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OF TELEVISION, SOUND PROGRAMME AND OTHER
MULTIMEDIA SIGNALS

IPCablecom

**Event message requirements for the support of
real-time services over cable television
networks using cable modems**

ITU-T Recommendation J.164



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ITU-T Recommendation J.164

Event message requirements for the support of real-time services over cable television networks using cable modems

Summary

ITU-T Recommendation J.164 describes the concept of Event Messages used to collect usage for the purposes of billing within the IPCablecom architecture. It details the RADIUS protocol used to carry these messages, defines 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.

Source

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FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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ITU-T Recommendation J.164

Event message requirements for the support of real-time services over cable television networks using cable modems

1 Scope

This Recommendation describes the concept of Event Messages used to collect usage for the purposes of billing within the IPCablecom architecture. It details the RADIUS protocol used to carry these messages, defines 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.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T J.112] ITU-T Recommendation J.112 (1998), *Transmission systems for interactive cable television services*.
- [ITU-T J.112-A] ITU-T Recommendation J.112 Annex A (2001), *Digital Video Broadcasting: DVB interaction channel for Cable TV (CATV) distribution systems*.
- [ITU-T J.112-B] ITU-T Recommendation J.112 Annex B (2004), *Data-over-cable service interface specifications: Radio-frequency interface specification*.
- [ITU-T J.162] ITU-T Recommendation J.162 (2007), *Network call signalling protocol for the delivery of time-critical services over cable television networks using cable modems*.
- [ITU-T J.163] ITU-T Recommendation J.163 (2007), *Dynamic quality of service for the provision of real-time services over cable television networks using cable modems*.
- [ITU-T J.170] ITU-T Recommendation J.170 (2005), *IPCablecom security specification*.
- [ITU-T J.171.x] ITU-T Recommendation J.171.x (2005), *IPCablecom trunking gateway control protocol (TGCP)*.
- [ITU-T X.680] ITU-T Recommendation X.680 (2002), *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*.
- [ITU-T X.681] ITU-T Recommendation X.681 (2002), *Information technology – Abstract Syntax Notation One (ASN.1): Information object specification*.
- [ITU-T X.682] ITU-T Recommendation X.682 (2002), *Information technology – Abstract Syntax Notation One (ASN.1): Constraint specification*.
- [ITU-T X.683] ITU-T Recommendation X.683 (2002), *Information technology – Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 specifications*.

- [ITU-T X.690] ITU-T Recommendation X.690 (2002), *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*.
- [IETF RFC 2865] IETF RFC 2865 (2000), *Remote Authentication Dial In User Service (RADIUS)*.
- [IETF RFC 2866] IETF RFC 2866 (2000), *RADIUS Accounting*.

3 Terms and definitions

This Recommendation defines the following terms:

3.1 cable modem: A cable modem is a layer two termination device that terminates the customer end of the J.112 connection.

3.2 attribute: An *Event Message Attribute* is a predefined data element described by an attribute definition and attribute type.

3.3 call: A *call* is an instance of user-initiated voice communication capabilities. 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.

3.4 event message: An *Event Message* is a set of data, representative of an event in the IPCablecom architecture that could be indicative of usage of one or more billable IPCablecom capabilities. 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.

3.5 IPCablecom: An ITU-T project that includes an architecture and a series of Recommendations that enable the delivery of real-time services over cable television networks using cable modems.

3.6 IPCablecom transaction: An IPCablecom *transaction* is a collection of events on the IPCablecom network when delivering a service to a subscriber. Event Messages for the same transaction are identified by one unique billing correlation ID (as described in Table 39). 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.

3.7 service: A *service* is an individual or package of communications features a subscriber may select. 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.

4 Abbreviations and conventions

4.1 Abbreviations

This Recommendation uses the following abbreviations:

AMA	Automated Message Accounting
CDR	Call Detail Record
CM	Cable Modem
CMS	Call Management Server

CPE	Customer Premises Equipment
FID	Flow Identifier
HFC	Hybrid Fibre Coax
IP	Internet Protocol
MGC	Media Gateway Controller
MTA	Media Terminal Adapter
OSS	Operations Support System
PSTN	Public Switched Telephone Network
RKS	Record-Keeping Server
SS7	Signalling System No. 7
VAD	Voice Activity Detection

4.2 Conventions

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

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

5 Background

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 server (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 prepaid 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 IP-Cablecom 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 Recommendation 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 Recommendation is limited to defining Event Messages for simple voice communication activities, it is expected that this Recommendation will be expanded to support additional IPCablecom services as well as high-speed data services.

5.1 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" are 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.

5.2 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. This Recommendation defines the Event Message syntax and, in addition, it describes the transport protocols.

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. This Recommendation leverages the value of the information content from the existing billing formats, augmenting that with the distributed nature of the IPCablecom architecture.

5.3 Originating/terminating call model to support customer billing and settlements

The IPCablecom Event Messages contain sufficient per-call information to support customer billing for service as well as settlement between IPCablecom network providers for access. The information contained in the Event Messages supports a wide variety of billing and settlement models. IPCablecom does not mandate the use of specific billing or settlement models as these models are defined by and based on the specific business requirements of the individual operators. IPCablecom neither mandates nor precludes the use of a clearinghouse for settlements.

The IPCablecom Event Messages are based on a model where a call or service is divided into an originating half and a terminating half. The originating CMS or MGC **MUST** generate a unique

billing correlation ID (BCID) to identify all Event messages associated with the originating half of the call. The terminating CMS or MGC MUST generate a unique BCID to identify all Event Messages associated with the terminating half of the call. For each half of the call or service, the set of IPCablecom network elements that generate Event Messages (CMS, MGC, CMTS) must provide all necessary information required for billing and/or settlements, as appropriate, based on the service. The information generated by the originating half MUST be sent to the RKS supporting the originating half. The information generated by the terminating half MUST be sent to the RKS supporting the terminating half. The IPCablecom network elements also generate Event Messages that are not associated with any call. For those cases, the network element generating the Event Message MUST generate a unique BCID for the event and send the Event Message to the appropriate RKS supporting the network element.

The IPCablecom Event Messages support billing and settlement for single-zone, intra-domain and inter-domain architectures. In most cases, the basic set of Event Messages, their associated attributes, and the triggers for the Event Message, are identical for these three architectures. In the case of intra-domain and inter-domain architectures, additional triggers exist for a subset of the Event Messages. The IPCablecom Event Message specification details these requirements.

For the purposes of settlements, each IPCablecom zone is divided into one or more logical Financial Entities. Settlements occur between Financial Entities. Each Financial Entity is identified by a Financial Entity ID (FEID). FEIDs are pre-assigned to every CMS and MGC in the IPCablecom network. A single CMS may be assigned at most one FEID. One or more CMSes may be assigned the same FEID.

In the Intra-domain and Inter-domain cases, the originating and terminating CMSes exchange BCIDs and FEIDs. The originating CMS sends its BCID and FEID in the INVITE message. The terminating CMS sends its BCID and FEID in the first response to the INVITE message which is typically the 183 SDP.

5.4 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 prepaid 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.

5.5 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.

5.6 Terminology and concepts

This clause defines terminology (see Figure 1) 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 IP-Cablecom, do not establish any such dedicated paths. On the contrary, the IP-Cablecom architecture assumes a shared medium between the headend 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 for it to be used in this Recommendation to refer to packet-mode voice communications between two parties over an IP-Cablecom 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 IP-Cablecom architecture. These new services, which likely will not be derived from traditional telephony principles, will be based on the term "transaction", which is more indicative of the data flows across the IP-Cablecom network. The Event Message structure is designed to be flexible and to enable the addition of new IP-Cablecom 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.

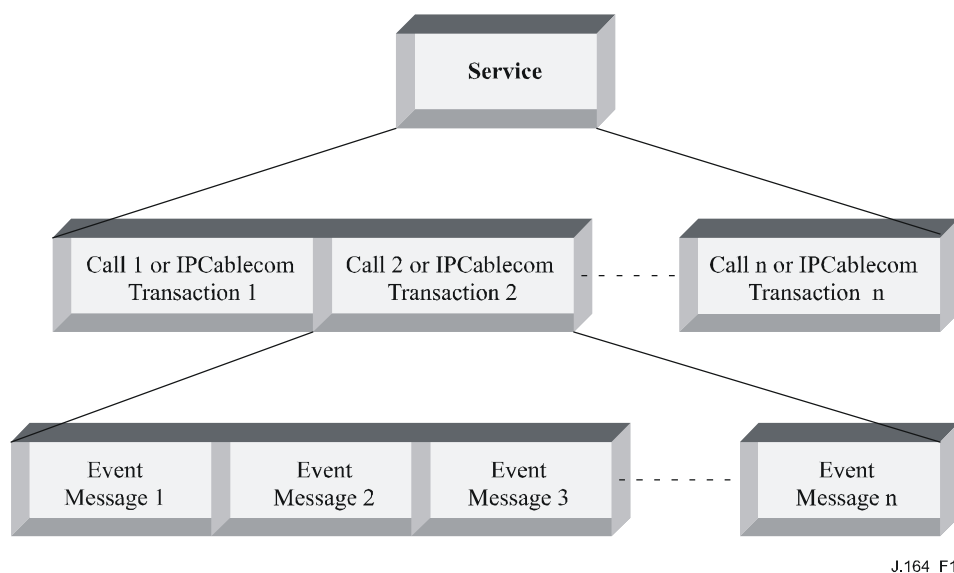


Figure 1 – IP-Cablecom terminology

5.6.1 Service

A service is an individual or package of communication features a subscriber may select. 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 IP-Cablecom subscribers, a 3-way call, pay-per-view movie, and a web-surfing session. A service may be instantaneous or persist over time. Service in the context of IP-Cablecom 1.0 implies voice communications only and may not necessarily apply to the variety of other services such as Data, traditional IP, E-Commerce, etc.

5.6.2 IP-Cablecom transaction

An IP-Cablecom transaction is a collection of events on the IP-Cablecom network when delivering a service to a subscriber. Event Messages for the same transaction are identified by one unique BCID (as described in Table 39). 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.

5.6.3 Call

A call is an instance of user-initiated voice communication capabilities. In traditional telephony, a call is generally considered as the establishment of connectivity directly between two points: originating party and terminating party. In the IP-Cablecom context, as noted above, the communication between the parties is "connectionless" in the traditional sense.

5.6.4 Event Message

An Event Message is a set of data, representative of an event in the IP-Cablecom architecture that could be indicative of usage of one or more billable IP-Cablecom capabilities. 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.

5.6.5 Attribute

An Event Message Attribute is a predefined data element described by an attribute definition and attribute type.

5.7 Supporting documentation

A number of documents and specifications describe the IP-Cablecom project. The IP-Cablecom Architecture Framework Recommendation [b-ITU-T J.160] is the starting point for understanding the IP-Cablecom project and the various IP-Cablecom Interface Recommendations, technical reports and other IP-Cablecom documents.

6 IP-Cablecom objectives

6.1 IP-Cablecom required services and capabilities

IP-Cablecom provides basic voice capabilities and, therefore, MUST support Event Messages for the following services. These services are described in more detail in clause 8.

- 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).

6.2 Additional IP-Cablecom supported services and capabilities

The following represents a list of possible additional IP-Cablecom 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 provided in this Recommendation.

- 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, prepaid services, etc.).

6.2.1 IP-Cablecom supported services and capabilities

The following represents a list of IP-Cablecom services that **MUST** be supported in addition to the IP-Cablecom services by IP-Cablecom EM implementations. These services are described in more detail in clause 8.

- Three-Way Call;
- Customer Originated Trace.

In addition, the following list represents a set of IP-Cablecom services that **MAY** be supported by IP-Cablecom CMS network elements. These additional services **MUST** be supported by IP-Cablecom RKS network elements. When these services are supported by an IP-Cablecom compliant CMS, they **MUST** be supported as defined in this Recommendation. These services are described in more detail in clause 8.

- Account Code and Authorization Code.

6.2.2 IP-Cablecom multimedia

The IP-Cablecom Multimedia specification (see ITU-T Rec. J.179) defines a service delivery framework that provides general-purpose QoS, event-based accounting, and security functionality founded upon the mechanisms defined in IP-Cablecom. The IP-Cablecom Multimedia specification extends this Recommendation and the capabilities of the present Event Messages specification; refer to ITU-T Rec. J.179 for more details.

6.3 Assumptions

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

- IP-Cablecom 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.
- IP-Cablecom 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.
- IP-Cablecom supports local number portability (LNP). The following information and references are applicable to LNP:

- 1) Location routing number (LRN) identifies routing information for a ported called party number; and jurisdiction information parameter (JIP) identifies the network element where the ported calling party number is currently getting the service from. The JIP parameter received in SS7 message is needed for billing settlement purpose.
 - 2) The originating half determines if the caller is ported-in and the terminating half determines if the called party is ported-in. The CMS or MGC determines if a number is ported based on different data including:
 - a) provisioned data;
 - b) signalling messages;
 - c) number portability database.
- Non-IP-Cablecom network elements, such as those residing in the public switched telephone network (PSTN) to which an IP-Cablecom 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.
 - IP-Cablecom Event Messages currently only support messages for actual billable events. This Recommendation does not specify messages related to provisioning of services by the operator of an IP-Cablecom network. This Recommendation does support Event Messages for subscriber service activation. This Recommendation does not specify messages related to selection of an entity other than the IP-Cablecom 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 IP-Cablecom that can be used to associate a subscriber with usage of network resources.
 - IP-Cablecom supports interconnection to both transit and local switches.
 - IP-Cablecom supports an emergency trunk group.
 - IP-Cablecom 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 CMTS, CMS, or MGC.
 - Element ID.
 - 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:
 - 1) are to be transported to the RKS as a single Event Message in real-time; or
 - 2) are to be batched and transported to the RKS as multiple Event Messages at a later time;
 - 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.
 - Others.
 - Enable or disable Media_Alive Event Message, configure the frequency of Media_Alive message (suggested 0 to 1440 minutes, with 0 being no Media_Alive Events).

7 Event messages architecture

Figure 2 shows a representative IP-Cablecom 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 2 are representative, and are not mandated by the IPCablecom architecture.

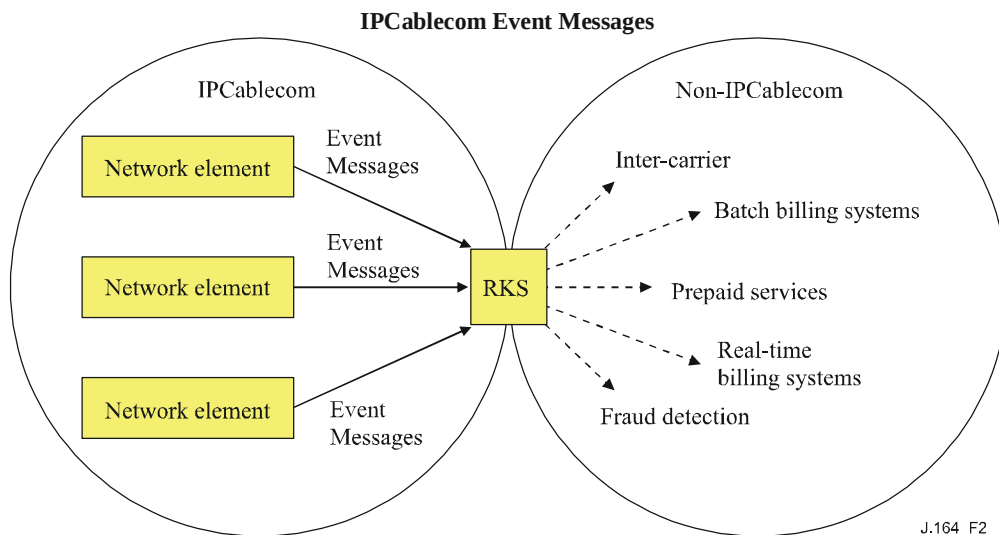


Figure 2 – Representative IPCablecom Event Messages architecture

7.1 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 ID (BCID), which can be leveraged for reconciliation and non-repudiation purposes.

7.2 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), cable modem termination system (CMTS), and 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.

[b-ITU-T J.160] 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.

7.2.1 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 IP-Cablecom 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; or
- when an Event Message not associated with any call is generated.

The CMS MUST send the billing correlation ID and other data as defined in Table 1 to the CMTS via the DQoS GateSet message as specified in [ITU-T J.163].

Table 1 – IP-Cablecom event reporting common elements

1	Billing_Correlation_ID (see Table 39)
2	IP address and port number of the primary RKS
3	IP address and port number of the secondary RKS
4	Flag indicating if CMTS should send Event Messages to the RKS in real time

The CMS MUST generate the appropriate Event Messages as defined in this Recommendation.

7.2.2 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 IP-Cablecom 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 SS7 IAM message; or
- a TGCP NTFY with digits (operator services);
- when an Event Message not associated with any call is generated.

The MGC MUST generate the appropriate Event Messages as defined in this Recommendation.

7.2.3 Cable modem termination system (CMTS)

The cable modem termination system (CMTS) terminates the connection from the CM on the customer premises into the IP-Cablecom network. The CMTS generates QoS Event Messages. QoS Event Messages are generated individually for both upstream and downstream bandwidth.

The CMTS MUST generate the appropriate Event Messages as defined in this Recommendation. For all EM messages it generates other than Time_Change, the CMTS MUST use the unique Billing-Correlation-ID assigned by the CMS and received from the CMS in the Event-Generation-Info object of the DQoS GateSet message as defined in 7.3.2.7 of [ITU-T J.163]. See 9.16 for the generation of BCID in Time_Change events.

DOCSIS provides a mechanism by which multiple sessions can be placed on a single upstream service flow. DQoS supports this feature and refers to it as multiple grants per interval. There are two side effects to Event Messages when an MTA uses multiple grants per interval. The service flow ID (SFID) will be common among the events for all sessions that share that flow. The QoS Descriptor attribute re-elects the total bandwidth of all sessions using the flow.

7.2.4 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 this Recommendation as a separate stand-alone element, but this Recommendation 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 IP-Cablecom Event Messages. It receives Event Messages from various trusted IP-Cablecom 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 IP-Cablecom network and the back-office applications.

Figure 3 gives a representative RKS deployment for information only and does not imply an implementation requirement.

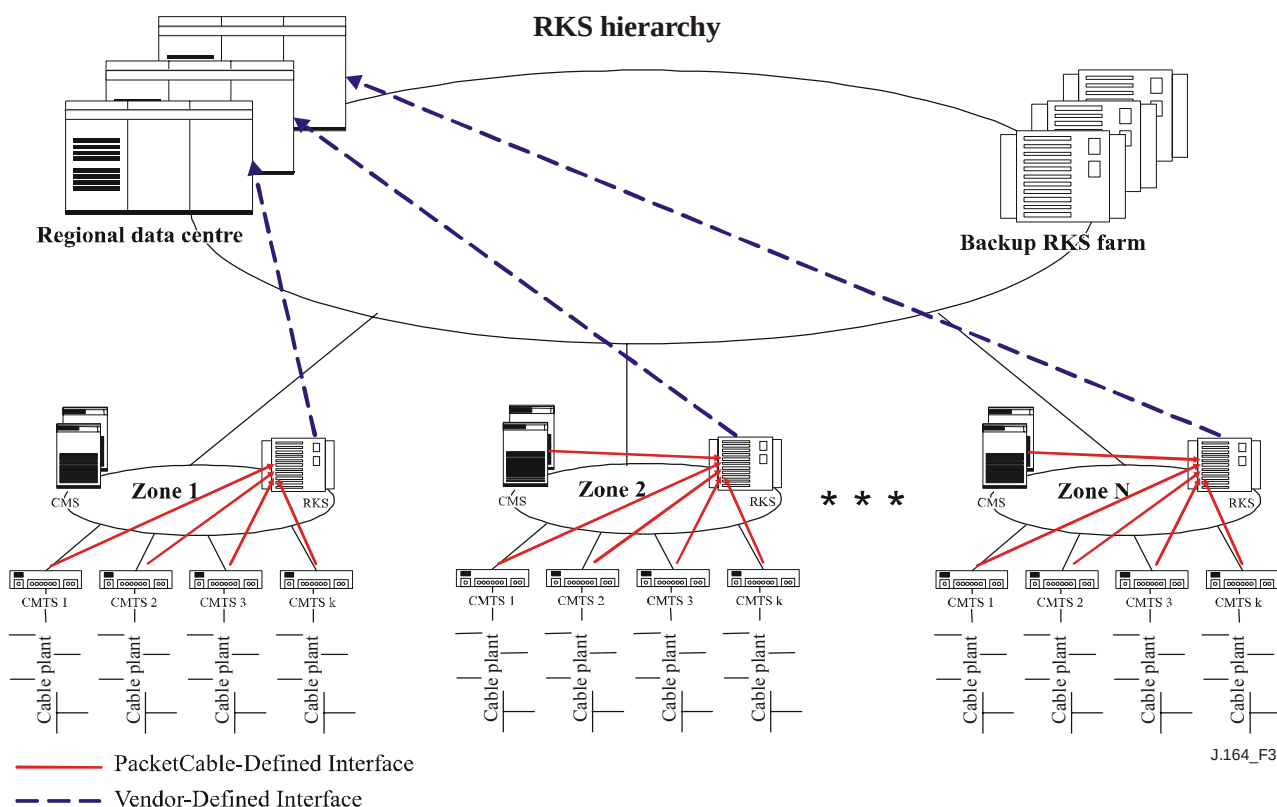


Figure 3 – Example RKS architecture

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 9. 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 this Recommendation, 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 [ITU-T J.170], *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.

7.3 General IPCablecom network element requirements

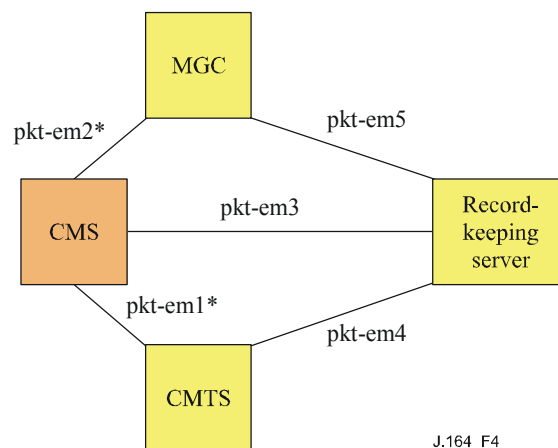
This clause lists requirements placed on the IPCablecom network elements:

- The CMS, CMTS, and MGC MUST create a security relationship with each RKS that these network elements will send Event Messages as defined in [ITU-T J.170].
- The CMS MUST support multiple sets of primary and secondary 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 (BCID), identify the primary and secondary RKSs, and determine if the Event Messages are to be delivered in real-time or batched and sent at a later time.

- The trusted IP-Cablecom network elements that generate Event Messages MUST timestamp Event Messages in 1 millisecond granularity ± 100 milliseconds based on information reported by network time sources such as edge devices (Clients and Gateways).
 - All IP-Cablecom 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 milliseconds real-time of the last synchronization value.
 - IP-Cablecom network elements that generate Event Messages MUST support network time protocol (NTP) time synchronization as defined in IETF RFC 1305.
 - The IP-Cablecom network elements MUST support transport to a primary RKS and failover to a secondary RKS when communication with the primary RKS fails for any reason (including situations where the primary RKS becomes inoperable).
 - IP-Cablecom 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 IP-Cablecom network element that generates an Event Message MUST identify itself with a static, unique element ID.
 - Implementations that combine CMS and MGC functionality MAY share a single element ID. Event Messages generated by a combined CMS/MGC MUST indicate which IP-Cablecom functional element (e.g., MGC or CMS) initiated the message using the Element_Type field in the EM_Header.

7.4 Event Message interfaces

This clause describes the interfaces between the IP-Cablecom network elements that are involved in the Event Messages process. It should be noted that additional requirements are imposed on these by other IP-Cablecom Recommendations and that the requirements listed in this Recommendation are specific to Event Messages. It should also be noted that additional requirements are specified for these interfaces and these IP-Cablecom network elements in other clauses of this Recommendation.



* indicates that the billing correlation ID and other data defined in Table 1 are carried on an existing signalling interface.

Figure 4 – Event message billing interfaces

7.4.1 CMS to CMTS (pkt-em1*)

The CMS to CMTS interface is defined by the IP-Cablecom DQoS protocol in [ITU-T J.163].

The CMS sends the billing correlation ID and other data as defined in Table 1 to the CMTS via the DQoS GateSet message as specified in [ITU-T J.163].

7.4.2 CMS to MGC (pkt-em2*)

The CMS to MGC interface is defined by the IPCablecom CMSS (ITU-T Rec. J.178). The CMS and MGC exchange originating/terminating information such as BCID, FEID, etc., across this interface as defined in [ITU-T J.178].

7.4.3 CMS to RKS (pkt-em3)

The CMS to RKS interface is defined by [ITU-T J.170] and also by the Event Message transport and syntax rules defined in this Recommendation.

7.4.4 CMTS to RKS (pkt-em4)

The CMTS to RKS interface is defined by [ITU-T J.170] and by the Event Message transport and syntax rules defined in this Recommendation.

7.4.5 MGC to RKS (pkt-em5)

The MGC to RKS interface is defined by [ITU-T J.170] and by the Event Message transport and syntax rules defined in this Recommendation.

7.4.6 CMS to CMS (pkt-em6)

The CMS to CMS interface is defined by the IPCablecom CMSS specification, (ITU-T Rec. J.178). The originating CMS and terminating CMS exchange originating/terminating information such as BCID, FEID, etc., across this interface as defined in ITU-T Rec. J.178.

7.4.7 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, CMTS, and MGC that will send Event Messages to any of those RKSs. The Event Messages are sent from the CMS, CMTS, and MGC to the RKS using one of the supported transport mechanisms, each of which must be possible to secure by IPsec. Refer to [ITU-T J.170] for a detailed description of the security requirements for the IPCablecom Event Message interfaces.

8 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 this Recommendation, 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.

8.1 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 along with the basic call, then refer to 8.2 for a list of additional Event Messages for these specific services.

8.1.1 On-net-to-on-net call configuration

The most basic IPCablecom call configuration is an on-net-to-on-net call (see Table 2) 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 CMTSs.

Both intra-domain and inter-domain on-net-to-on-net call configurations use two different MTAs that are both connected to two different CMSes.

For any on-net-to-on-net call configuration, the originating half and the terminating half of the call MUST each generate a complete set of Event Messages.

Table 2 – On-net-to-on-net call configuration

Event Message	Required or optional	Comments
Database_Query	O	If LNP is Required
Signalling_Start	R	CMS is starting signalling to support a call start
QoS_Reserve	R	CMTS reserves QoS
QoS_Commit	R	CMTS commits QoS
Intelligent_Peripheral_Usage_Start	O	e.g., if an announcement is needed NOTE – This Event Message will be defined in a future release of this IPCablecom Recommendation.
Intelligent_Peripheral_Usage_Stop	O	e.g., if an announcement is needed NOTE – This Event Message will be defined in a future release of this IPCablecom Recommendation
Call_Answer	R	Indicates start of media stream
Call_Disconnect	R	Indicates termination of media steam
QoS_Release	R	CMTS is releasing QoS
Signalling_Stop	R	Signalling for the service is complete
Media_Statistics	O	Media stream statistics reported by the gateway

8.1.2 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 an IP database). (See Table 3.)

For any on-net-to-off-net call configuration, the originating half and the terminating half of the call MUST each generate a complete set of Event Messages.

Table 3 – On-net-to-off-net call configuration

Event Message	Required or optional	Comments
Database_Query	O	If LNP is Required
Signalling_Start	R	Start signalling to support a call start
QoS_Reserve	R	CMTS reserves QoS
QoS_Commit	R	CMTS commits QoS

Table 3 – On-net-to-off-net call configuration

Event Message	Required or optional	Comments
Intelligent_Peripheral_Usage_Start	O	e.g., if an announcement is needed NOTE – This Event Message will be defined in a future release of this IPCablecom Recommendation.
Intelligent_Peripheral_Usage_Stop	O	e.g., if an announcement is needed NOTE – This Event Message will be defined in a future release of this IPCablecom Recommendation.
Interconnect_Start	R	For call setup
Call_Answer	R	Indicates start of media stream
Call_Disconnect	R	Indicates termination of media steam
Interconnect_Stop	R	For call tear-down
QoS_Release	R	CMTS releases bandwidth
Signalling_Stop	R	Indicates end of signalling
Media_Statistics	O	Media stream statistics reported by the gateway

8.1.3 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. (See Table 4.)

For any off-net-to-on-net call configuration, the originating half and the terminating half of the call MUST each generate a complete set of Event Messages.

Table 4 – Off-net-to-on-net call configuration

Event Message	Required or optional	Comments
Signalling_Start	R	Starting signalling to service a request to start a call
Interconnect_Start	R	For call setup
QoS_Reserve	R	CMTS reserves bandwidth
QoS_Commit	R	CMTS commits bandwidth
Intelligent_Peripheral_Usage_Start	O	e.g., if an announcement is needed NOTE – This Event Message will be defined in a future release of this IPCablecom Recommendation.
Intelligent_Peripheral_Usage_Stop	O	e.g., if an announcement is needed NOTE – This Event Message will be defined in a future release of this IPCablecom Recommendation.
Call_Answer	R	Indicates start of media stream
Call_Disconnect	R	Indicates termination of media steam
Interconnect_Stop	R	For call tear-down

Table 4 – Off-net-to-on-net call configuration

Event Message	Required or optional	Comments
QoS_Release	R	CMTS releases bandwidth
Signalling_Stop	R	Indicates end of signalling
Media_Statistics	O	Media stream statistics reported by the gateway

8.2 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 8.1.

This clause describes additional Event Messages that **MUST** be generated along with the basic set in order to describe specific IP_Cablecom 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.

8.2.1 Emergency service

An emergency call follows the standard on-net-to-off-net Event Message flow described in 8.1.2. Emergency calls require special treatment. In IP_Cablecom, 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 8.1.2.

8.2.2 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.

8.2.3 Freephone services

Freephone services follow the standard on-net-to-off-net Event Message flow described in 8.1.2. In IP_Cablecom, toll-free calls can be handled in 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 in 8.2.1 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. (See Table 5.)

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

8.2.4 Operator services

Operator services follow the standard on-net-to-off-net event message configuration described in 8.1.2. 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 the 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 encompass 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.

8.2.5 Call block service

Event Messages are generated for Call Block Service (see Table 6) 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 off-hook, dialling, 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	NOTE – This Event Message will be defined in a future release of this IPCablecom Recommendation.
Intelligent_Peripheral_Usage_Stop	O	NOTE – This Event Message will be defined in a future release of this IPCablecom Recommendation.

8.2.6 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/CMTS/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 an 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 8.1.2 and 8.1.3, but there may also be three additional Event Messages associated with this instance of Call Waiting, as detailed in Table 7. 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 is On_Net NOTE – This Event Message will be defined in a future release of this IPCablecom Recommendation.
Intelligent_Peripheral_Usage_Stop	O	Required only if Announcement Server is On_Net NOTE – This Event Message will be defined in a future release of this IPCablecom Recommendation.
Service_Instance	R	None