events. The present document does not specify messages related to provisioning of services by the operator of an IPCablecom network. The present document does support Event Messages for Subscriber service activation. The present document does not specify messages related to selection of an entity other than the IPCablecom network operator to handle off-network activities (e.g., inter-exchange communications).

- The initiating party number and the terminating party number are the only two attributes defined in IPCablecom that can be used to associate a subscriber with usage of network resources.

- IPCablecom supports interconnection to both Transit and Local Switches.

- IPCablecom supports an emergency Trunk Group.

- IPCablecom trusted network elements are expected to be pre-provisioned with a minimum set of data using a vendor-proprietary mechanism. Examples of this data may include:

  • Element Type, identifying the element as a AN, CMS, or MGC.

  • Element ID. It is assumed the Element ID will be a MAC address for IPCablecom, but in future IPCablecom releases may be changed to a more globally unique value, similar to the CLLI code in the PSTN.

  • Frequency (in minutes) of long-duration-call message generation (0 = never, 60 = hourly).

  • A list of which Event Messages are required and which Event Messages are optional as defined by the network operator. For each of these Event Messages, identify if the Event Messages are to be 1) transported to the RKS as a single Event Message in real-time or 2) batched and transported to the RKS as multiple Event Messages at a later time or 3) provide capability to configure both how many Event Messages are batched before being sent to the RKS.

  • number of days to keep Event Messages for short-term storage.

  • RADIUS protocol parameters:

    - Retry interval and Retry count.

    - For each RKS that may receive Event Messages, its IP address and UDP port.

    - The IP address of each RADIUS server that it may communicate with.

8 Event Messages Architecture

Figure 4 shows a representative IPCablecom Event Messages Architecture. By standardizing the transport, syntax and collection of appropriate Event Message attributes from a distributed set of network elements, the IPCablecom architecture provides a single reference point to interface to existing billing, settlement, reconciliation, and other systems. Note that only the shaded components are included within the scope of the IPCablecom architecture. Interfaces between the RKS and the shaded IPCablecom network elements are within scope of IPCablecom. Interfaces between the RKS and back office servers or applications are NOT within the scope of IPCablecom. It should be understood that the back office servers and applications shown in figure 4 are representative, and are not mandated by the IPCablecom architecture.

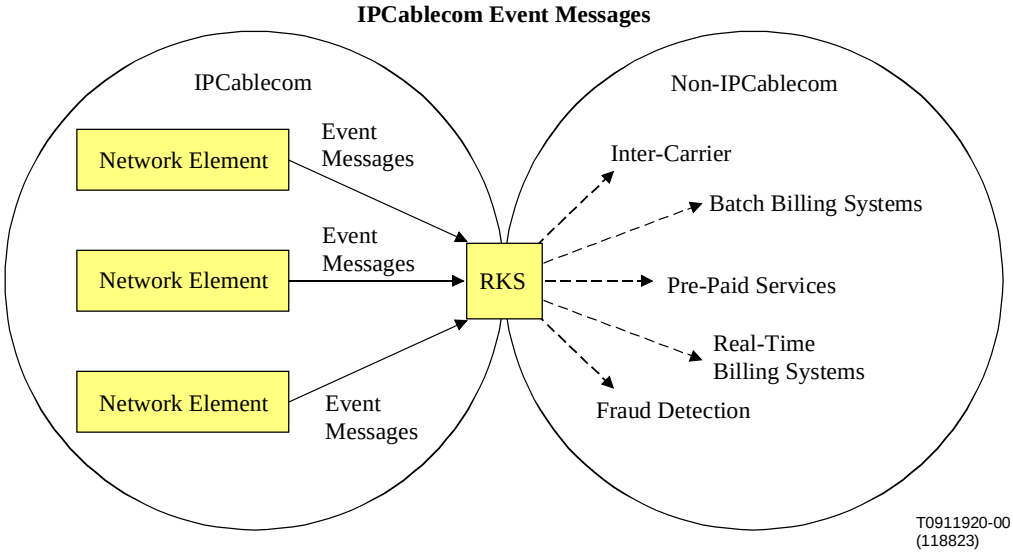


Figure 4: Representative IPCablecom Event Messages Architecture

8.1 IPCablecom Event Message Collection

Event Message collection occurs as follows: when trigger events occur (such as call signalling starts, activation of QoS service resources, call signalling stops, etc.), the relevant IPCablecom network element generates an Event Message. These messages may be sent immediately to the RKS, or a group of messages may be collected and sent at a later time. In either case, the actual time of the trigger event is reported allowing the back office applications to accurately calculate time-based resource usage. As these Event Messages are accumulated within the RKS, the network operator can then export them into their billing systems based on their business requirements. The data from multiple network elements are linked to a transaction (e.g. call) via a unique Billing Correlation identifier, which can be leveraged for reconciliation and non-repudiation purposes.

8.2 IPCablecom Network Elements

The IPCablecom architecture supports a system capable of creating, collecting, and delivering usage data from a subset of IPCablecom network elements to a cable operator's back office applications. Trusted IPCablecom network elements that create Event Messages include the Call Management Server (CMS) Access Node (AN), Media Gateway Controller (MGC).

The IPCablecom architecture contains trusted and untrusted network elements. Trusted network elements are typically located within a cable operator's facility and are controlled by the cable operator. Untrusted network elements are typically located within the consumer's home or outside of the cable operator's facility or exclusive control. In the IPCablecom architecture, Event messages are only accepted from trusted IPCablecom network elements.

TS 101 909-2 contains a detailed description of the IPCablecom network elements. A brief explanation of the IPCablecom network elements that will most likely generate IPCablecom Event Messages is listed in this clause for completeness.

8.2.1 Call Management Server (CMS)

The Call Management Server (CMS) provides signalling services necessary for voice communications. The primary purpose of the CMS is to establish standard "calls", as that term is used in the IPCablecom context. The media servers also provide support services for the media streams such as conference mixing bridges and announcement servers.

The CMS MUST create a Billing Correlation ID on receipt of an NCS-signalling NTFY message from an MTA.

The CMS MUST send the Billing Correlation ID and other data as defined in table 1 to the AN via the DQoS GateSet message as specified in TS 101 909-5.

Table 1: IPCablecom Event Reporting Common Elements

1	Billing_Correlation_ID (see table 32).
2	IP address and port number of the primary RKS.
3	IP address and port number of the secondary and other RKSs (optional).
4	Flag indicating if AN should send Event Messages to the RKS in real-time.

The CMS MUST generate the appropriate Event Messages as defined in the present document.

8.2.2 Media Gateway Controller (MGC)

The Media Gateway Controller (MGC) is the overall controller function of the PSTN gateway. It receives, mediates, and routes call signalling information between the IPCablecom and PSTN domains and it maintains and controls the overall call state for all calls connecting to and from the PSTN. It controls the Media Gateway function and communicates with the Signalling Gateway function via the MGC-SG protocol defined for the major protocol family in question, i.e., ISUP, In-band or TCAP.

The MGC MUST create a Billing Correlation ID on receipt of:

- an C7 IAM message, or
- a TCGP NTFY with digits (operator services),
- The MGC MUST generate the appropriate Event Messages as defined in the present document.

8.2.3 Access Node (AN)

The Access Node terminates the connection from the CM on the customer premises into the IPCablecom network. The AN generates QoS Event Messages.

The AN MUST generate the appropriate Event Messages as defined in the present document.

8.2.4 Record Keeping Server (RKS)

The Record Keeping Server (RKS) is a trusted network element function. In many cases, for simplicity reasons, the RKS is depicted in the present document as a separate standalone element, but the present document does not preclude a CMS, Billing System, or other application from performing the RKS functionality. The RKS is the mediation layer between the call signalling and transport layer and the back-office applications. The RKS is expected to pre-process the data from the Call Signalling and Transport layer and present it to the back-office applications in the format and within the time constraints deemed necessary by the operator.

The RKS also, at a minimum, is a short-term repository for IPCablecom Event Messages. It receives Event Messages from various trusted IPCablecom network elements. The RKS assembles the Event Messages into coherent sets, which are then made available to a usage-processing platform and potentially to several other back office systems. It acts as the demarcation point between the IPCablecom network and the back office applications.

The RKS is expected to perform the following functions:

- The RKS MUST receive Event Messages.
- The RKS MUST be capable of correlating all Event Messages related to an individual call and have an extensible output to meet the needs of the downstream applications.
- The RKS MUST assemble Events and Determine Completeness - this MUST include the capability to distinguish Event Messages, and recognize when a complete set, representing a coherent set of billing data is available for transport to the back office system.
- The RKS MUST provide interface network functions that require real time or near real time based on priority and where messages are being sent, as defined in clause 10. For example, a call may be sent real-time and a report may be sent at night. The correlation process MUST be user definable to support the various call events defined herein and defined in the future.
- The RKS MUST have the ability to store the Event Messages for at least one week or until sent to the other back office systems and successful receipt is acknowledged from those systems.
- The RKS MUST have the ability to dump the Event Messages to some other type of offline storage device on a regular basis (CD, TAPE, or other media) for retrieval and regulatory purposes.

The following list deals with other possible capabilities of an RKS. They are therefore beyond the scope of the requirements of the current document, and are included here for informational use only. Decisions on these optional requirements will be based upon the operator response to many regulatory and business variables.

- An RKS-RKS security interface MAY be required. IPCablecom does not define this interface. The security interface between the RKS and other IPCablecom trusted network elements is defined in TS 101 909-11 IPCablecom Security Specification.
- The RKS MAY support Backup and Recovery - this includes a nominal ability to restore the state and contents of billing data in the event of application or platform failures.
- The RKS MAY support distribution of billing data to all appropriate systems - this includes the implementation of a protocol that ensures data integrity and reliability on the usage collator interface.
- The RKS MAY support monitoring and reporting - this includes the ability to produce and send alarms to a network management system, and create various audit and measurement reports.
- The RKS MAY allow remote testing and maintenance capability.
- The RKS MAY support a Service Creation Environment.
- The RKS MAY support user defined fault handling in the case of incomplete Event Messages or other such anomalies.
- The RKS MAY support multiple downstream applications, and various transport methodologies.
- The RKS MAY support full auditability of data and processes.
- The RKS MAY support a user definable long-term storage mechanism.
- The RKS MAY support disaster planning and recovery processing.

8.3 General IPCablecom Network Element Requirements

This clause lists requirements placed on the IPCablecom network elements:

- The CMS and AN MUST create a security relationship with each RKS that these network elements will send Event Messages as defined in TS 101 909-11. The MGC MUST create a security relationship with each RKS that the MGC will send Event Messages.

- The CMS MUST support multiple primary RKSs, which might be required in cases in which total Event Message traffic exceeds the throughput capability of a single RKS.

- For each call, the CMS or the MGC MUST create a unique Billing_Correlation_ID, identify the primary and all other RKSs and determine if the Event Messages are to be delivered in real time or they may be batched and sent at a later time.

- The trusted IPCablecom network elements that generate Event Messages MUST timestamp Event Messages in 1 millisecond granularity ±100 ms based on information reported by network time sources such as edge devices (Clients and Gateways).

- All IPCablecom network elements that generate Event Messages MUST synchronize their clocks at least once per hour to a network clock source. This synchronization MUST assure the reporting device's own clock remains within ±100 ms real time of the last synchronization value.

- IPCablecom network elements that generate Event Messages MUST support system wide Network Time Protocol (NTP) time synchronization.

- The IPCablecom network elements MUST support transport to multiple RKSs for processing system segmentation, downstream overload conditions, and disaster recovery.

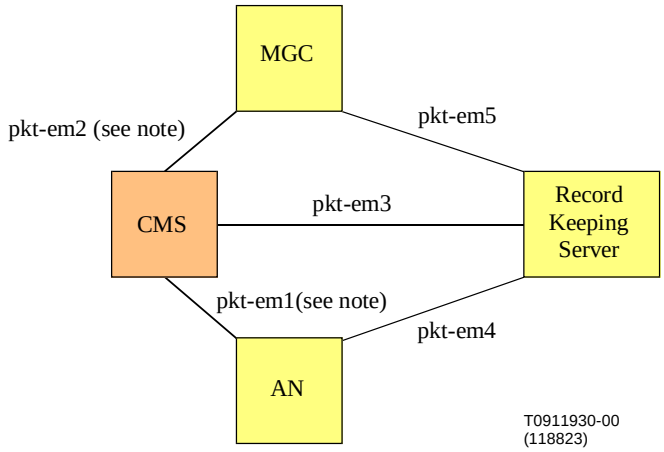
- IPCablecom network elements MUST support the transport of a single Event Message as well as a batch of Event Messages.

NOTE: Batch mode = multiple Event Message per single Radius message.

- Each trusted IPCablecom network element that generates an Event Message MUST identify itself with a static, unique element ID.

8.4 Event Message Interfaces

This clause describes the interfaces between the IPCablecom network elements that are involved in the Event Messages process. It should be noted that additional requirements are imposed on these by other IPCablecom Specifications and that the requirements listed in the present document are specific to Event Messages. It should also be noted that additional requirements are specified for these interfaces and these IPCablecom network elements in other clauses of the present document.



NOTE: It indicates that the Billing Correlation ID and other data defined in table 1 is carried on an existing signalling interface.

Figure 5: Event Message Billing Interfaces

8.4.1 CMS to AN (pkt-em1*)

The CMS to AN interface is defined by the IPCablecom DQoS protocol TS 101 909-5.

The CMS sends the Billing Correlation ID and other data as defined in table 1 to the AN via the DQoS GateSet message as specified in TS 101 909-5.

8.4.2 CMS to MGC (pkt-em2*)

The CMS to MGC interface is vendor proprietary in IPCablecom. This interface will be defined in a future IPCablecom Specification.

If the CMS routes a call to the MGC, then the CMS MUST send the Billing Correlation ID and other data as defined in table 1 to the MGC via a vendor-proprietary interface.

If the MGC routes a call to the CMS, then the MGC MUST send the Billing Correlation ID and other data as defined in table 1 to the CMS via a vendor-proprietary interface.

8.4.3 CMS to RKS (pkt-em3)

The CMS to RKS interface is defined by TS 101 909-11 and also by the Event Message transport and syntax rules defined in the present document.

8.4.4 AN to RKS (pkt-em4)

The AN to RKS interface is defined by TS 101 909-11 and by the Event Message transport and syntax rules defined in the present document.

8.4.5 MGC to RKS (pkt-em5)

The MGC to RKS interface is defined by the TS 101 909-11 and by the Event Message transport and syntax rules defined in the present document.

8.4.6 Security Requirements

When the network IPSec Security Associations are established, security keys MUST be created and exchanged between each RKS (primary, secondary, etc.) and every CMS, and AN that will send Event Messages to any of those RKSs. A security association MUST exist between the MGC and RKS and is left to vendor implementation in IPCablecom. The Event Messages are sent from the CMS and AN to the RKS using one of the supported transport protocol mechanisms, each of which must be possible to secure by IPSec. Refer to TS 101 909-11 for a detailed description of the security requirements for the IPCablecom Event Message interfaces.

8.4.7 Storage Requirements

IPCablecom network elements that generate Event Messages MUST support storage of Event Messages in a secure manner, until an acknowledgment from an RKS for those Event Messages is received. The RKS MUST have the ability to store the Event Messages for at least one week or until sent to the other operating systems and successful receipt is acknowledged from those systems. The RKS must also have the ability to dump the Event Messages to some type of off-line storage device on a regular basis (CD, TAPE, or other media) for retrieval and regulatory purposes.

9 IPCablecom Services and Their Associated Event Messages

This clause defines the supported IPCablecom Services and their associated Event Messages. Although many of the IPCablecom + services can be billed using the Event Messages and attributes defined in the present document, the services described in this clause are currently limited to IPCablecom services.

In order to identify appropriate Event Messages required for each service, representative call flows were developed for IPCablecom basic call configurations.

9.1 IPCablecom Call Configurations

This clause describes the three basic IPCablecom call configurations: On-Net to On-Net, On-Net to Off-Net, and Off-Net to On-Net. A required minimum set of Event Messages MUST be generated for each of these three basic call configurations. If specific services are initiated in along with the basic call, then refer to clause 9.2 for a list of additional Event Messages for these specific services.

9.1.1 On-Net to On-Net Call Configuration

The most basic IPCablecom call configuration is an On-Net to On-Net call within a single operator's network, using two different MTAs that are both connected to the same CMS. For IPCablecom, it is assumed that both the originating and terminating MTAs are using the same CMS and possibly two different ANs.

Table 2: On-Net to On-Net Call Configuration

Event Message	Required or Optional	Comments
Signalling_Start	R	CMS is starting signalling to support a call start.
QoS_Start	R	For Calling Party.
QoS_Start	R	For Called Party.
Database_Query	O	If LNP is required.
Intelligent_Peripheral_Usage_Start	O	e.g. if an announcement is needed (see note).
Intelligent_Peripheral_Usage_Stop	O	e.g. if an announcement is needed (see note).
Call_Answer	R	Indicates start of media stream.
Signalling_Stop	R	Generated for whichever party hangs up first.
Call_Disconnect	R	Indicates termination of media steam.
QoS_Stop	R	For Calling Party.
QoS_Stop	R	For Called Party.
NOTE: This Event Message will be defined in a future release of this IPCablecom Specification.		

9.1.2 On-Net to Off-Net Call Configuration (Outgoing PSTN Interconnect)

The only Off_Net interconnection supported by IPCablecom is to the PSTN. Therefore the CMS sends all Off_Net calls to the PSTN. The Interconnect_Start Event Message identifies the type of Off_Net trunk. The Off_Net call may require an LNP query. The CMS MUST generate a database query Event Message each time a LNP database is accessed (regardless of whether this query is requested from a PSTN database or IP database).

Table 3: On-Net to Off-Net Call Configuration

Event Message	Required or Optional	Comments
Signalling_Start	R	CMS is starting signalling to support a call start.
QoS_Start	R	For Calling Party.
Database_Query	O	If LNP is Required.
Intelligent_Peripheral_Usage_Start	O	e.g. if an announcement is needed (see note).
Intelligent_Peripheral_Usage_Stop	O	e.g. if an announcement is needed (see note).
Interconnect_Start	R	For call setup.
Call_Answer	R	Indicates start of media stream.
Signalling_Stop	R	Generated for whichever party hangs up first.
Interconnect_Stop	R	For call tear-down.
Call_Disconnect	R	Indicates termination of media steam.
QoS_Stop	R	For Calling Party.
NOTE: This Event Message will be defined in a future release of this IPCablecom Specification.		

9.1.3 Off-Net to On-Net Service (Incoming PSTN Interconnection)

The CMS receives calls that are incoming from other entities and establishes communications with the MTA on the operator's network. For IPCablecom, it is assumed that all incoming calls are from the PSTN.

Table 4: Off-Net to On-Net Call Configuration

Event Message	Required or Optional	Comments
Interconnect_Start	R	For call setup.
QoS_Start	R	For Called Party.
Intelligent_Peripheral_Usage_Start	O	e.g. if an announcement is needed (see note).
Intelligent_Peripheral_Usage_Stop	O	e.g. if an announcement is needed (see note).
Signalling_Start	R	CMS is starting signalling to service a request to start a call.
Call_Answer	R	Indicates start of media stream.
Signalling_Stop	R	Generated for whichever party hangs up first.
Interconnect_Stop	R	For call tear-down.
Call_Disconnect	R	Indicates termination of media steam.
QoS_Stop	R	For Called Party.
NOTE: This Event Message will be defined in a future release of this IPCablecom Specification.		

9.2 Specific Services

A basic set of Event Messages MUST be generated based on the type of call configuration: On_Net to On_Net, On_Net to Off_Net, Off_Net to On_Net. The basic set of Event Messages is described in clause 9.1.

This clause describes additional Event Messages that MUST be generated along with the basic set in order to describe specific IPCablecom services. This clause also describes optional Event Messages that MAY be generated along with the basic set and any additional required Event Messages. These additional required and optional Event Messages are identified in the tables in this clause. It is expected that these additional Event Messages will be able to be generated regardless of the particular implementation of the service.

9.2.1 Emergency Service

An emergency call follows the standard On-Net to Off-Net Event Message flow described above in clause 9.1.2, emergency calls require special treatment. In IPCablecom, it is assumed that the operator sends emergency calls to the PSTN on a special trunk. The Trunk Group ID is captured in the Interconnect_Start and Interconnect_Stop Event Messages, and it is assumed that the RKS or some element downstream of the RKS has the capability of inferring this trunk group type from that unique Trunk Group ID.

No additional Event Messages are required beyond the basic ones listed for an On_Net to Off_Net call in clause 9.1.2.

9.2.2 Other Short Code Services

These calls are identical to the emergency call both from a call flow and Event Message perspective. The determination of whether to bill or not can be performed at the Billing System based on the "Called Party Number" attribute. For example, charges for calls to directory assistance may be different than charges for emergency calls, which are free, but the Event Messages, which capture the usage for both types of services, are the same. They would differ only in the content of specific attribute values such as the Called_Party_Number within the Call_Answer Event Message. The billing system is expected to make a determination as to how much to bill the customer based on these attributes together with other factors such as whether the call is completed or not.

9.2.3 Freephone Services

Freephone Services follow the standard On-Net to Off-Net Event Message flow described above in clause 9.1.2. In IPCablecom, toll-free calls can be handled two ways:

- Send all Toll-free calls to the PSTN on a special trunk. The call is treated exactly like the emergency services case discussed above in clause 9.2.1 in terms of Event Messages, meaning that no additional Event Messages are required.

- Initiate a query to the toll-free SCP (in IP or PSTN) and, depending on the specified Carrier Identification Code, route the call to the appropriate network. A Database_Query Event Message MUST be generated to record the query to the toll-free database.

Table 5: Toll-Free Services

Additional Event Messages	Required or Optional	Comments
Database_Query	R	Not used for scenario 1 but required for scenario 2.

9.2.4 Operator Services

Operator Services follow the standard On-Net to Off-Net Event Message configuration described above in clause 9.1.2. There will be no new additional Event Messages beyond those already described for the On-Net to Off-Net calls in that clause. The CMS will send that call to the designated Operator Service Provider using the PSTN. There may be multiple Operator Service Providers with which the operator has contracts. The caller will just dial the normal code for operator services.

The CMS will generate an event identifying that call as a short code number dialled without any subsequent digits by using an appropriate value in the Called number field. The CMS will replace the short code in the Called Number field with the number of the Operator Service Provider (OSP). These parameters will be sent to PSTN so that call can be sent via PSTN to the OSP. It is assumed that dedicated private lines to the OSP from each IP-switch are impractical and expensive for operators, and not considered as an option.

For the purposes of IPCablecom, it is assumed that operator services only encompasses short code services. Short code plus service, in which the customer keys the dialled number in together with the initial short code, is not supported in IPCablecom.

9.2.5 Call Block Service

Event Messages are generated for Call Block Service only if the CMS blocks a call. Call Blocking is supported by all of the three basic call configurations: On_Net to On_Net, On_Net to Off_Net, and Off_Net to On_Net.

The CMS can block calls depending on the policies laid out by the operator. For example, the operator may allow the end-user to block all 900 calls at the user's request. As another example, the operator may recognize some calls as fraudulent and block those fraudulent calls. In this case an Event Message needs to be generated with some reason attributes as to why the call was blocked. In addition, depending on the type of blockage, the operator may desire to play an appropriate announcement (e.g. "Sorry your time is up …."). The CMS may initiate another call to the Announcement Server via the PSTN and play it to the caller. A series of Event Messages will be generated for this call, using the same Billing_Correlation_ID as the standard Event Messages associated with the off-hook, dialing, etc., which is not expected to be used for billing this call to the end-user.

Table 6: Call Block Service

Additional Event Messages	Required or Optional	Comments
Service_Instance	R	none
Intelligent_Peripheral_Usage_Start	O	see note
Intelligent_Peripheral_Usage_Stop	O	see note
NOTE: This Event Message will be defined in a future release of this IPCablecom Specification.		

9.2.6 Call Waiting Service

At any given time the caller may be talking and will hear the call waiting tone when another call is incoming. It is understood that at some point prior to this call, the called party subscribed to call waiting service. The called party can switch back and forth between the two calls by using the flash hook. Call Waiting can be supported by any of the three basic call configurations: On_Net to On_Net, On_Net to Off_Net, and Off_Net to On_Net.

The call flow is as follows:

There is an existing call to a number connected via the MTA/AN/CMS. Another call attempt is made to that number, the CMS:

- Verifies that an existing call is already in progress;
- Checks its internal database to verify whether the called party has subscribed to Call Waiting, if yes:
  - Establishes a voice connection to the Announcement Server (which will play the call waiting tone),
  - Creates a Event Message indicating that Call Waiting is being initiated,
  - Mixes the two voice calls (the currently established voice call and the Call Waiting tone voice call) so that the called party can hear the call waiting tone.

It is assumed that Call Waiting only supports two calls (one active and the other on hold) in IPCablecom. The call on hold will not be connected to any announcement server.

Both of the calls between which the subscriber is switching will generate a complete set of Event Messages on their own as detailed in clauses 5.1.2 and 9.1.3, but there may also be three additional Event Messages associated with this instance of Call Waiting, as detailed below. If the Announcement Server is located on the PSTN, then the previously discussed Call_Answer and Call_Disconnect Event Messages will be generated for this call.

Table 7: Call Waiting Service

Event Message	Required or Optional	Comments
Interconnect_Start	O	Required only if Announcement Server for Call Waiting tone is Off_Net on PSTN.
Interconnect_Stop	O	Required only if Announcement Server for Call Waiting tone is Off_Net.
Intelligent_Peripheral_Usage_Start	O	Required only if Announcement Server On_Net (see note).
Intelligent_Peripheral_Usage_Stop	O	Required only if Announcement Server On_Net (see note).
Service_Instance	R	none.
NOTE: This Event Message will be defined in a future release of this IPCablecom Specification.		

9.2.7 Call Forwarding Service

Call Forwarding Service applies only to calls terminating On_Net as described in clauses 9.1.1 and 9.1.3.

The CMS gets notification that a call needs to be completed to a specific dialled number/end device. The CMS checks its internal database and determines that the called number has subscribed to Call Forwarding, Call Forwarding is currently active, and the forwarding number is XYZ. The CMS will initiate ANOTHER call with the new Calling Party Number as the old Dialled number and the Forwarded Number (XYZ) as the new Dialled Number. Event Messages will be generated for the fact that a Call Forwarding instance was initiated. The Billing_Correlation_ID for this leg will be different than the first call. The rationale for using the Related Billing Correlation ID as the common identifier for call forwarding is that it may be desirable to flag calls made automatically by invocation of call forwarding on the subscribers monthly statement in order to make it clear the reason those calls were placed. For all purposes the original call and the forwarded call will be two different billable calls.

Table 8: Call Forwarding Service

Event Message	Required or Optional	Comments
Service_Instance	R	none

9.2.8 Return Call Service

This service applies only to calls originating On_Net, described in clauses 9.1.1 and 9.1.2. The CMS MUST keep a register with the Calling Party Number of the last call.

Return Call Service will return the last call that was made to an MTA. Upon instantiation of Return Call feature, the CMS will initiate another call with the Calling Party Number of the last call, retrieved from the register just described, as the Dialled number. Event Messages will be generated for the fact that the Return Call feature was initiated, using the Billing_Correlation_ID of this call. If the Calling Party Number of the last call had Caller ID privacy restrictions, then CMS may conference in a recording from an announcement server saying that this call can not be completed.

Table 9: Return Call Service

Event Message	Required or Optional	Comments
Service_Instance	R	none.
Interconnect_Start	O	Required only if Announcement Server for delivering the Message indicating reason Return Call cannot be activated is Off_Net on PSTN.
Interconnect_Stop	O	Required only if Announcement Server for delivering the Message indicating reason Return Call cannot be activated is Off_Net on PSTN.
Intelligent_Peripheral_Usage_Start	O	Required only if Announcement Server for delivering the Message indicating reason Return Call cannot be activated is On_Net (see note).
Intelligent_Peripheral_Usage_Stop	O	Required only if Announcement Server for delivering the Message indicating reason Return Call cannot be activated is On_Net (see note).
NOTE: This Event Message will be defined in a future release of this IPCablecom Specification.		

9.2.9 Repeat Call Service

Repeat Call Service applies only to calls terminating On_Net as described in clauses 9.1.1 and 9.1.3.

Repeat Call can be initiated when the caller dials a number and gets a busy signal. With this feature the caller dials a special pre-determined string of digits (*66 in USA) which then instructs the network to keep polling the called and calling party and when both free, establish the communication. In IPCablecom, the originating CMS will keep trying to establish communications to the called number for a pre-determined amount of time.

Table 10: Repeat Call Service

Event Message	Required or Optional	Comments
Service_Instance	R	none.
Interconnect_Start	O	Required if Announcement Server for delivering the Message indicating reason Repeat Call cannot be activated is Off_Net on PSTN.
Interconnect_Stop	O	Required only if the appropriate Interconnect_Start was activated.
Intelligent_Peripheral_Usage_Start	O	Required only if Announcement Server for delivering the Message indicating reason Repeat Call cannot be activated is On_Net (see note 1).
Intelligent_Peripheral_Usage_Stop	O	Required only if Announcement Server for delivering the Message indicating reason Repeat Call cannot be activated is On_Net (see note 1).
NOTE 1: This Event Message will be defined in a future release of this IPCablecom Specification. NOTE 2: There may be multiple Interconnect_Start and Stops capturing the multiple different times the originating CMS tries to make an Off-Net call to try to complete a Repeat Call request.		

9.2.10 Voicemail Service

Voicemail Service only applies to calls terminating On_Net, described in clauses 9.1.1 and 9.1.3.

It is assumed that the voicemail server will be located Off_Net for IPCablecom. It is therefore assumed if voicemail billing is usage sensitive, that connections to the Off_Net voicemail system will be counted in the same way whether they are voicemail messages being left for the subscriber (deposit) or calls to retrieve the messages on the voicemail server.

Voicemail deposit and retrieval scenarios will be treated as separate transactions that have associated Event Messages. Event Messages for voicemail deposit will look like a standard On_Net to Off_Net call. When the call is transferred to the Voicemail Server, the Routing Number MUST be captured and populated with the Voicemail Server Address.

The connection time to the Voicemail Server MAY also be derived through the standard On_Net to Off_Net Event Messages. Since the Voicemail Server is located Off_Net, Event Messages for voicemail retrieval MAY only be generated if the retrieval is initiated from a device within the operator's network (e.g. On_Net to Off_Net call).

9.2.11 Message Waiting Indicator Service

It is assumed that an Off_Net voicemail system is used as described in clause 9.2.10. Because it seems unreasonable for the CMS to have to place a separate call to the Off_Net system each time a voicemail subscriber goes off-hook, it is assumed that a mechanism exists which allows the Off_Net voicemail system pass the information to the CMS indicating which subscribers have voicemail waiting. A further assumption is that the MTA is capable of delivering the audible stutter-tone message-waiting indicator to the subscriber's MTA port going off-hook, on the command of the CMS.

Under the scenario described in the assumptions clause, and given the fact that billing will not be based on any per use delivery of the stutter tone, there will be no Event Messages required for this service. Billing will be based on a combination of information obtained from the Voicemail send/retrieve Event Messages discussed in clause 9.2.10 and provisioning information indicating when a subscriber has signed up for voicemail services.

10 IPCablecom Event Message Structure

This clause describes the various Event Messages, together with their associated list of attributes. Refer to clause 11 for a detailed description of the attributes described in this clause. Refer to clause 9 a detailed description of the services and their associated Event Messages.

The following tables show the association between IPCablecom services, supported by the aforementioned call configurations, and proposed Event Messages that may be generated for each service. Voice communications services that IPCablecom will provide are based on three main call configurations:

- On-Net to On-Net;
- On-Net to Off-Net;
- Off-Net to On-Net.

Table 11 provides a list of IPCablecom Event Messages defined in the present document. More than one set of Event Messages MAY be generated during a particular service instance.

Table 11: IPCablecom Event Message Summary

Event Message ID	IPCablecom Event Message	Description
0	Reserved	
1	Signalling_Start	Start of signalling for originating or terminating part of the call.
2	Signalling_Stop	Stop of signalling for originating or terminating part of the call.
3	Database_Query	An inquiry into an external database; for example a toll-free number database.
4	Intelligent_Peripheral_Usage_Start	Deferred.
5	Intelligent_Peripheral_Usage_Stop	Deferred.
6	Service_Instance	Indicates an occurrence of a service.
7	QoS_Start	Start of QoS for originating or terminating part of the call.
8	QoS_Stop	Stop of QoS for originating or terminating part of the call.
9	Service_Activation	Indicates a subscriber has activated a service.
10	Service_Deactivation	Indicates a subscriber has deactivated a service.
11	Undefined	
12	Undefined	
13	Interconnect_(Signalling)_Start	Start of network interconnect signalling (between IPCablecom and PSTN) for originating or terminating part of the call.
14	Interconnect_(Signalling)_Stop	Stop of network interconnect signalling (between IPCablecom and PSTN) for originating or terminating part of the call.
15	Call_Answer	Indicates that all network resources for have been allocated for originating or terminating part of the call.
16	Call_Disconnect	Indicates that all network resources for have been released for originating or terminating part of the call.
17	Time_Change	Indicates time change on a network element.
19	QoS_Change	Indicates a change in QoS.

Table 12: Services supported by On-Net to On-Net call configuration

Service	Event Message ID																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19
Basic	X	X	X	X	X		X	X			UNDEFINED	UNDEFINED			X	X		
Call Block	X	X		X	X	X	X	X	X	X					X	X		
Call Waiting	X	X		X	X	X	X	X	X	X					X	X		
Call Forwarding	X	X		X	X	X	X	X	X	X					X	X		
Return Call	X	X		X	X	X	X	X							X	X		
Repeat Call	X	X		X	X	X	X	X							X	X		
Voicemail	X	X		X	X		X	X							X	X		

Table 13: Services supported by On-Net to Off-Net call configuration

Service	Event Message ID																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19
Basic	X	X	X	X	X		X	X			UNDEFINED	UNDEFINED	X	X	X	X		
Call Block	X	X		X	X	X	X	X	X	X			X	X	X	X		
Call Waiting	X	X		X	X	X	X	X	X	X			X	X	X	X		
Return Call	X	X		X	X	X	X	X					X	X	X	X		
Repeat Call	X	X		X	X	X	X	X					X	X	X	X		
911	X	X	X	X	X		X	X					X	X	X	X		
N11	X	X	X	X	X		X	X					X	X	X	X		
Toll-Free	X	X	X	X	X		X	X					X	X	X	X		
Operator	X	X		X	X		X	X					X	X	X	X		

Table 14: Services supported by Off-Net to On-Net call configuration

Service	Event Message ID																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19
Basic	X	X	X	X	X		X	X			UNDEFINED	UNDEFINED	X	X	X	X		
Call Block	X	X		X	X	X	X	X	X	X			X	X	X	X		
Call Waiting	X	X		X	X	X	X	X	X	X			X	X	X	X		
Repeat Call	X	X		X	X	X	X	X					X	X	X	X		
Call Forwarding	X	X		X	X	X	X	X	X	X					X	X		
Voicemail	X	X		X	X		X	X					X	X	X	X		

10.1 Event Message Structure

An Event Message contains a header followed by attributes. The header is required on every Event Message. The attributes will vary based on the type of service the Event Message is describing. Refer to table 31 for a description of the Event Message Header. Example information contained in the header includes: version of Event Message structure, timestamp indicating when the trigger event occurred, Billing Correlation ID used to associate multiple Event Messages with a single service. Example information contained in attributes includes: Called Party Number, Calling Party Number, Trunk Group ID.

Header
Attribute #1
Attribute #2
Attribute #3
:
Attribute #n

10.2 Service_Instance

This event captures the fact that a service event has happened. The Event_Time attribute in the Event Message Header (see table 31) MUST contain the time at which the service occurred.

This Event Message indicates the time at which the CMS provides an instance of a call control/feature service. For example, the time at which a call is put on hold, the time at which a call is forwarded, the time at which a last call return service is provided, the time at which a call-waiting service is provided, etc.

The CMS MUST timestamp these messages immediately upon operation of the service instance being reported.

Table 15: Service_Instance Event Message

Attribute Name	Required or Optional	Comment
[Event Message Header] (see table 31)	R	none.
Service_Name	R	Class Service name: 1 Call_Block 2 Call_Forward 3 Call_Waiting 4 Repeat_Call 5 Return_Call
Call_Termination_Cause	O	1 = Required in the case of Call Block.
Related_Call_Billing_Correlation_ID	O	2, 3 = Required in the case of Call Forward or Call Waiting.
Charge_Number	O	2, 3, 4, 5 = Required in the case of Call Forward, Call Waiting, Repeat Call, Return Call.
First_Call_Calling_Party_Number	O	3 = Required in the case of Call Waiting.
Second_Call_Calling_Party_ Number	O	3 = Required in the case of Call Waiting.
Called_Party_Number	O	3 = Required in the case of Call Waiting.
Routing_Number	O	4, 5 = Required in the case of Repeat Call or Return Call.
Calling_Party_Number	O	4, 5 = Required in the case of Repeat Call or Return Call.

10.3 Service_Activation

This event captures a subscriber activating a service. The Event_Time attribute in the Event Message Header (see table 31) MUST contain the time when the service was activated.

This Event Message indicates the time at which the CMS records an attempt to activate a service. For example, the time at which call-forwarding is activated by the MTA user, the time at which the call-waiting service is activated by the MTA user, etc. These service activations are typically requested via a ∗XX dial-string.

The CMS MUST timestamp this message immediately upon successful activation of the requested service.

NOTE: Failed activation attempts are not reported at this time.

The CMS MUST create a new Billing Correlation ID for this Event Message even if a service is activated during an existing call.

Table 16: Service_Activation Event Message

Attribute Name	Required or Optional	Comment
[Event Message Header] (see table 31)	R	none.
Service_Name	R	Class Service name: 1 Call_Block 2 Call_Forward 3 Call_Waiting.
Forwarded_Number	O	Required.

10.4 Signalling_Start

This Event Message indicates the time at which signalling starts. The originating CMS or MGC MUST issue this Event Message for any given call.

The CMS or MGC MUST timestamp this message prior to digit translation. Note that the attributes contained in this Event Message contain information that is obtained after digit translation.

The CMS MUST timestamp this message immediately upon receipt of:

- a NCS-signalling NTFY message with a routable set of digits that indicate a call attempt.

The MGC MUST timestamp this message immediately upon receipt of:

- a C7 IAM message, or
- a TGCP NTFY with digits (operator services).

Table 17: Signalling_Start Event Message

Attribute Name	Required or Optional	Comment
[Event Message Header] (see table 31)	R	none.
Direction_indicator	R	none.
MTA_Endpoint_Name	R	This attribute if required when the CMS generates this message. This attribute is NOT required when the MGC generates this message.
Calling_Party_Number	R	none.
Called_Party_Number	R	none.
Carrier_Identification_Code	O	This attribute MUST be included when the MGC generates this message.
Trunk_Group_ID	O	This attribute MUST be included when the MGC generates this message.

10.5 Signalling_Stop

This Event Message indicates the time at which signalling terminates.

The CMS MUST timestamp this message immediately upon receipt of the last signalling event in the following list:

- acknowledgement of the CMS-issued NCS-signalling DLCX message;
- transmission of the acknowledgement of an MTA-issued NCS-signalling DLCX message; or
- the last signalling message to/from a peer CMS or MGC associated with this call.

The MGC MUST timestamp this message immediately upon receipt of the last signalling event in the following list:

- transmission/receipt of an RLC to/from the Signalling Gateway that communicates with the C7 network;
- receipt of the acknowledgement of the MGC-issued TGCP DLCX;
- transmission of the acknowledgement of an MG-issued TGCP DLCX; or
- transmission/receipt of the last signalling message to/from a CMS associated with this call.

Table 18: Signalling_Stop Event Message

Attribute Name	Required or Optional	Comment
[Event Message Header] (see table 31)	R	none.
Direction_indicator	R	none.
MTA_Endpoint_Name	R	This attribute MUST be included if the CMS generates this message. This attribute is NOT required if the MGC generates this message.

10.6 Service_Deactivation

This Event Message indicates the time at which the CMS records an attempt to deactivate a service. For example, the time at which call-forwarding is deactivated by the MTA user, the time at which the call-waiting service is deactivated by the MTA user, etc. These service deactivations are typically requested via a ∗XX dial-string.

The CMS MUST timestamp this message immediately upon successful deactivation of the requested service. Failed Deactivation attempts are not reported at this time

The CMS MUST create a new Billing Correlation ID for this Event Message even if a service is deactivated during an existing call.

Table 19: Service_Deactivation Event Message

Attribute Name	Required or Optional	Comment
[Event Message Header] (see table 31)	R	none
Service_Name	R	none

10.7 Database_Query

This Event Message indicates the time at which a one-time request/response transaction or database dip is completed by an intelligent peripheral (Freephone database, LNP database, etc.).

The CMS originating the call MUST timestamp this message immediately upon a receipt of the response from the Intelligent Peripheral.

Table 20: Database_Query Event Message

Attribute Name	Required or Optional	Comment
[Event Message Header] (table 31)	R	none.
Database_ID	R	none.
Query_Type	R	Freephone Number Lookup, LNP lookup, etc.
Called_Party_Number	R	none.
Returned_Number	R	see note.
NOTE: There may be multiple numbers returned. If multiple numbers are returned this Attribute MUST be included for each number returned.		

10.8 Intelligent_Peripheral_Usage_Start

Deferred.

10.9 Intelligent_Peripheral_Usage_Stop

Deferred.

10.10 Interconnect_Start

This Event Message indicates the time at which the start of network interconnect occurs. Only the MGC is permitted to issue this Event Message.

The MGC MUST timestamp this message immediately upon commitment of bandwidth between the IPCablecom network and the PSTN.

Table 21: Interconnect_Start Event Message

Attribute Name	Required or Optional	Comment
[Event Message Header] (see table 31)	R	none.
Carrier_Identification_Code	R	CIC Code of connecting operator.
Trunk_Group_ID	R	TGID of the trunk over which the interconnection is occurring.
Routing_Number	R	none.

10.11 Interconnect_Stop

This Event Message indicates the termination of bandwidth between the IPCablecom network and the PSTN. Only the MGC is permitted to issue this Event Message.

The MGC MUST timestamp this message immediately upon release of bandwidth between the IPCablecom network and the PSTN.

Table 22: Interconnect_Stop Event Message

Attribute Name	Required or Optional	Comment
[Event Message Header] (see table 31)	R	none.
Carrier_Identification_Code	R	CIC Code of connecting operator.
Trunk_Group_ID	R	TGID of the trunk over which the interconnection is occurring.

10.12 Call_Answer

This Event Message indicates that the media connection is open because answer has occurred. The terminating CMS or MGC MUST generate this Event Message. The originating CMS or MGC MAY generate this Event Message.

The CMS MUST timestamp this message immediately upon receipt of:

- a NCS-signalling NTFY message indicating off-hook at the destination MTA.

The MGC MUST timestamp this message immediately upon receipt of:

- a C7 ANS message from the PSTN; or
- an answer indication from the MG indicating answer has occurred on an operator services trunk.

Table 23: Call_Answer Event Message

Attribute Name	Required or Optional	Comment
[Event Message Header] (see table 31)	R	none.
Called_Party_Number	R	none.
Routing_Number	R	none.
Charge_Number	R	none.
Location_Routing_Number	R	For local number portability use.

10.13 Call_Disconnect

This Event Message indicates the time at which the media connection is closed because the calling party has terminated the call by going on-hook, or that the destination party has gone on-hook and the called-party's call-continuation timer has expired (see note 1). This message MUST be issued by the first party, either terminating or originating, to detect call termination as indicated below.

The CMS MUST timestamp this message immediately upon receipt of:

- an NCS-signalling NTFY message indicating on-hook at the calling party MTA (see note 2); or
- on expiration of the destination MTA's call-continuation timer

The MGC MUST timestamp this message immediately upon receipt of:

- an C7 REL message from the PSTN via the SG; or
- an indication from the MG that an operator services trunk has disconnected.

Table 24: Call_Disconnect Event Message

Attribute Name	Required or Optional	Comment
[Event Message Header] (see table 31)	R	none.
Direction_indicator	O	none.
Call_Termination_Cause	R	Normal Termination.

NOTE 1: In the current telephony network, when the called party goes on-hook, a 10-11 second timer is started. If the calling party remains off-hook, and the called party goes off-hook again within that time period, the call continues.

NOTE 2: For emergency services calls, the CMS will normally NOT issue this Event Message as the call duration is controlled by the emergency services operator.

10.14 QoS_Start

This Event Message indicates the time at which the AN committed bandwidth on the IPCablecom access network. The commitment MAY have been done either through a CM message or a RSVP message.

The AN MUST timestamp this message immediately upon receipt of:

- the first request for bandwidth commitment by the MTA as indicated in a CM or RSVP message.

Table 25: QoS_Start Event Message

Attribute Name	Required or Optional	Comment
[Event Message Header] (see table 31)	R	none
Direction_indicator	O	none
QoS_Descriptor	O	none
MTA_UDP_Portnum	R	none

10.15 QoS_Stop

This Event Message indicates the time at which the MTA released its bandwidth commitment on the IPCablecom access network. The release MAY be done either through a CM message or an RSVP message.

The AN MUST timestamp this message immediately upon receipt of:

- a release of bandwidth reservation by the MTA as indicated in a CM or RSVP message.

Table 26: QoS_Stop Event Message

Attribute Name	Required or Optional	Comment
[Event Message Header] (see table 31)	R	none
Direction_indicator	O	none
QoS_Descriptor	O	none
F_ID (NOTE)	R	none
NOTE: F ID is a 32 bit flow indicator: it is referred as connection ID in ITU-T Recommendation J.112 annex A and SF ID in annex B.		

10.16 Time_Change

This event captures an instance of a time change. The Event_Time attribute in the Event Message Header (table 31) MUST contain the time at which the clock on the trusted network element was adjusted.

Table 27: Time_Change Event Message

Attribute Name	Required or Optional	Comment
[Event Message Header] (see table 31)	R	none
Time_Adjustment	R	none

10.17 QoS_Change

This Event Message indicates the time at which the MTA modified its bandwidth commitment on the IPCablecom access network. The change MAY be done either through a CM message or an RSVP message.

The AN MUST timestamp this message immediately upon receipt of:

- a change in bandwidth reservation by the MTA as indicated in a CM or RSVP message.

Table 28: QoS Change Event Message

Attribute Name	Required or Optional	Comment
[Event Message Header] (see table 31)	R	none
Direction_indicator	O	none
QoS_Descriptor	O	none
MTA_UDP_Portnum	R	none

10.18 RTP_Connection_Parameters Event Message

Deferred.

11 IPCablecom Event message attributes

This clause describes the IPCablecom attributes that are included in the IPCablecom Event Messages.

Table 29 shows a mapping of the IPCablecom Event Messages and their associated IPCablecom attributes. Table 30 contains a detailed description of the IPCablecom attributes. Table 31 contains special IPCablecom attributes that MAY be added to the RADIUS accounting-response messages to support a request for retransmission of Event Messages.

Table 29: IPCablecom Attributes Mapped to IPCablecom Event Messages

EM Attribute ID	EM Attribute Name	Event Message ID																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19
0	Reserved																		
1	EM_Header	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X
2	Undefined																		
3	MTA_Endpoint_Name	X	X																
4	Calling_Party_Number	X					X												
5	Called_Party_Number	X		X			X			X						X			
6	Database_ID			X															
7	Query_Type			X															
8	Undefined																		
9	Returned_Number			X															
10	Undefined																		
11	Call_Termination_Cause						X										X		
12	Undefined																		
13	Related_Call_Billing_ Correlation_ID						X												
14	First_Call_Calling_ Party_Number						X												
15	Second_Call_Calling_ Party_Number						X												
16	Charge_Number						X									X			
17	Forwarded_Number									X									
18	Service_Name						X			X	X								
19	Undefined																		
20	Undefined																		
21	Undefined																		
22	Location_Routing_ Number															X			
23	Carrier_Identification_ Code	X												X	X				
24	Trunk_Group_ID	X												X	X				
25	Routing_Number						X							X		X			
26	MTA_UDP_Portnum							X											X
27	Undefined																		
28	Undefined																		
29	Undefined																		
30	SF_ID								X										
31	Error_Description																		
32	QoS_Descriptor							X	X										X
33	Undefined																		
34	Undefined																		
35	Undefined																		
36	Undefined																		
37	Direction_indicator	X	X					X									X		X
38	Time_Adjustment																	X	

UNDEFINED

Table 30 provides a detailed list of the IPCablecom Event Message attributes. A data value of an attribute may be represented by a simple data format (one data field) or by a more complex data format (Data Structure). Data Structure formats of the appropriate attributes are detailed in table 31 through table 39. It should be noted that Event Message 17 is not service dependant.

Table 30: IPCablecom Event Message attributes

EM Attribute ID	EM Attribute Length	EM Attribute Name	EM Attribute Value Type	Attribute Data Description
0	Reserved			
1	59 bytes	EM_Header	Data structure see table 31.	Common data required on every IPCablecom Event Message.
2	Undefined			
3	variable length, maximum of 255 bytes	MTA_Endpoint_Name	ASCII character string.	Physical Port name (aaln/#) as defined in the IPCablecom NCS Spec TS 101 909-4.
4	20 bytes	Calling_Party_ Number	Right justified, space padded ASCII character string.	IPCablecom will use E.164 formatted address specifying the number of the Originating party. In the future other numbering plans will be addressed.
5	20 bytes	Called_Party_ Number	Right justified, space padded ASCII character string.	IPCablecom will use E.164 formatted address specifying the number of the terminating party. In the future other numbering plans will be addressed.
6	Variable length, maximum of 255 bytes	Database_ID	Right justified, space padded ASCII character string.	A unique identifier of the referenced database.
7	2 bytes	Query_Type	Unsigned integer	Query type: 0 = Reserved 1 = Toll Free Number Lookup 2 = LNPNumberLookup.
8	Undefined			
9	20 bytes	Returned_ Number	Right justified, space padded ASCII character string.	IPCablecom will use E.164 formatted address specifying the number resulting from a database query. In the future other numbering plans will be addressed.
10	Undefined			
11	6 bytes	Call_Termination_Cause	Data structure. See table 34.	Termination code identifier.
12	Undefined			
13	16 bytes	Related_Call_ Billing_ Correlation_ID	Data structure. See table 32.	Billing Correlation ID for possible use in value added services.
14	20 bytes	First_Call_ Calling_Party_ Number	Right justified, space padded ASCII character string.	IPCablecom will use E.164 formatted address specifying the number of the calling party. In the future other numbering plans will be addressed.
15	20 bytes	Second_Call_ Calling_Party_ Number	Right justified, space padded ASCII character string.	IPCablecom will use E.164 formatted address specifying the number of the calling party. In the future other numbering plans will be addressed.
16	20 bytes	Charge_Number	Right justified, space padded ASCII character string.	IPCablecom will use E.164 formatted address specifying the number of billable party. In the future other numbering plans will be addressed.
17	20 Bytes	Forwarded_ Number	Right justified, space padded ASCII character string.	IPCablecom will use E.164 formatted address specifying the number of the Forwarded Number. In the future other numbering plans will be addressed.
18	32 Bytes	Service_Name	Right justified, space padded ASCII character string.	Class Service Name. Allowed names are: "Call_Block" "Call_Forward"

EM Attribute ID	EM Attribute Length	EM Attribute Name	EM Attribute Value Type	Attribute Data Description
				"Call_Waiting" "Repeat_Call" "Return_Call".
19	Undefined.			
20	Undefined.			
21	Undefined.			
22	20 bytes	Location_Routing_Number	Right justified, space padded ASCII character string.	IPCablecom will use E.164 formatted address specifying the number of the terminating party. In the future other numbering plans will be addressed. For LNP uses.
23	8 bytes	Carrier_ Identification_ Code	Right justified, space padded ASCII character string.	If the operator provides a service for a telecommunications operator, the Carrier Identification Code (CIC) or other identification is recorded in this field.
24	6 bytes	Trunk_Group_ID	Data structure. See table 36.	Trunk group identification.
25	20 bytes	Routing_Number	Right justified, space padded ASCII character string.	IPCablecom will use E.164 formatted address specifying the number of the terminating party. In the future other numbering plans will be addressed.
26	4 bytes	MTA_UDP_ Portnum	Unsigned integer	MTA Endpoint UDP Port Number.
27	Undefined.			
28	Undefined.			
29	Undefined.			
30	4 bytes	SF_ID	Unsigned integer	Flow ID, a 32-bit integer assigned by the AN The flow ID is a connection ID in the case of ITU-T Recommendation J.112 annex A and a SF ID in the case of annex B.
31	32 bytes	Error_Description	Right justified, space padded ASCII character string.	A user-defined description of the error conditions. Refer to table 33.
32	Variable; Min 8 bytes	QoS_Descriptor	Data structure. See table 37.	QoS parameters data.
37	2 bytes	Direction_ indicator	Unsigned integer	Specifies if a device acts on behalf of an originating or terminating part of the call at the time an Event Message is being generated. 0 = undefined 1 = Originating 2 = Terminating.
38	8 bytes	Time_Adjustment	Signed integer	Time adjustment of an element's (CMS, AN, MGC's) clock. This time is in millisecond, detailing the amount of the time change.

11.1 RADIUS Accounting-Response Retransmit Request Attributes

All Network Elements MUST store Event Messages until they have received an Acknowledgement (Ack) from an RKS that the data was correctly received and stored. Only when an Ack is received is the network element allowed to delete these Event Messages.

In order to guarantee the reliable transfer of the data the RADIUS Client SHOULD implement a user configurable RADIUS message Ack interval and the number of times the client needs to retransmit the event or message. The time interval should be configurable (suggested: 10 msec to 10 sec), the number of retries should be configurable (suggested 0 to 9). The number of retries MAY span multiple RADIUS Servers (RKSs). After exhausting the number of retries the Event Message SHOULD be written to an error file.

11.2 EM_Header Attribute Structure

Table 31 contains a detailed description of the fields in the EM_Header attribute structure. This Event Message Header attribute MUST be the first attribute in every IPCablecom Event Message.

Table 31: EM_Header Attribute Structure

Field Name	Semantics	Value Type	Length
Version ID	Identifies version of this structure. 1 = IPCablecom.	Unsigned integer	2 bytes
Billing Correlation ID	Unique identifier for a transaction within a network. See following clause.	Data Structure table 32.	16 bytes
Event Message Type	Identifies the type of Event Message. refer to table 12 for a listing of Event message types.	Unsigned integer	2 bytes
Element Type	Identifies Type of Originating Element: 0 = Reserved 1 = CMS 2 = AN 3 = Media Gateway Controller.	Unsigned integer	2 bytes
Element ID	Unique code indicating the originating IPCablecom network.	Right justified, space padded ASCII Character String.	8 bytes
Sequence Number	Each network element MUST assign a unique and monotonically increasing unsigned integer for each Event Message sent to a given RKS. This is used by the RKS to determine if Event Message are missing from a given network element.	Unsigned integer	4 bytes
Event_time	Event generation time and date. Millisecond granularity. Format: yyyymmddhhmmss.mmm	ASCII character string.	18 bytes
Status	Status indicators.	See table 33.	4 bytes
Priority	Indicates the importance to assign relative to other network traffic. For IPCablecom, values for this field will be user defined.	Unsigned integer	1 byte
Attribute Count	Indicates the number of attributes that follow (or are appended to) this header in the current Event Message.	Unsigned integer	2 bytes
Event Object	This is a "place holder" for future IPCablecom releases to allow for a grouping of services. It may be IPCablecom Voice, IPCablecom Video, etc. or it could be IPCablecom, CM, etc. It MUST have a value of zero for IPCablecom.	Unsigned integer	1 byte

11.2.1 Billing Correlation ID Attribute Structure

Table 32 describes the Billing Correlation ID. The RKS, or some other back office application, uses the Billing Correlation ID to correlate Event Messages that are generated for a single transaction. It is one of the fields in the Event Message Header. The Billing Correlation ID is unique for each Transaction in the network. All Event Messages with the same Billing Correlation ID SHOULD be sent to the same primary RKS except in failover circumstances in which case the Event Messages MUST be sent to the next RKS on the failover RKS list.

Table 32: Billing_Correlation_ID Description

Field Name	Semantics	Value Type	Length
Timestamp	High-order 32 bits of NTP time reference.	Unsigned integer	4 bytes
Element_ID	Network wide unique identifier for the originating CMS.	Right justified, space padded ASCII Character String.	8 bytes
Event Counter	Monotonically increasing for each Transaction.	Unsigned integer	4 bytes

11.2.2 Status Field Attribute Structure

The Status field of the Event Message Header is a 32-bit mask. Bit 0 is the low-order bit; the field is treated as a 4 byte unsigned integer. Table 33 presents Status Field description.

Table 33: Status Field Description

Start Bit	Semantics	Bit Count
0	Error Indicator: 0 = No Error 1 = Possible Error 2 = Known Error 3 = Reserved (see note)	2
2	Event Origin: 0 = Trusted Element 1 = Untrusted Element	1
3	Event Message Proxied: 0 = Not proxied, all data known by sending element 1 = proxied, data sent by a trusted element on behalf of an untrusted element	1
4	Reserved. IPCablecom value MUST be 0	28
NOTE: If Known error, then attribute 31 MUST be included in the Event Message corresponding to this header. If Possible error, then attribute 31 MAY be included in the Event Message corresponding to this header.		

11.3 Call Termination Cause Attribute Structure

Table 34 describes data structure of the Call_Termination_Cause attribute.

Table 34: Call Termination Cause Data Structure

Field Name	Semantics	Value Type	Length
Source_Document	Identifies the source Document of the Cause Codes: 0 = Reserved 1 = BAF (Bellcore Generic Requirements 1100 CORE). Automatic Message Accounting Format 2 = Future.	Unsigned integer	2 bytes
Cause_Code	Cause Code Identifier. Meaning determined by Source_Document defined in previous field.	Unsigned integer	4 bytes

11.4 Trunk Group ID Attribute Structure

Table 35 describes Trunk Group ID Data Structure.

Table 35: Trunk Group ID Data Structure

Field Name	Semantics	Value Type	Length
Trunk_Type	1 = Not Used 2 = Not Used 3 = C7 direct trunk group number 4 = C7 from IC to AT and C7 from AT to EO 5 = Not Used 6 = C7 from IC to AT and non-C7 from AT to EO (terminating only) 9 = Signalling type not specified.	Unsigned integer	2 bytes
Trunk_Number	ASCII Identifier. Values in the range 0000-9999.	Right justified, space padded ASCII character string.	4 bytes

11.5 QoS Descriptor Attribute Structure

Table 36 describes QoS Descriptor Data Structure.

Table 36: QoS Descriptor Data Structure

Field Name	Semantics	Value Type	Length
Status_Bitmask	Bitmask describing structure contents (see table 37).	Bit map	4 bytes
Service_Class_ Name	Service profile name.	Right justified, space padded ASCII character string.	4 bytes
QoS_Parameter_ Array	QoS Parameters. Contents determined by Status Bitmask.	Unsigned integer array.	Variable length array of 32-bit unsigned integers.

Table 37 describes the QoS Status Bitmask field of the QoS Descriptor attribute. Bits 2 to 17 describe the contents of the QoS_Parameter_Array. Each of these bits indicates the presence (bit = 1) or absence (bit = 0) of the named QoS parameter in the array. The location of a particular QoS parameter in the array matches the order in which that parameter's bit is encountered in the bitmask, starting from bit 2.

Each QoS parameter present in the QoS_Parameter_Array must occupy four bytes. The definition and encoding of the QoS parameters can be found in ITU-T Recommendation J.112. QoS parameters whose definition specifies less than four bytes must be right justified (were the 4 bytes to be treated as an unsigned integer) in the four bytes allocated for the array element.

Table 37: QoS Bit Mask for J.112 annex A

Start Bit	Semantics	Bit Count
	State Indication 0 = Illegal Value 1 = Resource Reserved but not activated 2 = Resource Activated 3 = Resource reserved and activated.	2
2	Max packet size	1
3	Average bit rate	1
4	Jitter window	1
5	Frame length	1
6	Requested bandwidth	1
7	Maximum distance between slots	1

Table 38: QoS Bit Mask for J.112 annex B

Start Bit	Semantics	Bit Count
0	State Indication: 0 = Illegal Value 1 = Resource Reserved but not Activated 2 = Resource Activated 3 = Resource Reserved & Activated	2
2	Service Flow Scheduling Type	1
3	Nominal Grant Interval	1
4	Tolerated Grant Jitter	1
5	Grants Per Interval	1
6	Unsolicited Grant Size	1
7	Traffic Priority	1
8	Maximum Sustained Rate	1
9	Sustained Traffic Rate	1
10	Maximum Traffic Burst	1
11	Minimum Reserved Traffic Rate	1
12	Maximum Concatenated Burst	1
13	Request/Transmission Policy	1
14	Nominal Polling Interval	1
15	Tolerated Poll Jitter	1
16	IP Type of Service Override	1
17	Maximum Downstream Latency	1

12 Transport Independent Event Message Attribute TLV Format

Every Event Message Attribute is defined by a Type Length Value (TLV) tuple. An attribute TLV tuple has the following format:

Table 39: Event Message Attribute TLV-tuple format

Field Name	Semantics	Field Length
Attribute Type	IPCablecom Attribute Type (refer to table 30).	4 bytes
Attribute Length	IPCablecom Attribute Length (refer to table 30) + 5.	1 byte
Attribute Value	IPCablecom Attribute Value.	Attribute Length bytes

13 IPCablecom Event Message File Format

The IPCablecom Event Message File Format has the following basic structure.

13.1 File Header

The following header MUST be written at the start of a file formatted using the IPCablecom Event Message File Format:

Table 39A

Field Name	Semantics	Length	Type
Format Version	Version number of file format	4 bytes	Unsigned int
EM Count	Number of EMs in File	8 bytes	Unsigned int
File Creation Timestamp	YYYYMMDDHHMMSS.MMM	18 bytes	ASCII
File Sequence Number	Monotonically increasing	8 bytes	Unsigned int
NodeID	Unique identifier of generating element	8 bytes	ASCII
File Completion Timestamp	YYYYMMDDHHMMSS.MMM	18 bytes	ASCII

NOTE: There is no checksum included in the file header. It is assumed that the transport mechanism is responsible for delivery of damage free files. For example, both of the IP transport protocols, UDP and TCP, contain a checksum to protect against damaged messages.

13.2 File Naming Convention

Files created using the IPCablecom Event Message File Format MUST use the following naming convention: "PKT-EM-yyyymmmddhhmmss-pri-nodeid-seq.bin".

13.2.1 PKT-EM-yyyymmmddhhmmss-pri-nodeid-seq.bin

The following table describes each of the components of the filename.

Table 39B

Component	Semantics	Type	Length
File ID	Identifies this file as containing IPCablecom Event Messages.	Literal string "PKT-EM"	6 characters
Timestamp	Time at which file was opened by the network element.	yyyymmddhhmmss	14 characters
Priority	Priority of this file.	Integer in the range 1-4	1 character
NodeId	Uniquely identifies the IPCablecom Network Element from which this file originated.	ASCII String	8 bytes
Sequence number	Monotonically increasing sequence number.	Integer in the range 000001-999999. Zero filled.	6 characters.

Each of the filename components is separated by a hyphen "-" character.

13.3 Configuration Items

The following items MUST be configurable by the IPCablecom network element creating the file.

Table 39C

Name	Semantics	Type	Length
Maximum File Length	Maximum size of file, in bytes, to which flat file can grow before being closed for transport.	Unsigned integer	4 octets
Maximum Open Time	Maximum amount of time, in seconds, before file must be closed for transport.	Unsigned integer	4 octets

The IPCablecom Network Element that created the file MUST close any currently open flat file at the first occurrence of either of the following events:

- The file size exceeds the Max File Length.
- The file open duration exceeds the Maximum Open Time.

14 Transport Protocol

14.1 RADIUS

This clause describes how RADIUS is used as a transport protocol between the IPCablecom network elements that generate Event Messages (CMS, AN, MGC) and the Record Keeping Server (RKS). The required transport protocol for IPCablecom is RADIUS Accounting (RFC 2139) with IPCablecom extensions and MUST be used to transport Event Messages from IPCablecom network elements to the RKS.

14.1.1 IPCablecom Transport Requirements

- The Event Message transactions MUST be authenticated.
- The transport protocol MAY support confidentiality of Event Messages.
- End-to-end security across multiple administrative domains is not required.

14.1.2 RADIUS Accounting Protocol

The RADIUS Accounting protocol is a client/server protocol that consists of two message types: Accounting-Request and Accounting-Response. IPCablecom network elements that generate Event Messages are RADIUS clients that send Accounting-Request messages to the RKS. The RKS is a RADIUS server that sends Accounting-Response messages back to the IPCablecom network elements indicating that it has successfully received and stored the Event Message.

The Event Messages are formatted as RADIUS Accounting-Request and Accounting-Response packets as specified in RFC 2139. Although IPCablecom specifies RADIUS as the transport protocol, alternate transport protocols MAY be supported in future IPCablecom releases.

14.1.2.1 Reliability

The RADIUS messages are transported over UDP, which does not guarantee reliable delivery of messages, hence the request/response nature of the protocol (see RFC 2138 for the technical justification of choosing UDP over TCP for the transport of Authentication, Authorization and Accounting messages).

When an RKS receives and successfully records all IPCablecom Event Messages in a RADIUS Accounting-Request message, it MUST send an Accounting-Response message to the client. If the IPCablecom network element does not receive an Accounting-Response within the configured retry interval, it MUST resend the same Accounting-Request either to the same RKS or the next RKS on its failover list. The IPCablecom network element SHOULD continue resending the Accounting-Request until it receives an acknowledgement from an RKS or the message expires from its cache. The RADIUS server MUST NOT transmit any Accounting-Response reply if it fails to successfully record the Event Message.

14.1.2.2 Authentication and Confidentiality

Refer to TS 101 909-11 for details concerning the use of IPSec to provide both authentication and confidentiality of the RADIUS messages.

Each IPCablecom network element generating Event Messages MUST use a shared secret hard coded to the value of 16 ASCII 0s, i.e. the shared secret is "0000000000000000" to calculate the Authenticator field in the RADIUS message header. In order to improve interoperability with existing RADIUS server implementations, the RADIUS clients and servers MUST still calculate and populate the Authenticator field as described in RFC 2139.

14.1.2.3 Standard RADIUS Attributes

Each RADIUS message starts with the standard RADIUS header shown in table 40.

Table 40: RADIUS Message Header

Field Name	Semantics	Field Length
Code	Accounting-Request = 4 Accounting-Response = 5	1 byte
Identifier	Used to match accounting-request and accounting-response messages.	1 byte
Length	Total length of RADIUS message. Min. value = 20, max value = 4 096.	2 bytes
Authenticator	Accounting-Request: MD5 checksum with null shared secret calculated per RFC 2139. Accounting-Response: MD5 Response Authenticator with null shared secret calculated per RFC 2139.	16 bytes

The standard RADIUS Acct_Status_Type attribute MUST follow the RADIUS Message Header in every Accounting-Request message. This attribute indicates the type of this RADIUS Accounting-Request and is specific to the use of RADIUS as the transport protocol. An Acct-Status-Type value of Interim-Update is used to represent IPCablecom Event Messages. This improves interoperability with existing RADIUS server implementation.

Table 41: RADIUS Acct_Status_Type

Type	Length	Value
40	6 bytes	Interim-Update = 3

The Acct_Status_Type attribute is the only standard RADIUS attribute used by IPCablecom. IPCablecom attributes are defined in clause 11 of the present document. IPCablecom attributes are encoded in the RADIUS Vendor Specific Attributes (VSA) structure as described in table 42. Additional IPCablecom or VSAs can be added to existing Event Messages by adding additional RADIUS VSAs to the message.

The VSA includes a field to identify the vendor and the Internet Assigned Number Authority (IANA) has assigned IPCablecom an SMI Network Management Private Enterprise Number of 4 491 for the encoding of these attributes. The RKS server SHOULD ignore Event Messages where the IPCablecom "Event Message type" is unidentified. The RKS server SHOULD also ignore IPCablecom event attributes where the event attribute type is unidentified.

Table 42: Radius VSA Structure for IPCablecom Attributes

Field Name	Semantics	Field Length
Type	Vendor Specific = 26.	1 byte
Length	Total Attribute Length (see note).	1 byte
Vendor ID	CableLabs = 4 491.	4 bytes
Vendor Attribute Type	IPCablecom Attribute Type (refer to table 34).	4 bytes
Vendor Attribute Length	IPCablecom Attribute Length (refer to table 34).	1 byte
Vendor Attribute Value	IPCablecom Attribute Value.	Vendor Length bytes
NOTE: Value is Vendor Length + 8.		

14.1.3 IPCablecom Extensions

14.1.3.1 IPCablecom RADIUS Accounting-Request Packet Syntax

```
<RADIUS Accounting-Request> ::==
<RADIUS message Header>
<RADIUS Acct-Status-Type Attribute>
<IP Cablecom EM List>

<IP Cablecom EM List> ::==
<IP Cablecom EM> |
<IP Cablecom EM List> <IP Cablecom EM>

<IP Cablecom EM> ::==
<RADIUS VSA for IP Cablecom EM Header Attribute>
<IP Cablecom EM Attribute List>

<IP Cablecom EM Attribute List> ::==
<RADIUS VSA for IP Cablecom EM Attribute> |
<IP Cablecom EM Attribute List> <RADIUS VSA for IP Cablecom EM Attribute>
```

The potential of a high Event Message volume raised the concern that the RADIUS mechanism for ensuring reliability via request/response may consume too much bandwidth or be too computationally intensive. This led to the requirement that it be possible to transit multiple IPCablecom Event Messages in a single RADIUS message. The use of this "batch mode" is left to the discretion of the IPCablecom network element and will likely depend on the latency requirements of the particular event type. The number of Event Messages encapsulated in a single RADIUS message is still subject to the maximum RADIUS message length restriction of 4 096 bytes.

The Event Message Header MUST be the first attribute within a given Event Message. If multiple Event Messages are sent in a single RADIUS Accounting-Request, the Event Message Header attribute indicates the start of a new Event Message. The order of the Event Message attributes which follow the Event Message Header is arbitrary.

IPCablecom extends RADIUS Accounting, by introducing new attributes and new values for existing attributes. Since the RADIUS protocol is extendable in this manner, it is expected that existing RADIUS server implementations will require minimal modifications to support the batch collection of IPCablecom Event Messages.

The only mandatory attribute in a RADIUS Accounting-Request message is the Acct-Status-Type, which typically indicates whether the Accounting-Request marks the beginning of the user service (Start) or the end (Stop). Since a IPCablecom Accounting-Request message may contain multiple Event Message Packets, a single message may contain Event Messages, which mark both the beginning and end of the user service. For this reason, an Acct-Status-Type value of Interim-Update is used to represent IPCablecom Event Messages. This improves interoperability with existing RADIUS server implementation.

14.1.3.2 Retransmission Using RADIUS Accounting-Response Packet Syntax

Due to the presence of the sequence number in the Event Message Header, it is possible for the RKS to detect missing Event Messages. The RKS MAY request retransmission of these Event Messages by including additional IPCablecom Event Message attributes in an Accounting-Response. Refer to table 32 for a description of these attributes.

```
<RADIUS Accounting-Response> :==
<RADIUS message Header>
<RADIUS VSA for IP Cablecom Missing_Event_Time_Start attribute>
<RADIUS VSA for IP Cablecom Missing_Event_Time_Stop attribute>

<RADIUS Accounting-Response> :==
<RADIUS message Header>
<RADIUS VSA for IP Cablecom Missing_Event_Sequence_Start attribute>
<RADIUS VSA for IP Cablecom Missing_Event_Sequence_Stop attribute>
```

Two mechanisms for retransmission request SHOULD be supported by the IPCablecom network elements and the RKS:

- Time based: Refer to table 32 for a detailed description of the IPCablecom Event Message time-based retransmission attributes: Missing_Event_Start_Time and Missing_Event_Stop_Time.

- Sequence number based: Refer to table 1 for a detailed description of the IPCablecom Event Message sequence-based retransmission attributes: Missing_Event_Start_Sequence and Missing_Event_Stop_Sequence.

- The IPCablecom network element behaviour on receipt of a retransmission request for Event Messages, which are still in its cache depends on whether the requested Event Messages have already been acknowledged by an RKS and if so, the RKS that acknowledged them.

- If the IPCablecom network element still has the requested events in its event cache and has not received confirmation from any RKS that the events have been successfully recorded, it MUST send the Event Messages to the requesting RKS.

- If the IPCablecom network element still has the requested events in its event cache but has already received confirmation that the events have been successfully recorded from the RKS requesting the retransmission, it SHOULD send the Event Messages to the requesting RKS.

- If the IPCablecom network element still has the requested events in its event cache but has already received confirmation from an RKS other than the one requesting the retransmission that the events have been successfully recorded, it SHOULD send the Event Messages to the requesting RKS.

14.2 File Transport Protocol (FTP)

The File Transfer Protocol (FTP) MAY be used to transport Event Messages from IPCablecom network elements to the RKS. If this transport protocol is used, the RKS hosts an FTP server to accept files transferred by the IPCablecom network element. The IPCablecom network element acts as the FTP client, pushing the files to the RKS for processing.

If FTP is used as a transport protocol, then the file MUST be formatted using the IPCablecom Event Message File Format.

14.2.1 Required FTP Server Capabilities

The FTP server at the RKS MUST have the following capabilities:

- PASV Mode;
- Authentication support;
- File Transfer logging.

Annex A (informative): Bibliography

Telcordia GR-1100-CORE Bellcore Automatic Message Accounting Format (BAF) Requirements

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ETSI TS 101 909-13: "Access and Terminals (AT); Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 13: Trunking Gateway Control Protocol".

List of ITU-T Recommendations referring to IP Cablecom:

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ITU-T Recommendation J.161: "Audio codec requirements for the provision of bi-directional audio service over cable television networks using cable modems".

ITU-T Recommendation J.162: "Network call signalling protocol for the delivery of time critical services over cable television networks using cable modems".

ITU-T Recommendation J.163: "Dynamic quality of service for the provision of real time services over cable television networks using cable modems".

ITU-T Recommendation J.164: "Event Message requirements for the support of real-time services over cable television networks using cable modems".

ITU-T Recommendation J.166: "IPCablecom management information base (MIB) framework".

ITU-T Recommendation J.167: "Media terminal adapter (MTA) device provisioning requirements for the delivery of real time services over cable television networks using cable modems".

ITU-T Recommendation J.168: "IPCablecom media Terminal Adapter (MTA) MIB Requirement".

ITU-T Recommendation J.169: "IPCablecom Network Call Signalling (NCS) MIB Requirements".

ITU-T Recommendation X.680 (1997): "Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation".

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History

Document history		
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