PacketCable™ Electronic Surveillance Call Flows Technical Report

PKT-TR-ESCF-V01-991229

Notice

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1 INTRODUCTION

It is the intent of CableLabs to design mechanisms that will make it possible for cable operators who implement PacketCable™ specifications, and are or become "telecommunications carriers" subject to the Communications Assistance for Law Enforcement Act (CALEA) with respect to their use of PacketCable capabilities, to support lawfully authorized electronic surveillance consistent with the requirements of CALEA.

Electronic surveillance requirements cover three specific types of interception:

- "Pen register" which records information regarding all calls originated by a subject (but not call content),
- "Trap and trace" which records information regarding all calls received by a subject (but not call content), and
- "Surveillance" which allows Law Enforcement to listen to the conversations of the subject.

Approximately 90% of all interceptions are of the first two types. In the US both Federal law and laws of 42 states only allow the use of the third technique in the investigation of serious criminal offenses, and when other techniques have not worked, will not work, or are too dangerous.

Current PSTN telecommunications carriers are expected to ensure that their systems are:

- Capable of intercepting all communications to or from a subscriber through the carrier's facilities,
- Accessing all reasonably available call-identifying information, and
- Associating the call-identifying information with the communication to which it pertains while protecting the privacy of communications not otherwise authorized to be intercepted, and
- Delivering the intercepted communications and call-identifying information to the government in a format such that it can be transmitted over facilities procured by the government to a location other than the carrier's premises.

Also it is expected that these interceptions and access to call-identifying information be done:

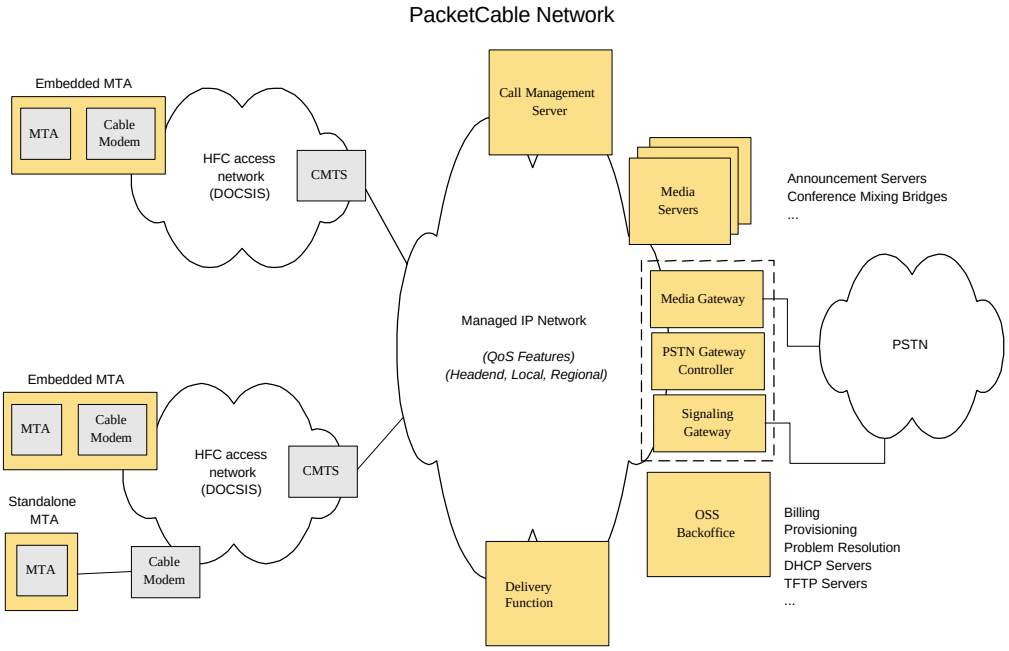
- unobtrusively, and with a minimum of interference with the subscriber's telecommunications service,
- in a manner that protects the privacy and security of the intercepted information, and
- protects the information regarding the government's interception of the communication and call-identifying information.

Cable operators are not ordinarily telecommunications carriers, but if a cable operator has taken the steps to become a carrier, and uses PacketCable to provide carrier services, then the Communications Assistance for Law Enforcement Act (CALEA) might apply to the equipment used to implement PacketCable. For this reason, we are providing consideration of CALEA concerns as part of the PacketCable specification, for the benefit of anyone who might use this architecture/technology as part of their carrier activities. For purposes of this discussion, we refer to a cable operator that has implemented PacketCable capabilities and taken the steps to be come a telecommunications carrier as a PacketCable Telecommunications Service Provider (PC/TSP). A telecommunications carrier that is found in compliance with a publicly available technical requirement or standard adopted by an industry association or standards-setting organization shall be found to be in compliance with the assistance capability requirements of CALEA; consequently it is useful to establish standards and/or technical requirements applicable to the use of PacketCable capabilities by cable operators that have taken the steps to become carriers.

This document refers to the IP-based voice communications capabilities of a PacketCable network. The legal/regulatory classification of IP-based voice communications provided over cable networks and otherwise, and the legal/regulatory obligations, if any, borne by providers of such voice communications, are not yet fully defined by appropriate legal and regulatory authorities. Nothing in this document is addressed to, or intended to affect, those issues. In particular, while this document uses standard terms such as “call,” “call flow,” “telephone number,” etc., it should be recalled that while a PacketCable network performs activities analogous to the PSTN functions referenced by these terms, the manner by which it does so differs considerably from the manner in which they are performed in the PSTN by telecommunications carriers, and that these differences may be significant for legal/regulatory purposes. No particular legal/regulatory consequences are assumed or implied by the use of these terms.

2 FUNCTIONAL COMPONENTS TO SUPPORT ELECTRONIC SURVEILLANCE

Support of Electronic Surveillance adds an additional functional component to the PacketCable Network Reference Model, called an Electronic Surveillance Delivery Function. The description of the Delivery Function, and the additional functional requirements for other components, are described in the following subsections.



2.1 Electronic Surveillance Delivery Function (DF)

The Electronic Surveillance Delivery Function includes the interface responsible for delivering intercepted communication from the PacketCable elements to the Law Enforcement Agencies authorized to receive it. The Delivery Function delivers reasonably available call-identifying information and call content based on the requirements of the lawful authorization. The Delivery Function includes the ability to:

- collect and deliver call content and reasonably available call-identifying information for each intercept subject to the identified law enforcement facilities.
- ensure that the call content and call-identifying information delivered from the Delivery Function is authorized for a particular Law Enforcement Agency (LEA);
- protect (i.e. prevent unauthorized access to, or manipulation and disclosure of) intercept controls, intercepted call content, and call-identifying information, through methods that are consistent with PC/TSP normal security policies and practices;
- ensure that delivery of surveillance information is only available for the time stated in the lawful authorization;

- deliver call content and reasonably available call-identifying information, using the PacketCable Electronic Surveillance Protocol (PCESP) [PKT-SP-ESP-I01-991229], to up to five Law Enforcement Agencies independently;
- when the service provider has deployed multiple Delivery Functions, duplicate the incoming event messages and call content, and forward to another Delivery Function element in support of redirected calls.

Call-identifying information, call content, or both, associated with a particular subject may need to be delivered to more than one LEA simultaneously. This will occur when different LEAs are conducting independent investigations on the same subject. The Delivery Function duplicates the call content, call-identifying information, or both, and delivers authorized information to each LEA.

Call-identifying information, call content, or both, associated with a particular subject may need to be delivered to another Delivery Function element. This typically occurs when a call is redirected by the terminating service, or when a completed call is transferred to another destination. The Intercept Access Points (IAPs) for the new destination deliver the call-identifying information and call content to their locally-configured Delivery Function, who then forwards the events and call content to the Delivery Function serving the subject under surveillance.

The Delivery Function will act as the direct interface to the LEA CFs. It will maintain a Call Data Connection (CDC), over which call detail information will be delivered to the Law Enforcement Agency's Collection Function (CF), and a Call Content Connection (CCC), over which call content will be delivered to the CF.

The DF will associate a subject with one or more LEA Case-IDs. Up to five LEAs may have simultaneous wiretap requests for the same subject telephone number. When the DF receives event messages from the IAP, it will format the information using the PCESP protocol and send a copy to each CF authorized to receive information for the subject. The DF must be able to support simultaneous delivery of CDC information for a subject to multiple CFs.

The DF will send CDC messages to the CFs to reflect the following call events:

- Origination – call attempt by a subject
- Termination Attempt – call attempt to a subject's number
- Redirection – call to a subject is being redirected or transferred
- Answer – call placed by a subject or to a subject is answered
- Release – resources associated with a wiretap call are released

When call content is delivered to the DF from an IAP, the DF will forward the call content packets to each CF authorized to receive call content for the subject. The DF must be able to support simultaneous delivery of CCC information for a subject to multiple CFs.

2.2 Cable Modem Termination System (CMTS)

The Cable Modem Termination System (CMTS) provides the interface between the HFC network and the IP network. In a PacketCable network it is the aggregation device for Multimedia Terminal Adapters (MTAs) such that all traffic to and from each MTA must flow through a CMTS. The CMTS is therefore the prime candidate to act as an Intercept Access Point (IAP) for call content. Within the PacketCable architecture, the CMTS also provides some event (call detail) messages to a Record-Keeping Server (RKS) and as such is a candidate source for some of the Call Data Connection (CDC) information required for Lawful Intercept.

In order to intercept call content for media streams going to and from an MTA, the CMTS must be supplied with packet classifiers to identify the media streams in each direction. Based on those classifiers and a requirement to intercept the media streams, the CMTS must be capable of encapsulating a single copy of each media stream without altering the original packet flow and send the encapsulated packets to a required destination (the Delivery Function). The encapsulated packets shall be in the same CCC PCESP format as the CCC information sent between the DF and the CF. The Call Content Identifier in the CCC packets delivered to the DF is the Gate-ID.

The CMTS in its role as an IAP must not result in a noticeable degradation in performance in its primary role of providing service in terms of either dropped or delayed media stream packets or in terms of any alteration in call-setup delays. In order to insure that, the maximum number of intercepts allowed is 5% of the call capacity of the CMTS.

In addition to Call Content, the CMTS may also provide event messages to the DF for generation of CDC messages.

2.3 Media Gateway (MG)

Media Gateways must be capable of acting as an Intercept Access Point (IAP) for CCC information for cases in which a call for an intercept subject is redirected to the PSTN.

The MG must be capable of encapsulating a single copy of each media stream going to and from an endpoint and sending the encapsulated packets to a required destination (the Delivery Function). The encapsulated packets shall be in the same CCC PCESP format as the CCC information sent between the DF and the CF. The Call Content Identifier in the CCC packets, assigned by the MGC, will identify the call content for delivery to the DF.

The MG in its role as an IAP must not result in a noticeable degradation in performance in its primary role of providing service in terms of either dropped or delayed media stream packets or in terms of any alteration in call-setup delays.

2.4 Call Management System (CMS)

The Call Management System (CMS) is a PacketCable element that performs call management functions (e.g. address translation, call routing, usage recording, etc.). The CMS in this section includes both the Call Agent (CMS/CA) and Media Gateway Controller (CMS/MGC), unless stated otherwise. The CMS sends requests to the appropriate network elements in regards to call setup and teardown. In the PCESP, the CMS will serve as an access point for call-identifying information and as the requester to network IAPs for call content delivery.

Call-Identifying Information

The CMS will associate an active wiretap status with an intercept subject's telephone number. When it recognizes that a call involves a subject's telephone number, it will send messages to the DF at various points-in-call that provide the appropriate call-identifying information. (The DF will deliver this information over the CDC to the LEA/s that have requested the wiretap on the subject).

The CMS will deal with the following call scenarios:

- call made by a subject (subject origination)
- call made to a subject (termination to a subject)
- call made to a subject but redirected to another number; or call redirected to a subject's number
- call involving multiple subjects

The CMS will generate messages to the DF at certain points-in-call for each of the above call scenarios. These messages will be created when:

1. call made by a subject (applies to CMS/CA only)
    - origination attempt – CMS recognizes that a subject is attempting to place a call
    - origination answer – CMS recognizes that a call placed by a subject is answered. Alternately, the CMS may set the parameters of the gate in the CMTS so that this message is generated by the CMTS
    - origination release – CMS recognizes that the resources associated with a call placed by a subject are being released (onhook). Alternately, the CMS may set the parameters of the gate in the CMTS so that this message is generated by the CMTS.
2. call made to a subject (applies to CMS/CA and CMS/MGC)
    - termination attempt – CMS recognizes that a call is being attempted to a subject's number
    - termination answer – CMS recognizes that a call placed to a subject is answered. Alternately, the CMS may set the parameters of the gate in the CMTS so that this message is generated by the CMTS

- termination release – CMS recognizes that the resources associated with a call placed to a subject are being released (onhook). Alternately, the CMS may set the parameters of the gate in the CMTS so that this message is generated by the CMTS.

3. call redirection

    - redirection attempt – CMS recognizes that there is an attempt to redirect the call by a surveillance subject

As an example, if a call is placed to a subject's number and is redirected to another number, the CMS should provide event messages to the DF in the following sequence: termination attempt, redirection attempt, termination answer and termination release.

Call Content Information

When the CMS recognizes that a call involves a subject's telephone number and that the delivery of call content is required along with call detail information, it will send messages to the appropriate IAP (i.e. CMTS or MG) to request that call content be delivered to the DF. The steps:

- CMS identifies that call content is to be delivered along with call detail information.
- CMS identifies (via provisioning) an address/port on the DF to which call content should be delivered.
- The CMS includes the call content request with the delivery address information in existing interfaces to the appropriate IAP. For the MG, the request will be included in TGCP messages used for connection control [PKT-SP-TGCP-I01-991201]. For the CMTS, the request will be included in D-QoS messages [PKT-SP-DQOS-I01-991201]. (The IAP will intercept, replicate and deliver the call content packets to the DF.)

Depending on a particular PC/TSP's architecture, CMS functionality may be executed from a single element or from distributed elements. For instance, an architecture may operate under a half call model in which separate CMS elements control the originating and terminating sides of a call. Also, certain call features (e.g. call forwarding) may require call management to be transferred from one CMS element to another. When multiple CMS elements are involved in a call, internal messaging within the CMS elements will be responsible for passing on the information that a specific call is involved in a wiretap.

3 PROVISIONING REQUIREMENTS

Provisioning is required at both the CMS and DF for support of electronic surveillance. For each surveillance order, a database maintained by the DF must contain the E.164 phone number under surveillance, the Law Enforcement Agency's Collection Function address&port for CDC messages, the LEA's Collection Function address&port for CCC messages, the LEA's Case-ID, and the type of surveillance.

For each surveillance subject, the subscriber information database maintained by the CMS must contain an indication of the type of surveillance (surveillance, interception, or none).

The CMS must be provisioned with the DF address&port for call content packet delivery.

In addition, both the CMS and CMTS must be provisioned with whatever information is necessary to establish a RADIUS connection with the DF, similar to what is currently provisioned for their event message connection to the RKS.

4 PROTOCOL INTERFACES AND REQUIREMENTS

4.1 Interface between CMS and DF

This interface is identical to that between the CMS and RKS for transfer of event messages, as described in [PKT-SP-EM-I01-991201]. All events related to a call under surveillance, such as Signaling-Start, Call-Answer, and Call-Disconnect, are duplicated (with minor changes in some cases) and sent to both the RKS and to the DF.

4.2 Interface between CMS and CMTS

This interface is an extension of the COPS protocol as defined by D-QoS [PKT-SP-DQOS-I01-991201]. A special object in the Gate-Set message tells the CMTS to perform packet duplication for all packets flowing through this gate, and tells the CMTS the address&port of where to send the duplicates. The Gate-Set message may also tell the CMTS an address&port to send duplicate event messages related to this session.

4.3 Interface between CMS/MGC and MG

This interface uses the MGCP/TGCP protocol, as defined in [PKT-SP-TGCP-I01-991201], with a local connection extension in the create connection (CRCX) and modify connection (MDCX) messages. Parameters associated with this new local connection option include the DF address&port for delivery of a duplicated stream of packets, and the CCC-ID value (assigned by the CMS/MGC) to insert in the duplicated packets.

4.4 Interface between CMTS and DF for Event Messages

This interface is identical to that between the CMTS and RKS for transfer of event messages, as described in [PKT-SP-EM-I01-991201]. All events related to a call being intercepted, such as QoS-Start and QoS-Stop, are duplicated and sent to both the RKS and to the DF.

4.5 Interface between CMTS and DF for Call Content

This interface is identical to that described in Section 4 of the PacketCable Electronic Surveillance Specification [PKT-SP-ESP-I01-991229]. Call Content packets are duplicated by the CMTS, and encapsulated in the payload of a UDP/IP packet and sent to the DF. Also included in the payload of the UDP/IP packet is the Gate-ID in the place of the Call-Content-Connection-ID field.

4.6 Interface between MG and DF for Call Content

This interface is identical to that described in Section 4 of the PacketCable Electronic Surveillance Specification [PKT-SP-ESP-I01-991229]. Call Content packets are duplicated by the MG, and encapsulated in the payload of a UDP/IP packet and sent to the DF. Also included in the payload of the UDP/IP packet is the value assigned by CMS/MGC for the Call-Content-Connection-ID field.

4.7 Interface between CMS and CMS

This interface is not defined in PacketCable 1.0 for NCS. Changes needed to support Electronic Surveillance in DCS will be included in the first released DCS specification [PKT-SP-DCS-I01-xxxxxx, not yet released].

[Note: The change needed in the proprietary implementations of CMS-to-CMS protocols include an indication carried with a redirected call that a previous destination of this call (possibly the party doing the redirection, or possibly a previous one) has an outstanding surveillance order, the address&port of the delivery function for the CDC messages, and, if the surveillance includes call content, the address&port of the delivery function for CCC packets. Also included in this CMS-CMS message is the information needed by the two DFs to establish a security association for the event message stream.]

4.8 Interface between DF and DF

This interface is utilized when a forwarded call from a surveillance subject is intercepted and delivered to a DF other than the one configured to serve the surveillance subject. The DF associated with the terminating party forwards a copy of each event message and call content packet to the DF associated with the subject under surveillance. Event messages are transported by the same mechanism as is used for PacketCable elements to send events to the RKS. Call content is transported by the same mechanism as is used for the MG/CMTS to send call content to the DF. The Call-Content-Connection-ID (CCC-ID) in the call content packets is updated by the sending DF to be a unique value for that interface, and the forwarded QoS-Start event indicates the chosen CCC-ID value.

5 DETAILED DESCRIPTION OF DELIVERY FUNCTION

This informative section describes a prototype implementation of the delivery function, the data structures maintained by the delivery function, and the processing performed for each event message.

5.1 Active Call Data Structure

The following data structure is maintained in the Delivery Function for each active call:

Field in Active-Call-Data-Structure	Description of contents:	Set by	Used by
Call-ID	Billing-Correlation-ID, assigned by CMS uniquely for each call, and contained in Event Messages.	Signaling-Start Event Message	Indexed, and used by all other Event Messages.
CMTS-Address and Gate-ID	Source IP address of CMTS providing call content packets for this call, and Gate-ID assigned by that CMTS (which is used as the content-identifier in intercepted packets)	QoS-Start Event Message	Indexed, and used by call content packets
Next Call Data Structure	Pointer to another identical structure, containing additional information regarding this call.	Signaling-Start Event Message	All
Surveillance-Party-ID	E.164 number of the party under surveillance; either the originator, terminator, or redirector of this call	Signaling-Start Event Message	Service-Instance Event Message
Direction	Indication whether the "surveillance-party-id' above is the originator or terminator of this call	Signaling-Start Event Message	Call-Answer and QoS-Start Event Messages
Signaling Status	Indication of whether the DF has sent the Origination or Termination Attempt message to LEA	Signaling-Start Event Message	Signaling-Start Event Message
Content-Status	Indication of whether the DF has sent the CCOpen message to LEA	QoS-Start Event Message	QoS-Start Event Message
Call-Content-Value	32-bit value assigned by DF that identifies the call content packets delivered to LEA	Signaling-Start Event Message	QoS-Start Event Message and Call Content packets
LEA Information (five independent entries)	Delivery instructions for call content and call-identifying information to LEA. Includes Case-ID (26-char string), CF-address, CCC-Port, and CDC-Port. DF-address of zero indicates an unused entry. CCC-Port of zero indicates no call content is to be delivered	Internal Database lookup performed in handling of Signaling-Start Event Message	All

DF-Information	Address, CCC-Port, and CDC-Port of another Delivery Function that requires surveillance of this call. Also includes key information for secure transfer of the information	Signaling-Start Event Message	All

Two indices are maintained for searching this data structure: first is based on Call-ID, and second is based on CMTS-address and Gate-ID.

For a basic call with one party under surveillance, there is one Active-Call-Data-Structure, which contains all the information necessary to control the surveillance of the call. The 'LEA-Information' contains up to five LEA Collection-Function addresses. The fields 'next-call-data-structure' and 'DF-Information' are empty. All entries except CMTS-address and Gate-ID are set on receipt of the Signaling-Start Event Message. All Event Messages contain the Call-ID (Billing-Correlation-ID), which is used as an index to find the data structure entry for the call. If the call content is intercepted as well, then the CMTS-address and Gate-ID are set by the QoS-Start Event Message. Call content packets contain the CMTS-Address and Gate-ID, which is used to locate the Active-Call-Data-Structure and forward the content packet to the proper LEAs.

A call to a surveillance subject that is redirected to another surveillance subject served by the same DF results in two Active-Call-Data-Structures linked together with the 'next-call-data-structure' field. Both are identified with the same value of Call-ID, CMTS-address, and Gate-ID. For such a call there may be up to ten LEAs to receive surveillance information – up to five in each Active-Call-Data-Structure.

A call to a surveillance subject that is redirected to a destination served by another DF results in an Active-Call-Data-Structure in each DF, with the 'DF-Information' field set with the information needed to establish a secure link between them. All Event Messages are sent to the terminating DF, who forwards the Event Messages to the DF serving the redirecting surveillance subject.

The simple implementation described in this section, which covers the above three scenarios, also handles other complex scenarios in a very simpleminded way. A call redirected by a surveillance subject to another surveillance subject results in a Active-Call-Data-Structure with both 'LEA-information' fields and 'DF-Information' fields. A call from a party under surveillance to a party under surveillance, both served by the same DF, has two Active-Call-Data-Structures linked together (if both intercept the content and send it to the DF, the DF will discard one copy).

5.2 Processing of Signaling-Start Event Message

The following steps are performed on receipt of a Signaling-Start Event Message:

1. Allocate a new Active-Call data structure. Initialize values of Call-ID (from the Event Message), Direction (from the Event Message), Signaling-Status (no message sent), Content-Status (no message sent), Call-Content-Value (0), Lea-information (all 5, set CF-addr to 0), Next-Call-Data-Structure (null), and DF-Information (address, cdc-port, and ccc-port from Electronic-Surveillance-

Indication in Event Message, if present, else 0). If the direction-indicator is 'originate' set Surveillance-Party-ID to Calling-Party-Number from Event Message; if direction-indicator is 'terminate' set Surveillance-Party-ID to Called-Party-Number from Event Message.

2. Consult the surveillance database for the Surveillance-Party-ID. Copy the LEA case-ids, address, ports, and authorizations to the Active-Call data structure. Note that in cases of forwarded calls, there may be no database entry, and therefore no LEA entries.
3. Check for existing Active-Call data structures with matching Call-ID. If found, link together using the 'next' pointer. Update indices for searches based on call-id.
4. If the Event Message contains the Electronic Surveillance Indication object, establish a TCP/IP connection with the indicated DF. Establish a security association using IKE, utilizing the call-id and pre-shared key information given in the Event Message.
5. Assign a locally unique, and not recently used, value for Call-Content-Value.
6. If the direction-indicator is 'originate', for each LEA entry in the Active-Call data structure, send a PCES Originate message containing:

Field in PCES Message	Obtained from:
Case-ID	LEA entry in Active-Call data structure
Accessing-Element-ID	Event Message Header
Event-Time	Event Message Header
Call-ID	Event Message Header
Calling-Party-ID	Calling-Party-Number in Event Message
Called-Party-ID	Called-Party-Number in Event Message
User-Input	User-Input in Event Message, if present
Translation-Input	Translation-Input in Event Message, if present
Transit-Carrier-ID	Carrier-Identification-Code in Event Message, if present

7. If the direction-indicator is 'terminate,' for each LEA entry in the Active-Call data structure, send a PCES Termination-Attempt message containing:

Field in PCES Message	Obtained from:
Case-ID	LEA entry in Active-Call data structure
Accessing-Element-ID	Event Message Header
Event-Time	Event Message Header
Call-ID	Event Message Header
Calling-Party-ID	Calling-Party-Number in Event Message
Called-Party-ID	Called-Party-Number in Event Message
Redirected-From-Info	Redirected-From-Info in Event Message, if present

8. If the Active-Call data structure contains a DF address:port, send the Event Message to that DF
9. If the Active-Call data structure contains a pointer to another Active-Call data structure, go back to step 2 for that entry.

5.3 Processing of Call-Answer Event Message

The following steps are performed on receipt of a Call-Answer Event Message:

1. Locate the Active-Call data structure with matching Call-ID. If not found, ignore the Event message
2. If the 'Signaling-Status' indicates the Answer message has been sent, skip this Active-Call-Data-Structure and follow the pointer to the next one (step 5 below). Mark the 'Signaling-Status' to indicate the Answer message has been sent.
3. For each LEA entry in the Active-Call data structure, send a PCES Answer message containing:

Field in PCES Message	Obtained from:
Case-ID	LEA entry in Active-Call data structure
Accessing-Element-ID	Event Message Header
Event-Time	Event Message Header
Call-ID	Event Message Header
Answering-Party-ID	Called-Party-Number in Event Message

4. If the Active-Call data structure contains 'DF-Information', send the Event Message to that DF
5. If the Active-Call data structure contains a pointer to another Active-Call data structure, go back to step 2 for that entry.

5.4 Processing of Call-Disconnect Event Message

The following steps are performed on receipt of a Call-Disconnect Event Message:

1. Locate the Active-Call data structure with matching Call-ID. If not found, ignore the Event message
2. For each LEA listed in the Active-Call data structure, send a PCES Release message containing:

Field in PCES Message	Obtained from:
Case-ID	LEA entry in Active-Call data structure
Accessing-Element-ID	Event Message Header
Event-Time	Event Message Header
Call-ID	Event Message Header

3. If the Active-Call data structure contains 'DF-Information', send the Event Message to that DF

4. Mark the 'Signaling-Status' in the Active-Call data structure as 'closed'. If the Content-Status is 'closed', then delete the Active-Call data structure entry (but first save the pointer needed in step #5).
5. If the Active Call Data Structure contains a pointer to another Active-Call data structure, go back to step 2 for that entry.

5.5 Processing of QoS-Start Event Message

The following steps are performed on receipt of a QoS-Start Event Message:

1. Locate the Active-Call data structure with matching Call-ID. If not found, ignore the Event message
2. Fill in CMTS_Addr and Gate_ID from the Event Message's source address and CCC_ID. Update an index to optimize searches using CMTS-Addr and Gate-ID.
3. If the 'Content-Status' indicates the CCOpen message has been sent, skip this Active-Call-Data-Structure and follow the pointer to the next one (step 6 below). Mark the 'Content-Status' to indicate the CCOpen message has been sent.
4. For each LEA listed in the Active-Call data structure that is authorized to receive call content, send a PCES CCOpen message containing:

Field in PCES Message	Obtained from:
Case-ID	LEA entry in Active-Call data structure
Accessing-Element-ID	Event Message Header
Event-Time	Event Message Header
Call-ID	Event Message Header
Originating-SDP	If Direction-Value in the Active-Call data structure matches the Event Message, then SDP-Downstream in Event Message; otherwise SDP-Upstream
Terminating-SDP	If Direction-Value in the Active-Call data structure matches the Event Message, then SDP-Upstream in Event Message; otherwise SDP-Downstream
CCC-ID	Call-Content-Value in Active-Call data structure

5. If the Active-Call data structure contains 'DF-Information', send the Event Message to that DF
6. If the Active Call Data Structure contains a pointer to another Active-Call data structure, go back to step 2 for that entry.

5.6 Processing of QoS-Change Event Message

The following steps are performed on receipt of a QoS-Change Event Message:

1. Locate the Active-Call data structure with matching Call-ID. If not found, ignore the Event message

2. For each LEA listed in the Active-Call data structure that is authorized to receive call content, send a PCES CCChange message containing:

Field in PCES Message	Obtained from:
Case-ID	LEA entry in Active-Call data structure
Accessing-Element-ID	Event Message Header
Event-Time	Event Message Header
Call-ID	Event Message Header
Originating-SDP	If Direction Value in Active-Call data structure is 'originate', then SDP-Downstream in Event Message; otherwise SDP-Upstream
Terminating-SDP	If Direction Value in Active-Call data structure is 'originate', then SDP-Upstream in Event Message; otherwise SDP-Downstream
CCC-ID	CCC Value in Active-Call data structure

3. If the Active-Call data structure contains 'DF-Information', send the Event Message to that DF
4. If the Active Call Data Structure contains a pointer to another Active-Call data structure, go back to step 2 for that entry.

5.7 Processing of QoS-Stop Event Message

The following steps are performed on receipt of a QoS-Stop Event Message:

1. Locate the Active-Call data structure with matching Call-ID. If not found, ignore the Event message
2. For each LEA listed in the Active-Call data structure that is authorized to receive call content, send a PCES CCClose message containing:

Field in PCES Message	Obtained from:
Case-ID	LEA entry in Active-Call data structure
Accessing-Element-ID	Event Message Header
Event-Time	Event Message Header
CCC-ID	CCC Value in Active-Call data structure

3. If the Active-Call data structure contains 'DF-Information', send the Event Message to that DF
4. Mark the Content-Status in the Active-Call data structure as 'closed'. If the Signaling-Status is 'closed', then delete the Active-Call data structure entry (but first save the pointer needed in step #5).
5. If the Active Call Data Structure contains a pointer to another Active-Call data structure, go back to step 2 for that entry.

5.8 Processing of Service-Instance (Call Forward) Event Message

The following steps are performed on receipt of a Service-Instance Event Message:

1. Locate the Active-Call data structure with matching Call-ID. If not found, ignore the Event message
2. If the Surveillance-Party-ID in the Active-Call data structure matches the Redirected-From-Party-Number in the Event Message, for each LEA listed in the Active-Call data structure, send a PCES Redirect message containing:

Field in PCES Message	Obtained from:
Case-ID	LEA entry in Active-Call data structure
Accessing-Element-ID	Event Message Header
Event-Time	Event Message Header
Call-ID	Event Message Header
Redirected-From-Party-ID	Redirected-From-Party-Number in Event Message
Redirected-To-Party-ID	Redirected-To-Party-Number in Event Message
Transit-Carrier-ID	Carrier-Identification-Code in Event Message, if present

3. If the Active-Call data structure contains 'DF-Information', send the Event Message to that DF
4. If no LEAs are listed in the Active-Call data structure, then delete the Active-Call data structure entry (but first save the pointer needed in step #5).
5. If the Active Call Data Structure contains a pointer to another Active-Call data structure, go back to step 2 for that entry.

5.9 Processing of Call Content Packet

The following steps are performed on receipt of a Call Content packet:

1. Locate the Active-Call data structure with CMTS-Address matching the source IP address of the packet, and Gate-ID matching the ccc-id contained in the packet. If not found, ignore the call content packet.
2. For each LEA listed in the Active-Call data structure that is authorized to receive call content, send a PCES CCC message containing:

Field in PCES Message	Obtained from:
CCC-ID	CCC Value in Active-Call data structure
Packet Content	Call Content Packet

3. If the Active-Call data structure contains 'DF-Information' containing a ccc-port, send the call content packet to that DF, with the CCC-ID value from the Active-Call data structure.

4. If the Active Call Data Structure contains a pointer to another Active-Call data structure, go back to step 2 for that entry.

6 EXAMPLES OF ELECTRONIC SURVEILLANCE

This section contains "use cases" and their associated end-end call flows for a basic set of PacketCable services. The end-end call flows described in this section are for reference purpose only and are not intended to be prescriptive or limit the realization of any PacketCable service.

The following subsections contain variations of a basic call, show the additional messages added in support of Electronic Surveillance, and show where those messages appear in the normal signaling flow. The diagrams in each section show a subset of the signaling messages in order to establish the immediate context of each Electronic Surveillance message. They also show the Event Messages generated by the PacketCable elements sent to the Delivery Function, and show the PCESP messages sent by the Delivery Function to the Law Enforcement Agency. Messages that are changed in support of Electronic Surveillance are highlighted in bold, and the detailed flow description after the diagram gives the contents of each.

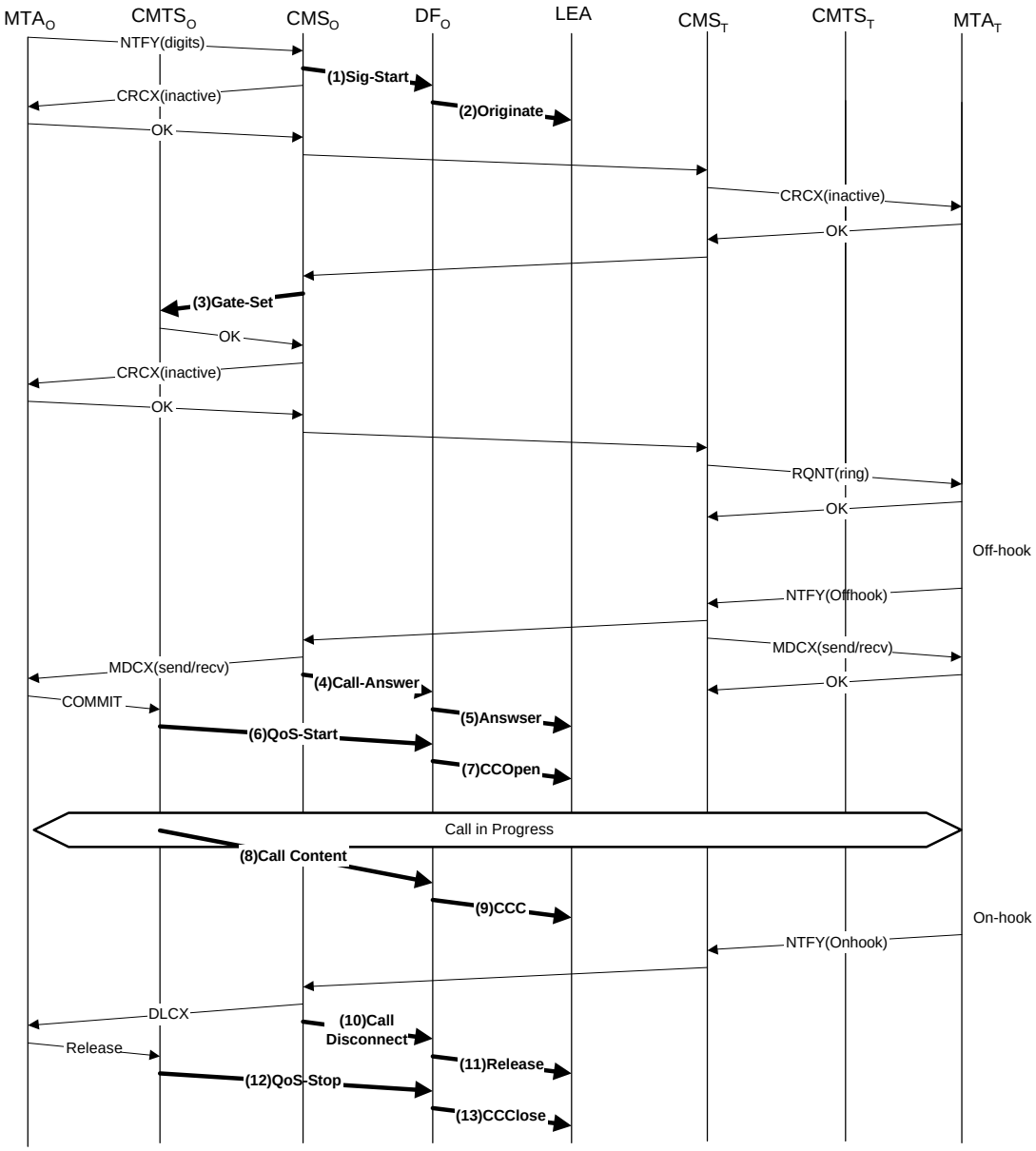
All messages shown are transmitted using a reliable transport protocol, either the application-layer facilities of RADIUS for event messages sent to the Delivery Function, TCP/IP for messages between Delivery Functions, or TCP/IP for messages from the Delivery Function to the Law Enforcement Agency. In all cases, the acknowledgements sent in response to a message are not shown in the diagrams, nor in the detailed description.

The most basic instance of electronic surveillance of the PacketCable service is an on-net to on-net call, within a single MSO's network, with one party having an outstanding surveillance order. The first two subsections (sections 6.1 and 6.2) show this case for the originator under surveillance, and for the destination under surveillance. Merging of the two diagrams shows the message sequence when both the originator and destination are under surveillance.

Note that multiple surveillance orders for a single subscriber, as well as the handling of call content vs. pen register/trap&trace for each individual order, is handled by the Delivery Function and does not appear in the call flows (except that calls that do not require call content will not send the duplicate packet stream to the DF).

Most of the complexity in the specification of Electronic Surveillance comes from handling of redirections. Section 6.3 shows the basic case of a redirected call, where the redirecting party is under a surveillance order but neither the originator nor the final destination are under surveillance. Section 6.4 extends that case to show a redirected call to a destination on the PSTN, and section 6.6 extends the original case to show both the redirected party and the final destination under surveillance.

6.1 Basic Call of On-Net Subscriber under Surveillance to On-Net Subscriber



Flow	Flow Description
1 (EM)	Upon completion of dialed-number translation, CMS$_O$ sends DF$_O$ a Signaling-Start Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Signaling_Start Element Type CMS Element ID xxxxCMSo Sequence ID AA01 Event Message Time and Date YYYYMMDDHHMMSS.MMM Direction_Indicator originate MTA_Port_ID MTAo_PORT_NUMBER Calling_Party_Number +1-212-555-1111

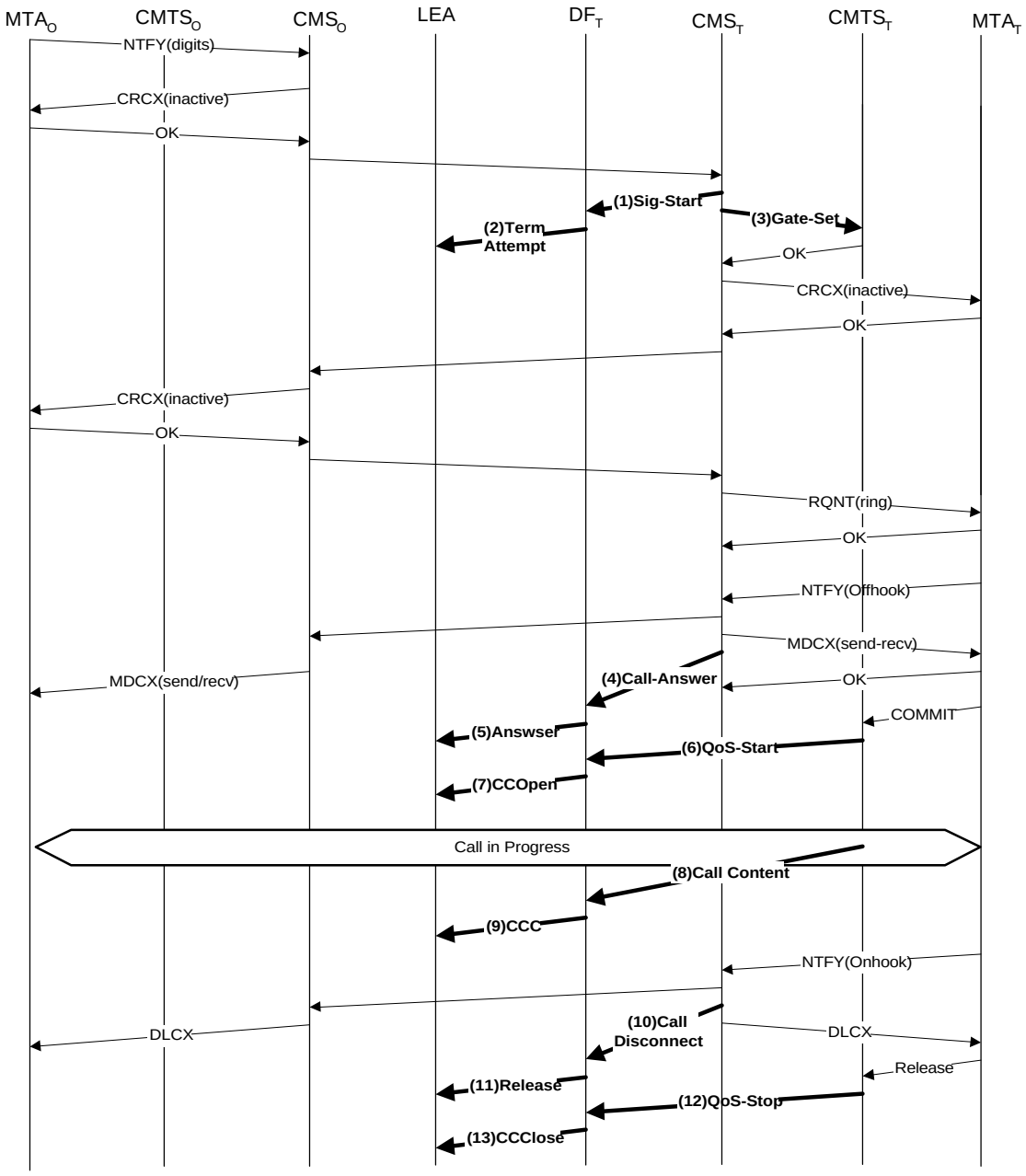
Flow	Flow Description
	Called_Party_Number +1-212-555-2222 User_Input 555-2222
2 (ESP)	DF_O sends LEA an Origination message PCES Message-Type Origination Case-ID Sub-1111 Accessing_Element_ID xxxxCMSo Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Calling_Party_ID +1-212-555-1111 Called_Party_ID +1-212-555-2222 User_Input 555-2222
3 (D-QoS)	When CMS_O knows the call destination and QoS requirements, it sends $CMTS_O$ a Gate-Set message. This includes an additional object specific to the Electronic Surveillance, telling $CMTS_O$ to send an additional copy of the event messages and a copy of all voice payload packets to DF_O. Transaction ID 3178 Subscriber MTAo Remote Gate Info – CMS address 128.96.22.15 CMS Port 2562 Remote Gate ID 8096 Flags No-Gate-Open Authentication Algorithm 0x64 Security Key WhenInTheCourseOfHumanEvents Billing Info – Billing Correlation ID TTTTxxxxCMSoCCCC RKS_Primary 128.96.60.110, 5000 RKS_Secondary 128.96.60.210, 5001 Real_time_Flag 0 (false) GateSpec Direction upstream Protocol UDP SourceAddress 128.96.41.1 (MTA-o) DestinationAddress 128.96.63.25 (MTA-t) SourcePort 0 Destination Port 1296 b 120 r 12000 p 12000 m 120 M 120 R 12000 S 0 GateSpec Direction downstream Protocol UDP SourceAddress 128.96.63.25 (MTA-t) DestinationAddress 128.96.41.1 (MTA-o) SourcePort 0 Destination Port 3456 b 120 r 12000 p 12000 m 120 M 120 R 12000 S 0 Electronic-Surveillance-Parameters DF-IP-Address-CDC 128.96.60.212 (DF_0) DF-IP-Port-CDC 3001 DF-IP-Address-CCC 128.96.60.212 (DF_0)

Flow	Flow Description
	DF-IP-Port-CCC 4001 Flags 3 (dup_event + dup_content) Session-Description-Parameters Downstream v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV Upstream v=0 o=- 4723891 7428910 IN IP4 128.96.63.25 s=- c=IN IP4 128.96.63.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
4 (EM)	CMS_O sends DF_O a Call-Answer Event Message. This is identical to the Event Message sent to the RKS, and is triggered by the same conditions. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Answer Element Type CMS Element ID xxxxCMSo Sequence ID AA02 Event Message Time and Date YYYYMMDDHHMMSS.MMM Called_Party_Number +1-212-555-2222 Routing_Number +1-212-555-2222 Charged_Number +1-212-555-1111 Location_Routing_Number +1-212-555-2222
5 (ESP)	DF_O sends LEA an Answer message PCES Message-Type Answer Case-ID Sub-1111 Accessing_Element_ID xxxxCMSo Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Answering_Party_ID +1-212-555-2222
6 (EM)	On receipt of the COMMIT message from MTA_O (which indicates the desire to start a media flow), $CMTS_O$ sends DF_O a QoS_Start Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMTSCCCC Event Message Type QoS_Start Element Type CMTS Element ID xxxCMTSo Sequence ID BB01 Event Message Time and Date YYYYMMDDHHMMSS.MMM QoS_Descriptor Status Bitmask 0x000000FF service_flow_scheduling_type UGS nominal_grant_interval 10,000 tolerated_grant_jitter 2,000

Flow	Flow Description
	grants_per_interval 1 unsolicited_grant_size 161 traffic_priority 5 MTA_Port_ID MTAo_PORT_NUMBER SDP-Downstream v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV SDP-Upstream v=0 o=- 4723891 7428910 IN IP4 128.96.63.25 s=- c=IN IP4 128.96.63.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV CCC-ID 37125
7 (ESP)	DF_O sends LEA a CCOpen message PCES Message-Type CCOpen Case-ID Sub-1111 Accessing_Element_ID xxxCMTSo Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Originating-SDP v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV Terminating-SDP v=0 o=- 4723891 7428910 IN IP4 128.96.63.25 s=- c=IN IP4 128.96.63.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV CCC-ID 31
8 (CODEC)	MTA_O sends Voice payload packet to MTA_T, intercepted by $CMTS_O$, duplicated, and the duplicate is passed to DF_O. CCC-ID 37125 Intercepted-Information <RTP/UDP/IP Packet as sent by/to MTA_O>
9 (ESP)	DF_O sends LEA a CCC packet CCC-ID 31 Intercepted-Information <RTP/UDP/IP Packet as sent by/to MTA_O>

Flow	Flow Description
10 (EM)	CMS_O sends DF_O a Call-Disconnect Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Disconnect Element Type CMS Element ID xxxxCMSo Sequence ID AA03 Event Message Time and Date YYYYMMDDHHMMSS.MMM Call_Terimination_Cause any
11 (ESP)	DF_O sends LEA a Release message PCES Message-Type Release Case-ID Sub-1111 Accessing_Element_ID xxxxCMSo Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC
12 (EM)	$CMTS_O$ sends DF_O a QoS_Stop Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type QoS_Stop Element Type CMTS Element ID xxxCMTSo Sequence ID BB02 Event Message Time and Date YYYYMMDDHHMMSS.MMM SF_ID SFID CCC-ID 37125
13 (ESP)	DF_O sends LEA a CCClose message PCES Message-Type CCClose Case-ID Sub-1111 Accessing_Element_ID xxxCMTSo Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC CCC-ID 31

6.2 Basic Call of On-net Subscriber to On-net Subscriber under Surveillance



Flow	Flow Description
1 (EM)	CMS_T sends DF_T a Signaling_Start Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Signaling_Start Element Type CMS Element ID xxxxCMSt Sequence ID AA01 Event Message Time and Date YYYYMMDDHHMMSS.MMM Direction_Indication termination MTA_Port_ID MTA_T_PORT_NUMBER Calling_Party_Number +1-212-555-1111 Called_Party_Number +1-212-555-2222
2 (ESP)	DF_T sends LEA a TerminationAttempt message PCES Message-Type TerminationAttempt Case_ID Sub-2222 Accessing_Element_ID xxxxCMSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Calling_Party_ID +1-212-555-1111 Called_Party_ID +1-212-555-2222
3 (D-QoS)	CMS_T sends $CMTS_T$ a GateSet message authorizing resources. This includes an additional object specific to the Electronic Surveillance, telling $CMTS_T$ to send an additional copy of the event messages and a copy of all voice payload packets to DF_T. Transaction ID 3177 Subscriber MTAt Remote Gate Info – CMS address 128.96.22.15 CMS Port 2562 Flags No-Gate-Open Remote Gate ID 8095 Authentication Algorithm 0x64 Security Key PackMyBoxWithFiveDozenLiquorJugs Billing Info – Billing Correlation ID TTTTxxxxCMSoCCCC RKS_Primary 128.96.60.110, 5000 RKS_Secondary 128.96.60.210, 5001 Real_time_Flag 0 (false) GateSpec Direction upstream Protocol UDP SourceAddress 128.96.63.25 (MTA-t) DestinationAddress 128.96.41.1 (MTA-o) SourcePort 0 Destination Port 3456 b 120 r 12000 p 12000 m 120 M 120 R 12000 S 0 GateSpec Direction downstream Protocol UDP SourceAddress 128.96.41.1 (MTA-o) DestinationAddress 128.96.63.25 (MTA-t) SourcePort 0 Destination Port 1296

Flow	Flow Description
	b 120 r 12000 p 12000 m 120 M 120 R 12000 S 0 Electronic-Surveillance-Parameters DF-IP-Address-CDC 128.96.60.212 DF-IP-Port-CDC 3001 DF-IP-Address-CCC 128.96.60.212 DF-IP-Port-CCC 4001 Flags 3 (dup_event + dup_content) Session-Description-Parameters Downstream v=0 o=- 4723891 7428910 IN IP4 128.96.63.25 s=- c=IN IP4 128.96.63.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV Upstream v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
4 (EM)	CMS_T sends DF_T a Call-Answer Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Answer Element Type CMS Element ID xxxxCMSt Sequence ID AA02 Event Message Time and Date YYYYMMDDHHMMSS.MMM Called_Party_Number +1-212-555-2222 Routing_Number +1-212-555-2222 Charged_Number +1-212-555-1111 Location_Routing_Number +1-212-555-2222
5 (ESP)	DF_T sends LEA an Answer message PCES Message-Type Answer Case-ID Sub-1111 Accessing_Element_ID xxxxCMSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Answering_Party_ID +1-212-555-2222
6 (EM)	On receipt of the COMMIT message from MTA_T (which indicates the desire to start a media flow), $CMTS_T$ sends DF_T a QoS_Start Event Message. RADIUS Message Header Accounting-Request

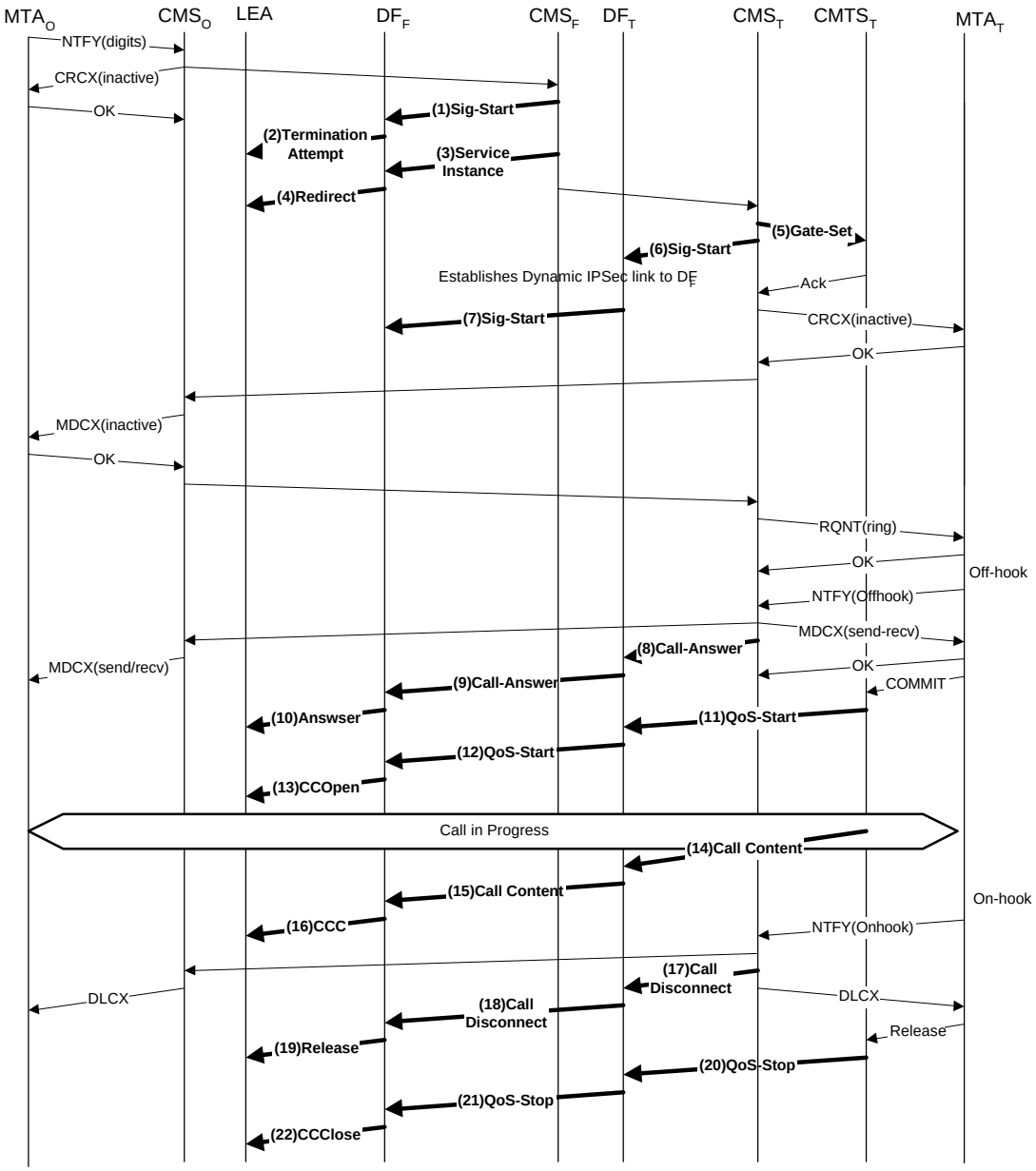
Flow	Flow Description

	PacketCable Event Message Header
	  Billing Correlation ID TTTTxxxxCMSoCCCC
	  Event Message Type QoS_Start
	  Element Type CMTS
	  Element ID xxxCMTSt
	  Sequence ID BB01
	  Event Message Time and Date YYYYMMDDHHMMSS.MMM
	QoS_Descriptor
	  Status Bitmask 0x000000FF
	  service_flow_scheduling_type UGS
	  nominal_grant_interval 10,000
	  tolerated_grant_jitter 2,000
	  grants_per_interval 1
	  unsolicited_grant_size 161
	  traffic_priority 5
	MTA_Port_ID MTAt_PORT_NUMBER
	SDP-Downstream v=0
	o=- 4723891 7428910 IN IP4 128.96.63.25
	s=-
	c=IN IP4 128.96.63.25
	t=0 0
	m=audio 1296 RTP/AVP 0
	a=X-pc-csuites-rtp: 62/51
	a=X-pc-csuites-rtcp: 02/03
	a=X-pc-spi-rtcp: 453A78F1
	a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf
	ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	SDP-Upstream v=0
	o=- 25678 753849 IN IP4 128.96.41.1
	s=-
	c=IN IP4 128.96.41.1
	t=0 0
	m=audio 3456 RTP/AVP 0
	a=X-pc-csuites-rtp: 62/51
	a=X-pc-csuites-rtcp: 02/03 01/03
	a=X-pc-spi-rtcp: A7843B2
	a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf
	ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	CCC-ID 2094

7 (ESP)	DF_T sends LEA a CCOpen message PCES Message-Type CCOpen Case-ID Sub-2222 Accessing_Element_ID xxxCMTSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Terminating-SDP v=0 o=- 4723891 7428910 IN IP4 128.96.63.25 s=- c=IN IP4 128.96.63.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV Originating-SDP v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV

Flow	Flow Description
	CCC-ID 314
8 (CODEC)	MTA_T sends Voice payload packet to MTA_O, intercepted by $CMTS_T$, duplicated, and the duplicate is passed to DF_T. CCC-ID 2094 Intercepted-Information <RTP/UDP/IP Packet as sent by/to MTA_T>
9 (ESP)	DF_T sends LEA a CCC packet CCC-ID 314 Intercepted-Information <RTP/UDP/IP Packet as sent by/to MTA_T>
10 (EM)	CMS_T sends DF_T a Call-Disconnect Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Disconnect Element Type CMS Element ID xxxxCMSt Sequence ID AA03 Event Message Time and Date YYYYMMDDHHMMSS.MMM Call_Termination_Cause any
11 (ESP)	DF_T sends LEA a Release message PCES Message-Type Release Case-ID Sub-2222 Accessing_Element_ID xxxxCMSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC
12 (EM)	$CMTS_O$ sends DF_O a QoS_Stop Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type QoS_Stop Element Type CMTS Element ID xxxCMTSt Sequence ID BB02 Event Message Time and Date YYYYMMDDHHMMSS.MMM SF_ID SFID CCC-ID 2094
13 (ESP)	DF_T sends LEA a CCClose message PCES Message-Type CCClose Case-ID Sub-2222 Accessing_Element_ID xxxCMTSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC CCC-ID 314

6.3 Call from On-net Subscriber to On-net Subscriber under Surveillance, Redirected to On-net Subscriber



Flow	Flow Description
1 (EM)	CMS_F sends DF_F a Signaling_Start Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Signaling_Start Element Type CMS Element ID xxxxCMSf Sequence ID AA01 Event Message Time and Date YYYYMMDDHHMMSS.MMM Direction_Indicator termination MTA_Port_ID MTA_F_PORT_NUMBER

Flow	Flow Description
	Calling_Party_Number +1-212-555-1111 Called_Party_Number +1-212-555-2222
2 (ESP)	DF_F sends LEA a TerminationAttempt message PCES Message-Type TerminationAttempt Case_ID Sub-2222 Accessing_Element_ID xxxxCMSf Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Calling_Party_ID +1-212-555-1111 Called_Party_ID +1-212-555-2222
3 (EM)	CMS_F sends DF_F a Service-Instance Event Message RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Service-Instance Element Type CMS Element ID xxxxCMSf Sequence ID AA02 Event Message Time and Date YYYYMMDDHHMMSS.MMM Service-Name Call-Forward Redirected-From-Party-Number +1-212-555-2222 Redirected-To-Party-Number +1-212-555-3333 PCES-DF-Security FourScoreAndSevenYearsAgo
4 (ESP)	DF_F sends LEA a Redirect message PCES Message-Type Redirect Case_ID Sub-2222 Accessing_Element_ID xxxxCMSf Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Redirected_From_Party_ID +1-212-555-2222 Redirected_To_Party_ID +1-212-555-3333
5 (D-QoS)	CMS_T sends $CMTS_T$ a GateSet message authorizing resources. This includes an additional object specific to the Electronic Surveillance, telling $CMTS_T$ to send an additional copy of the event messages and a copy of all voice payload packets to DF_T Transaction ID 3177 Subscriber MTA_T Remote Gate Info – CMS address 128.96.22.15 CMS Port 2562 Flags No-Gate-Open Remote Gate ID 8095 Authentication Algorithm 0x64 Security Key PackMyBoxWithFiveDozenLiquorJugs Billing Info – Billing Correlation ID TTTTxxxxCMSoCCCC RKS_Primary 128.96.60.110, 5000 RKS_Secondary 128.96.60.210, 5001 Real_time_Flag 0 (false) GateSpec Direction upstream Protocol UDP SourceAddress 128.96.67.25 (MTA-t) DestinationAddress 128.96.41.1 (MTA-o) SourcePort 0 Destination Port 3456 b 120 r 12000 p 12000 m 120

Flow	Flow Description
	M 120 R 12000 S 0 GateSpec Direction downstream Protocol UDP SourceAddress 128.96.41.1 (MTA-o) DestinationAddress 128.96.67.25 (MTA-t) SourcePort 0 Destination Port 1296 b 120 r 12000 p 12000 m 120 M 120 R 12000 S 0 Electronic-Surveillance-Parameters DF-IP-Address-CDC – 128.96.68.212 DF-IP-Port-CDC - 3001 DF-IP-Address-CCC - 128.96.68.212 DF-IP-Port-CCC - 4001 Flags - 3 (dup_event + dup_content) Session-Description-Parameters Downstream v=0 o=- 4723891 7428910 IN IP4 128.96.67.25 s=- c=IN IP4 128.96.67.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV Upstream v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
6 (EM)	CMS_T sends DF_T a Signaling-Start Event Message RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Signaling_Start Element Type CMS Element ID xxxxCMSt Sequence ID AA01 Event Message Time and Date YYYYMMDDHHMMSS.MMM Direction_Indication termination MTA_Port_ID MTA_T_PORT_NUMBER Calling_Party_Number +1-212-555-1111 Called_Party_Number +1-212-555-3333 Redirected_From_Information Last_Redirecting_Party +1-212-555-2222 Original_Called_Party +1-212-555-2222 Number_Redirections 1

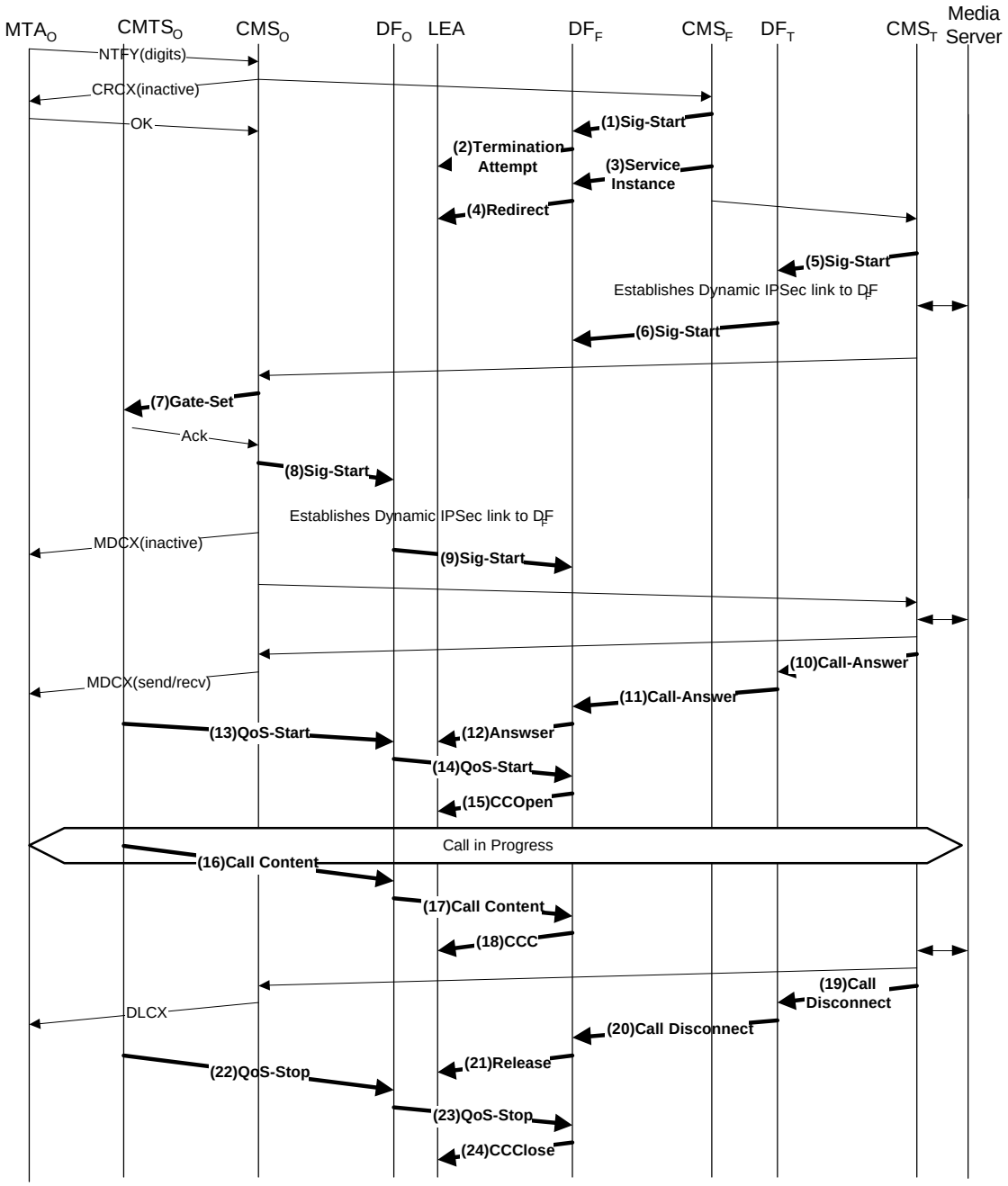
Flow	Flow Description
	PCES_Indication DF_Address 128.96.60.212 CDC_Port 3001 CCC_Port 4001 DF_DF_Key FourScoreAndSevenYearsAgo
7 (ESP/EM)	DF_T establishes an IPSec security association with DF_F, and sends the Signaling-Start Event RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Signaling_Start Element Type CMS Element ID xxxxCMSt Sequence ID AA01 Event Message Time and Date YYYYMMDDHHMMSS.MMM Direction_Indication termination MTA_Port_ID MTA_T_PORT_NUMBER Calling_Party_Number +1-212-555-1111 Called_Party_Number +1-212-555-3333 Redirected_From_Information Last_Redirecting_Party +1-212-555-2222 Original_Called_Party +1-212-555-2222 Number_Redirections 1 PCES_Indication DF_Address 128.96.60.212 CDC_Port 3001 CCC_Port 4001 DF_DF_Key FourScoreAndSevenYearsAgo
8 (EM)	CMS_T sends DF_T a Call-Answer Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Answer Element Type CMS Element ID xxxxCMSt Sequence ID AA02 Event Message Time and Date YYYYMMDDHHMMSS.MMM Called_Party_Number +1-212-555-3333 Routing_Number +1-212-555-3333 Charged_Number +1-212-555-1111 Location_Routing_Number +1-212-555-3333
9 (EM)	DF_T sends DF_F a Call-Answer Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Answer Element Type CMS Element ID xxxxCMSt Sequence ID AA02 Event Message Time and Date YYYYMMDDHHMMSS.MMM Called_Party_Number +1-212-555-3333 Routing_Number +1-212-555-3333 Charged_Number +1-212-555-1111 Location_Routing_Number +1-212-555-3333
10 (ESP)	DF_F sends LEA an Answer message PCES Message-Type Answer Case-ID Sub-2222 Accessing_Element_ID xxxxCMSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Answering_Party_ID +1-212-555-3333

Flow	Flow Description
11 (EM)	On receipt of the COMMIT message from MTA_T (which indicates the desire to start a media flow), $CMTS_T$ sends DF_T a QoS_Start Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMTSCCCC Event Message Type QoS_Start Element Type CMTS Element ID xxxCMTSt Sequence ID BB01 Event Message Time and Date YYYYMMDDHHMMSS.MMM QoS_Descriptor Status Bitmask 0x000000FF service_flow_scheduling_type UGS nominal_grant_interval 10,000 tolerated_grant_jitter 2,000 grants_per_interval 1 unsolicited_grant_size 161 traffic_priority 5 MTA_Port_ID MTAt_PORT_NUMBER SDP-Downstream v=0 o=- 4723891 7428910 IN IP4 128.96.67.25 s=- c=IN IP4 128.96.67.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV SDP-Upstream v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV CCC-ID 9106
12 (EM)	DF sends DF a QoS_Start Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMTSCCCC Event Message Type QoS_Start Element Type CMTS Element ID xxxCMTSt Sequence ID BB01 Event Message Time and Date YYYYMMDDHHMMSS.MMM QoS_Descriptor Status Bitmask 0x000000FF service_flow_scheduling_type UGS nominal_grant_interval 10,000 tolerated_grant_jitter 2,000 grants_per_interval 1 unsolicited_grant_size 161 traffic_priority 5 MTA_Port_ID MTAt_PORT_NUMBER SDP-Downstream v=0 o=- 4723891 7428910 IN IP4 128.96.67.25 s=- c=IN IP4 128.96.67.25 t=0 0 m=audio 1296 RTP/AVP 0

Flow	Flow Description	
		a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	SDP-Upstream	v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	CCC-ID	57
13 (ESP)	DF_F sends LEA a CCOpen message	
	PCES Message-Type	CCOpen
	Case-ID	Sub-2222
	Accessing_Element_ID	xxxCMTSt
	Event_Time	YYYYMMDDHHMMSS.MMM
	Call_ID	TTTTxxxxCMSoCCCC
	Terminating-SDP	v=0 o=- 4723891 7428910 IN IP4 128.96.67.25 s=- c=IN IP4 128.96.67.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	Originating-SDP	v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	CCC-ID	17
14	MTA_T sends Voice payload packet to MTA_O, intercepted by $CMTS_T$, duplicated, and the duplicate is passed to DF_T.	
	CCC-ID	9106
	Intercepted-Information	<RTP/UDP/IP Packet as sent by/to MTA_T>
15	DF_T passes the Voice payload packet to DF_F.	
	CCC-ID	57
	Intercepted-Information	<RTP/UDP/IP Packet as sent by/to MTA_T>
16 (ESP)	DF_F sends LEA a CCC packet	
	CCC-ID	17
	Intercepted-Information	<RTP/UDP/IP Packet as sent by/to MTA_T>
17 (EM)	CMS_T sends DF_T a Call-Disconnect Event Message.	
	RADIUS Message Header	Accounting-Request
	PacketCable Event Message Header	

Flow	Flow Description
	Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Disconnect Element Type CMS Element ID xxxxCMSt Sequence ID AA03 Event Message Time and Date YYYYMMDDHHMMSS.MMM Call_Termination_Cause any
18 (EM)	DF_T sends DF_F a Call-Disconnect Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Disconnect Element Type CMS Element ID xxxxCMSt Sequence ID AA03 Event Message Time and Date YYYYMMDDHHMMSS.MMM Call_Termination_Cause any
19 (ESP)	DF_F sends LEA a Release message PCES Message-Type Release Case-ID Sub-2222 Accessing_Element_ID xxxxCMSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC
20 (EM)	$CMTS_T$ sends DF_T a QoS_Stop Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type QoS_Stop Element Type CMTS Element ID xxxCMTSt Sequence ID BB02 Event Message Time and Date YYYYMMDDHHMMSS.MMM SF_ID SFID CCC-ID 9106
21 (EM)	DF_T sends DF_F a QoS_Stop Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type QoS_Stop Element Type CMTS Element ID xxxCMTSt Sequence ID BB02 Event Message Time and Date YYYYMMDDHHMMSS.MMM SF_ID SFID CCC-ID 57
22 (ESP)	DF_F sends LEA a CCClose message PCES Message-Type CCClose Case-ID Sub-2222 Accessing_Element_ID xxxCMTSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC CCC-ID 17

6.4 Call from On-net Subscriber to On-net Subscriber under Surveillance, Redirected to On-net VoiceMail Server



Flow	Flow Description
1 (EM)	CMS$_F$ sends DF$_F$ a Signaling_Start Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Signaling_Start Element Type CMS Element ID xxxxCMSf

Flow	Flow Description
	Sequence ID AA01 Event Message Time and Date YYYYMMDDHHMMSS.MMM Direction_Indicator termination MTA_Port_ID MTA_F_PORT_NUMBER Calling_Party_Number +1-212-555-1111 Called_Party_Number +1-212-555-2222
2 (ESP)	DF_F sends LEA a TerminationAttempt message PCES Message-Type TerminationAttempt Case_ID Sub-2222 Accessing_Element_ID xxxxCMSf Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Calling_Party_ID +1-212-555-1111 Called_Party_ID +1-212-555-2222
3 (EM)	CMS_F sends DF_F a Service-Instance Event Message RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Service-Instance Element Type CMS Element ID xxxxCMSf Sequence ID AA02 Event Message Time and Date YYYYMMDDHHMMSS.MMM Service-Name Call-Forward Redirected-From-Party-Number +1-212-555-2222 Redirected-To-Party-Number +1-212-555-9090 PCES-DF-Security FourScoreAndSevenYearsAgo
4 (ESP)	DF_F sends LEA a Redirect message PCES Message-Type Redirect Case_ID Sub-2222 Accessing_Element_ID xxxxCMSf Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Redirected_From_Party_ID +1-212-555-2222 Redirected_To_Party_ID +1-212-555-9090
5 (EM)	CMS_T sends DF_T a Signaling-Start Event Message RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Signaling_Start Element Type CMS Element ID xxxxCMSt Sequence ID AA01 Event Message Time and Date YYYYMMDDHHMMSS.MMM Direction_Indication termination MTA_Port_ID MTA_T_PORT_NUMBER Calling_Party_Number +1-212-555-1111 Called_Party_Number +1-212-555-9090 Redirected_From_Information Last_Redirecting_Party +1-212-555-2222 Original_Called_Party +1-212-555-2222 Number_Redirections 1 PCES_Indication DF_Address 128.96.60.212 CDC_Port 3001 CCC_Port 4001 DF_DF_Key FourScoreAndSevenYearsAgo
6 (ESP/EM)	DF_T establishes an IPSec security association with DF_F, and sends the Signaling-Start Event RADIUS Message Header Accounting-Request

Flow	Flow Description

	PacketCable Event Message Header
	  Billing Correlation ID TTTTxxxxCMSoCCCC
	  Event Message Type Signaling_Start
	  Element Type CMS
	  Element ID xxxxCMSt
	  Sequence ID AA01
	  Event Message Time and Date YYYYMMDDHHMMSS.MMM
	Direction_Indication termination
	MTA_Port_ID MTA_T_PORT_NUMBER
	Calling_Party_Number +1-212-555-1111
	Called_Party_Number +1-212-555-9090
	Redirected_From_Information
	  Last_Redirecting_Party +1-212-555-2222
	  Original_Called_Party +1-212-555-2222
	  Number_Redirections 1
	PCES_Indication
	  DF_Address 128.96.60.212
	  CDC_Port 3001
	  CCC_Port 4001
	  DF_DF_Key FourScoreAndSevenYearsAgo

7 (D-QoS)	CMS_O sends $CMTS_O$ a GateSet message authorizing resources. This includes an additional object specific to the Electronic Surveillance, telling $CMTS_O$ to send an additional copy of the event messages and a copy of all voice payload packets to DF_O
	
	Transaction ID 3177
	Subscriber MTA_0
	Remote Gate Info –
	  CMS address 128.96.22.15
	  CMS Port 2562
	  Flags No-Gate-Open
	  Remote Gate ID 8095
	  Authentication Algorithm 0x64
	  Security Key PackMyBoxWithFiveDozenLiquorJugs
	
	Billing Info –
	  Billing Correlation ID TTTTxxxxCMSoCCCC
	  RKS_Primary 128.96.60.110, 5000
	  RKS_Secondary 128.96.60.210, 5001
	  Real_time_Flag 0 (false)
	
	GateSpec
	  Direction upstream
	  Protocol UDP
	  SourceAddress 128.96.41.1 (MTA-o)
	  DestinationAddress 128.96.82.3 (VoiceMail)
	  SourcePort 0
	  Destination Port 3456
	  b 120
	  r 12000
	  p 12000
	  m 120
	  M 120
	  R 12000
	  S 0
	
	GateSpec
	  Direction downstream
	  Protocol UDP
	  SourceAddress 128.96.82.3 (VoiceMail)
	  DestinationAddress 128.96.41.1 (MTA-o)
	  SourcePort 0
	  Destination Port 1296
	  b 120
	  r 12000
	  p 12000
	  m 120
	  M 120
	  R 12000

Flow	Flow Description
	S 0 Electronic-Surveillance-Parameters DF-IP-Address-CDC – 128.96.68.212 DF-IP-Port-CDC - 3001 DF-IP-Address-CCC - 128.96.68.212 DF-IP-Port-CCC - 4001 Flags - 3 (dup_event + dup_content) Session-Description-Parameters Downstream v=0 o=- 4723891 7428910 IN IP4 128.96.67.25 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV Upstream v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.82.3 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
8 (EM)	CMS_O sends DF_O a Signaling-Start Event Message RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Signaling_Start Element Type CMS Element ID xxxxCMSo Sequence ID AA01 Event Message Time and Date YYYYMMDDHHMMSS.MMM Direction_Indication termination MTA_Port_ID 3456 Calling_Party_Number +1-212-555-1111 Called_Party_Number +1-212-555-9090 Redirected_From_Information Last_Redirecting_Party +1-212-555-2222 Original_Called_Party +1-212-555-2222 Number_Redirections 1 PCES_Indication DF_Address 128.96.60.212 CDC_Port 3001 CCC_Port 4001 DF_DF_Key FourScoreAndSevenYearsAgo
9 (ESP/EM)	DF_O establishes an IPSec security association with DF_F, and sends the Signaling-Start Event RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Signaling_Start Element Type CMS Element ID xxxxCMSt Sequence ID AA01 Event Message Time and Date YYYYMMDDHHMMSS.MMM Direction_Indication termination

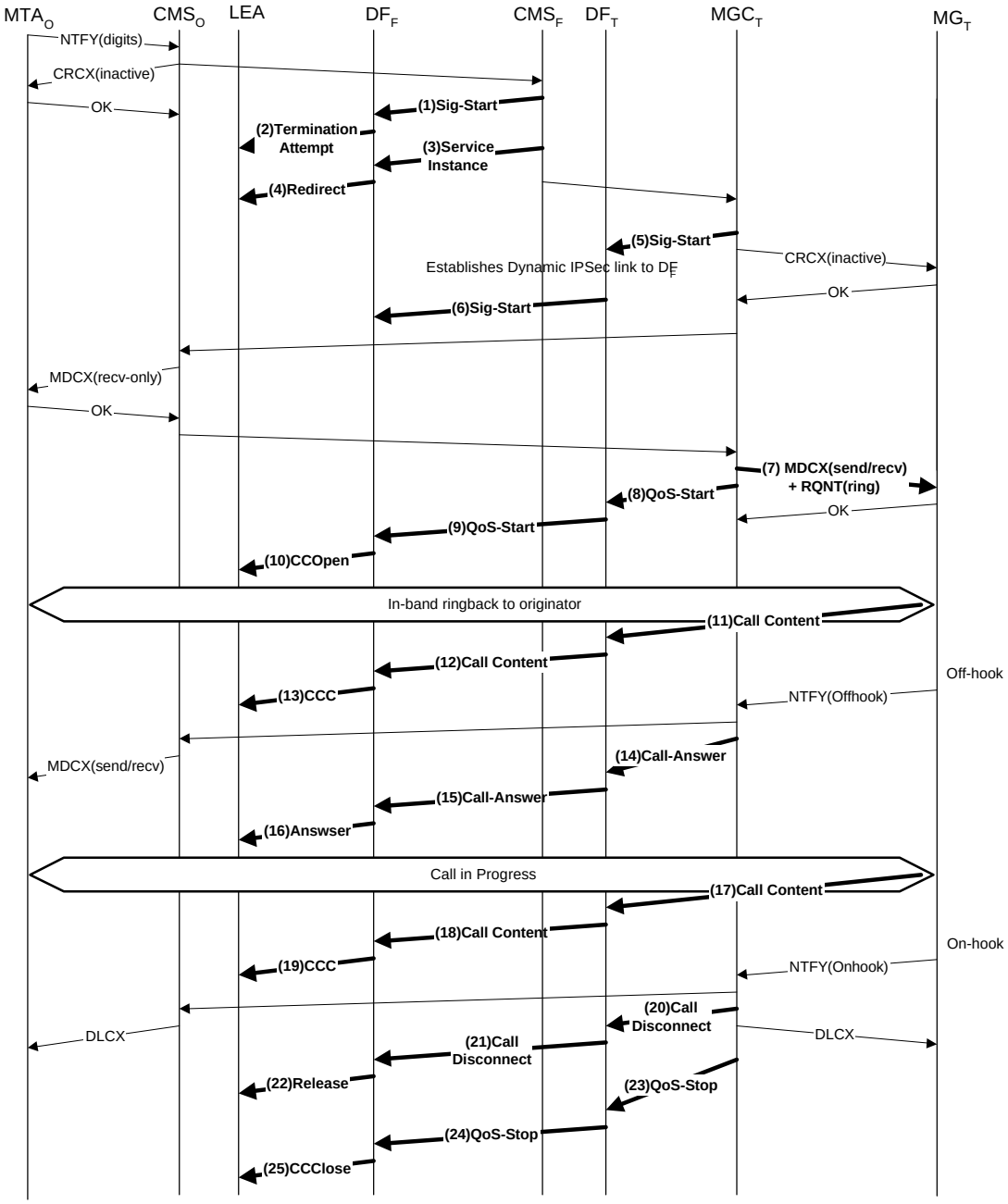
Flow	Flow Description
	MTA_Port_ID 3456 Calling_Party_Number +1-212-555-1111 Called_Party_Number +1-212-555-9090 Redirected_From_Information Last_Redirecting_Party +1-212-555-2222 Original_Called_Party +1-212-555-2222 Number_Redirections 1 PCES_Indication DF_Address 128.96.60.212 CDC_Port 3001 CCC_Port 4001 DF_DF_Key FourScoreAndSevenYearsAgo
10 (EM)	CMS_T sends DF_T a Call-Answer Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Answer Element Type CMS Element ID xxxxCMSt Sequence ID AA02 Event Message Time and Date YYYYMMDDHHMMSS.MMM Called_Party_Number +1-212-555-9090 Routing_Number +1-212-555-9090 Charged_Number +1-212-555-1111 Location_Routing_Number +1-212-555-9090
11 (EM)	DF_T sends DF_F a Call-Answer Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Answer Element Type CMS Element ID xxxxCMSt Sequence ID AA02 Event Message Time and Date YYYYMMDDHHMMSS.MMM Called_Party_Number +1-212-555-9090 Routing_Number +1-212-555-9090 Charged_Number +1-212-555-1111 Location_Routing_Number +1-212-555-9090
12 (ESP)	DF_F sends LEA an Answer message PCES Message-Type Answer Case-ID Sub-2222 Accessing_Element_ID xxxxCMSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Answering_Party_ID +1-212-555-9090
13 (EM)	On receipt of the COMMIT message from MTA_O (which indicates the desire to start a media flow), $CMTS_O$ sends DF_O a QoS_Start Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMTSCCCC Event Message Type QoS_Start Element Type CMTS Element ID xxxCMTSo Sequence ID BB01 Event Message Time and Date YYYYMMDDHHMMSS.MMM QoS_Descriptor Status Bitmask 0x000000FF service_flow_scheduling_type UGS nominal_grant_interval 10,000 tolerated_grant_jitter 2,000 grants_per_interval 1

Flow	Flow Description	
	unsolicited_grant_size	161
	traffic_priority	5
	MTA_Port_ID	MTAt_PORT_NUMBER
	SDP-Downstream	v=0 o=- 4723891 7428910 IN IP4 128.96.67.25 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	SDP-Upstream	v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.82.3 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	CCC-ID	9106
14 (EM)	DF_O sends DF_F a QoS_Start Event Message.	
	RADIUS Message Header	Accounting-Request
	PacketCable Event Message Header	
	Billing Correlation ID	TTTTxxxxCMTSCCCC
	Event Message Type	QoS_Start
	Element Type	CMTS
	Element ID	xxxCMTSo
	Sequence ID	BB01
	Event Message Time and Date	YYYYMMDDHHMMSS.MMM
	QoS_Descriptor	
	Status Bitmask	0x000000FF
	service_flow_scheduling_type	UGS
	nominal_grant_interval	10,000
	tolerated_grant_jitter	2,000
	grants_per_interval	1
	unsolicited_grant_size	161
	traffic_priority	5
	MTA_Port_ID	MTAt_PORT_NUMBER
	SDP-Downstream	v=0 o=- 4723891 7428910 IN IP4 128.96.67.25 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	SDP-Upstream	v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.82.3 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	CCC-ID	57

Flow	Flow Description
15 (ESP)	DF_F sends LEA a CCOpen message PCES Message-Type: CCOpen Case-ID: Sub-2222 Accessing_Element_ID: xxxCMTSo Event_Time: YYYYMMDDHHMMSS.MMM Call_ID: TTTTxxxxCMSoCCCC Terminating-SDP: v=0 o=- 4723891 7428910 IN IP4 128.96.67.25 s=- c=IN IP4 128.96.82.3 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV Originating-SDP: v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV CCC-ID: 17
16	MTA_O sends Voice payload packet to VoiceMail, intercepted by $CMTS_O$, duplicated, and the duplicate is passed to DF_O. CCC-ID: 9106 Intercepted-Information: <RTP/UDP/IP Packet as sent by/to MTA_O>
17	DF_O passes the Voice payload packet to DF_F. CCC-ID: 57 Intercepted-Information: <RTP/UDP/IP Packet as sent by/to MTA_O>
18 (ESP)	DF_F sends LEA a CCC packet CCC-ID: 17 Intercepted-Information: <RTP/UDP/IP Packet as sent by/to MTA_O>
19 (EM)	CMS_T sends DF_T a Call-Disconnect Event Message. RADIUS Message Header: Accounting-Request PacketCable Event Message Header Billing Correlation ID: TTTTxxxxCMSoCCCC Event Message Type: Call-Disconnect Element Type: CMS Element ID: xxxxCMSt Sequence ID: AA03 Event Message Time and Date: YYYYMMDDHHMMSS.MMM Call_Termination_Cause: any
20 (EM)	DF_T sends DF_F a Call-Disconnect Event Message. RADIUS Message Header: Accounting-Request PacketCable Event Message Header Billing Correlation ID: TTTTxxxxCMSoCCCC Event Message Type: Call-Disconnect Element Type: CMS Element ID: xxxxCMSt Sequence ID: AA03

Flow	Flow Description
	Event Message Time and Date YYYYMMDDHHMMSS.MMM Call_Terimination_Cause any
21 (ESP)	DF_F sends LEA a Release message PCES Message-Type Release Case-ID Sub-2222 Accessing_Element_ID xxxxCMSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC
22 (EM)	$CMTS_O$ sends DF_O a QoS_Stop Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type QoS_Stop Element Type CMTS Element ID xxxCMTSo Sequence ID BB02 Event Message Time and Date YYYYMMDDHHMMSS.MMM SF_ID SFID CCC-ID 9106
23 (EM)	DF_O sends DF_F a QoS_Stop Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type QoS_Stop Element Type CMTS Element ID xxxCMTSo Sequence ID BB02 Event Message Time and Date YYYYMMDDHHMMSS.MMM SF_ID SFID CCC-ID 57
24 (ESP)	DF_F sends LEA a CCClose message PCES Message-Type CCClose Case-ID Sub-2222 Accessing_Element_ID xxxCMTSo Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC CCC-ID 17

6.5 Call from On-net Subscriber to On-net Subscriber under Surveillance, Redirected to Off-net Destination



Flow	Flow Description
1 (EM)	CMS$_F$ sends DF$_F$ a Signaling_Start Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Signaling_Start Element Type CMS Element ID xxxxCMSf Sequence ID AA01

Flow	Flow Description
	Event Message Time and Date YYYYMMDDHHMMSS.MMM Direction_Indicator termination MTA_Port_ID MTA_F_PORT_NUMBER Calling_Party_Number +1-212-555-1111 Called_Party_Number +1-212-555-2222
2 (ESP)	DF_F sends LEA a TerminationAttempt message PCES Message-Type TerminationAttempt Case_ID Sub-2222 Accessing_Element_ID xxxxCMSf Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Calling_Party_ID +1-212-555-1111 Called_Party_ID +1-212-555-2222
3 (EM)	CMS_F sends DF_F a Service-Instance Event Message RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Service-Instance Element Type CMS Element ID xxxxCMSf Sequence ID AA02 Event Message Time and Date YYYYMMDDHHMMSS.MMM Service-Name Call-Forward Redirected-From-Party-Number +1-212-555-2222 Redirected-To-Party-Number +1-212-555-3333 PCES-DF-Security FourScoreAndSevenYearsAgo
4 (ESP)	DF_F sends LEA a Redirect message PCES Message-Type Redirect Case_ID Sub-2222 Accessing_Element_ID xxxxCMSf Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Redirected_From_Party_ID +1-212-555-2222 Redirected_To_Party_ID +1-212-555-3333
5 (EM)	MGC_T sends DF_T a Signaling-Start Event Message RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Signaling_Start Element Type CMS Element ID xxxxCMSt Sequence ID AA01 Event Message Time and Date YYYYMMDDHHMMSS.MMM Event_Time YYYYMMDDHHMMSS.MMM Direction_Indication termination MTA_Port_ID MTA_T_PORT_NUMBER Calling_Party_Number +1-212-555-1111 Called_Party_Number +1-212-555-3333 Redirected_From_Information Last_Redirecting_Party +1-212-555-2222 Original_Called_Party +1-212-555-2222 Number_Redirections 1 PCES_Indication DF_Address 128.96.60.212 CDC_Port 3001 CCC_Port 4001 DF_DF_Key FourScoreAndSevenYearsAgo
6 (ESP/EM)	DF_T establishes an IPSec security association with DF_F, and sends the Signaling-Start Event RADIUS Message Header Accounting-Request

Flow	Flow Description

	PacketCable Event Message Header
	  Billing Correlation ID TTTTxxxxCMSoCCCC
	  Event Message Type Signaling_Start
	  Element Type CMS
	  Element ID xxxxCMSt
	  Sequence ID AA01
	  Event Message Time and Date YYYYMMDDHHMMSS.MMM
	Direction_Indication termination
	MTA_Port_ID MTA_T_PORT_NUMBER
	Calling_Party_Number +1-212-555-1111
	Called_Party_Number +1-212-555-3333
	Redirected_From_Information
	  Last_Redirecting_Party +1-212-555-2222
	  Original_Called_Party +1-212-555-2222
	  Number_Redirections 1
	PCES_Indication
	  DF_Address 128.96.60.212
	  CDC_Port 3001
	  CCC_Port 4001
	  DF_DF_Key FourScoreAndSevenYearsAgo

7 (TGCP)	MGC_T updates the connection mode to be sendonly, in order to pass the ringback signal to the originator MDCX 5051 ds/12/1@ec-2.mso.net MGCP 0.1 NCS 1.X N:ca@ca2.mso.net:5678 C: A3C47F21456789F0 I: FDE234C8 M: sendonly X: 0123456789B0 L: es-ccd:128.96.73.215:4001 es-cci:00002392

8 (EM)	When MGC_T tells MG_T to begin sending Voice packets (for the audible ringback tones), MGC_T sends DF_T a QoS_Start Event Message.
	
	RADIUS Message Header Accounting-Request
	PacketCable Event Message Header
	  Billing Correlation ID TTTTxxxxCMTSCCCC
	  Event Message Type QoS_Start
	  Element Type CMTS
	  Element ID xxxCMTSt
	  Sequence ID BB01
	  Event Message Time and Date YYYYMMDDHHMMSS.MMM
	QoS_Descriptor
	  Status Bitmask 0x00000080
	  traffic_priority 5
	MTA_Port_ID MGt_PORT_NUMBER
	SDP-Downstream v=0
	o=- 4723891 7428910 IN IP4 128.96.67.25
	s=-
	c=IN IP4 128.96.67.25
	t=0 0
	m=audio 1296 RTP/AVP 0
	a=X-pc-csuites-rtp: 62/51
	a=X-pc-csuites-rtcp: 02/03
	a=X-pc-spi-rtcp: 453A78F1
	a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	SDP-Upstream v=0
	o=- 25678 753849 IN IP4 128.96.41.1
	s=-
	c=IN IP4 128.96.41.1
	t=0 0
	m=audio 3456 RTP/AVP 0
	a=X-pc-csuites-rtp: 62/51
	a=X-pc-csuites-rtcp: 02/03 01/03
	a=X-pc-spi-rtcp: A7843B2
	a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	CCC-ID 9106

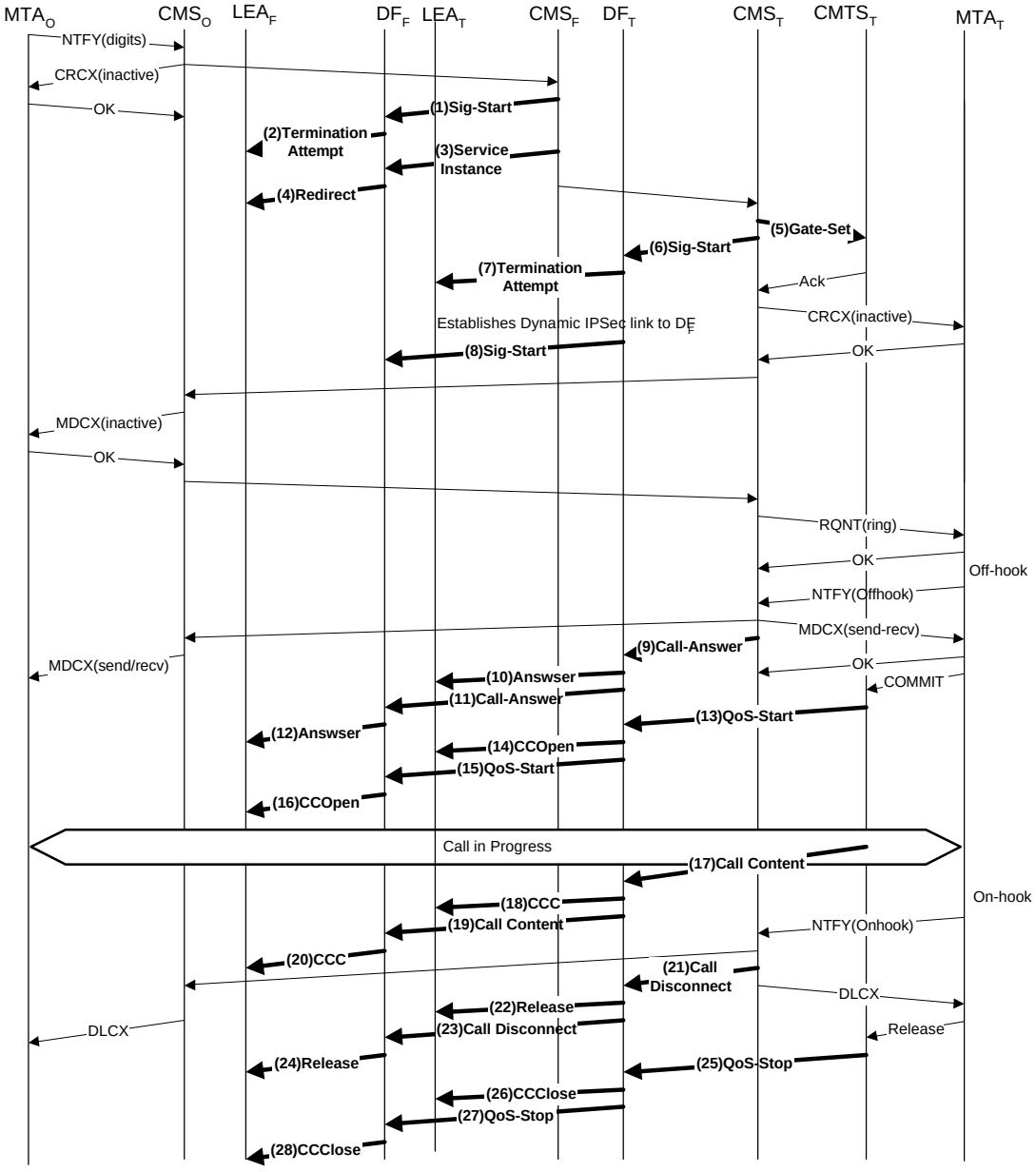
Flow	Flow Description
9 (EM)	DF_T sends DF_F a QoS_Start Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMTSCCCC Event Message Type QoS_Start Element Type CMTS Element ID xxxCMTSt Sequence ID BB01 Event Message Time and Date YYYYMMDDHHMMSS.MMM QoS_Descriptor Status Bitmask 0x000000FF service_flow_scheduling_type UGS nominal_grant_interval 10,000 tolerated_grant_jitter 2,000 grants_per_interval 1 unsolicited_grant_size 161 traffic_priority 5 MTA_Port_ID MGt_PORT_NUMBER SDP-Downstream v=0 o=- 4723891 7428910 IN IP4 128.96.67.25 s=- c=IN IP4 128.96.67.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV SDP-Upstream v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV CCC-ID 57
10 (ESP)	DF_F sends LEA a CCOpen message PCES Message-Type CCOpen Case-ID Sub-2222 Accessing_Element_ID xxxCMTSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Terminating-SDP v=0 o=- 4723891 7428910 IN IP4 128.96.67.25 s=- c=IN IP4 128.96.67.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV Originating-SDP v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03

Flow	Flow Description
	a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV CCC-ID 17
11	MG_T sends inband ringback packet to MTA_O, which are duplicated, and the duplicate is passed to DF_T. CCC-ID 9106 Intercepted-Information <RTP/UDP/IP Packet as sent by MG_T>
12	DF_T passes the Voice payload packet to DF_F. CCC-ID 57 Intercepted-Information <RTP/UDP/IP Packet as sent by MG_T>
13 (ESP)	DF_F sends LEA a CCC packet CCC-ID 17 Intercepted-Information <RTP/UDP/IP Packet as sent by MG_T>
14 (EM)	MGC_T sends DF_T a Call-Answer Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Answer Element Type CMS Element ID xxxxCMSt Sequence ID AA02 Event Message Time and Date YYYYMMDDHHMMSS.MMM Called_Party_Number +1-212-555-3333 Routing_Number +1-212-555-3333 Charged_Number +1-212-555-1111 Location_Routing_Number +1-212-555-3333
15 (EM)	DF_T sends DF_F a Call-Answer Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Answer Element Type CMS Element ID xxxxCMSt Sequence ID AA02 Event Message Time and Date YYYYMMDDHHMMSS.MMM Called_Party_Number +1-212-555-3333 Routing_Number +1-212-555-3333 Charged_Number +1-212-555-1111 Location_Routing_Number +1-212-555-3333
16 (ESP)	DF_F sends LEA an Answer message PCES Message-Type Answer Case-ID Sub-2222 Accessing_Element_ID xxxxCMSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Answering_Party_ID +1-212-555-3333
17	MG_T sends Voice payload packet to MTA_O, and passes a duplicate to DF_T. CCC-ID 9106 Intercepted-Information <RTP/UDP/IP Packet as sent by/to MTA_T>
18	DF_T passes the Voice payload packet to DF_F. CCC-ID 57 Intercepted-Information <RTP/UDP/IP Packet as sent by/to MTA_T>

Flow	Flow Description
19 (ESP)	DF_F sends LEA a CCC packet CCC-ID 17 Intercepted-Information <RTP/UDP/IP Packet as sent by/to MTA_T>
20 (EM)	MGC_T sends DF_T a Call-Disconnect Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Disconnect Element Type CMS Element ID xxxxCMSt Sequence ID AA03 Event Message Time and Date YYYYMMDDHHMMSS.MMM Call_Terimination_Cause any
21 (EM)	DF_T sends DF_F a Call-Disconnect Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Disconnect Element Type CMS Element ID xxxxCMSt Sequence ID AA03 Event Message Time and Date YYYYMMDDHHMMSS.MMM Call_Terimination_Cause any
22 (ESP)	DF_F sends LEA a Release message PCES Message-Type Release Case-ID Sub-2222 Accessing_Element_ID xxxxCMSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC
23 (EM)	MGC_T sends DF_T a QoS_Stop Event Message when it instructs MG_T to stop sending Voice Packets. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type QoS_Stop Element Type CMTS Element ID xxxCMTSt Sequence ID BB02 Event Message Time and Date YYYYMMDDHHMMSS.MMM SF_ID SFID CCC-ID 9106
24 (EM)	DF_T sends DF_F a QoS_Stop Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type QoS_Stop Element Type CMTS Element ID xxxCMTSt Sequence ID BB02 Event Message Time and Date YYYYMMDDHHMMSS.MMM SF_ID SFID CCC-ID 57
25 (ESP)	DF_F sends LEA a CCClose message PCES Message-Type CCClose Case-ID Sub-2222 Accessing_Element_ID xxxCMTSt Event_Time YYYYMMDDHHMMSS.MMM

Flow	Flow Description	
	Call_ID	TTTTxxxxCMSoCCCC
	CCC-ID	17

6.6 Call from On-net Subscriber to On-net Subscriber under Surveillance, Redirected to On-net Subscriber under Surveillance



Flow	Flow Description
1 (EM)	CMS_F sends DF_F a Signaling_Start Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Signaling_Start Element Type CMS Element ID xxxxCMSf Sequence ID AA01 Event Message Time and Date YYYYMMDDHHMMSS.MMM Direction_Indicator termination MTA_Port_ID MTA_F_PORT_NUMBER Calling_Party_Number +1-212-555-1111 Called_Party_Number +1-212-555-2222
2 (ESP)	DF_F sends LEA a TerminationAttempt message PCES Message-Type TerminationAttempt Case_ID Sub-2222 Accessing_Element_ID xxxxCMSf Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Calling_Party_ID +1-212-555-1111 Called_Party_ID +1-212-555-2222
3 (EM)	CMS_F sends DF_F a Service-Instance Event Message RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Service-Instance Element Type CMS Element ID xxxxCMSf Sequence ID AA02 Event Message Time and Date YYYYMMDDHHMMSS.MMM Service-Name Call-Forward Redirected-From-Party-Number +1-212-555-2222 Redirected-To-Party-Number +1-212-555-3333 PCES-DF-Security FourScoreAndSevenYearsAgo
4 (ESP)	DF_F sends LEA a Redirect message PCES Message-Type Redirect Case_ID Sub-2222 Accessing_Element_ID xxxxCMSf Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Redirected_From_Party_ID +1-212-555-2222 Redirected_To_Party_ID +1-212-555-3333
5 (D-QoS)	CMS_T sends $CMTS_T$ a GateSet message authorizing resources. This includes an additional object specific to the Electronic Surveillance, telling $CMTS_T$ to send an additional copy of the event messages and a copy of all voice payload packets to DF_T Transaction ID 3177 Subscriber MTA_T Remote Gate Info – CMS address 128.96.22.15 CMS Port 2562 Flags No-Gate-Open Remote Gate ID 8095 Authentication Algorithm 0x64 Security Key PackMyBoxWithFiveDozenLiquorJugs Billing Info – Billing Correlation ID TTTTxxxxCMSoCCCC RKS_Primary 128.96.60.110, 5000

Flow	Flow Description
	RKS_Secondary 128.96.60.210, 5001 Real_time_Flag 0 (false) GateSpec Direction upstream Protocol UDP SourceAddress 128.96.67.25 (MTA-t) DestinationAddress 128.96.41.1 (MTA-o) SourcePort 0 Destination Port 3456 b 120 r 12000 p 12000 m 120 M 120 R 12000 S 0 GateSpec Direction downstream Protocol UDP SourceAddress 128.96.41.1 (MTA-o) DestinationAddress 128.96.67.25 (MTA-t) SourcePort 0 Destination Port 1296 b 120 r 12000 p 12000 m 120 M 120 R 12000 S 0 Electronic-Surveillance-Parameters DF-IP-Address-CDC – 128.96.68.212 DF-IP-Port-CDC - 3001 DF-IP-Address-CCC - 128.96.68.212 DF-IP-Port-CCC - 4001 Flags - 3 (dup_event + dup_content) Session-Description-Parameters Downstream v=0 o=- 4723891 7428910 IN IP4 128.96.67.25 s=- c=IN IP4 128.96.67.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV Upstream v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
6 (EM)	CMS_T sends DF_T a Signaling-Start Event Message RADIUS Message Header Accounting-Request PacketCable Event Message Header

Flow	Flow Description
	Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Signaling_Start Element Type CMS Element ID xxxxCMSt Sequence ID AA01 Event Message Time and Date YYYYMMDDHHMMSS.MMM Event_Time YYYYMMDDHHMMSS.MMM Direction_Indication termination MTA_Port_ID MTA_T_PORT_NUMBER Calling_Party_Number +1-212-555-1111 Called_Party_Number +1-212-555-3333 Redirected_From_Information Last_Redirecting_Party +1-212-555-2222 Original_Called_Party +1-212-555-2222 Number_Redirections 1 PCES_Indication DF_Address 128.96.60.212 CDC_Port 3001 CCC_Port 4001 DF_DF_Key FourScoreAndSevenYearsAgo
7 (ESP)	DF_T sends LEA a TerminationAttempt message PCES Message-Type TerminationAttempt Case_ID Sub-3333 Accessing_Element_ID xxxxCMSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Calling_Party_ID +1-212-555-1111 Called_Party_ID +1-212-555-3333 Redirected_From_Information Last_Redirecting_Party +1-212-555-2222 Original_Called_Party +1-212-555-2222 Number_Redirections 1
8 (ESP/EM)	DF_T establishes an IPSec security association with DF_F, and sends the Signaling-Start Event RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Signaling_Start Element Type CMS Element ID xxxxCMSt Sequence ID AA01 Event Message Time and Date YYYYMMDDHHMMSS.MMM Direction_Indication termination MTA_Port_ID MTA_T_PORT_NUMBER Calling_Party_Number +1-212-555-1111 Called_Party_Number +1-212-555-3333 Redirected_From_Information Last_Redirecting_Party +1-212-555-2222 Original_Called_Party +1-212-555-2222 Number_Redirections 1 PCES_Indication DF_Address 128.96.60.212 CDC_Port 3001 CCC_Port 4001 DF_DF_Key FourScoreAndSevenYearsAgo

Flow	Flow Description
9 (EM)	CMS_T sends DF_T a Call-Answer Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Answer Element Type CMS Element ID xxxxCMSt Sequence ID AA02 Event Message Time and Date YYYYMMDDHHMMSS.MMM Called_Party_Number +1-212-555-3333 Routing_Number +1-212-555-3333 Charged_Number +1-212-555-1111 Location_Routing_Number +1-212-555-3333
10 (ESP)	DF_T sends LEA an Answer message PCES Message-Type Answer Case-ID Sub-3333 Accessing_Element_ID xxxxCMSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Answering_Party_ID +1-212-555-3333
11 (EM)	DF_T sends DF_F a Call-Answer Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Answer Element Type CMS Element ID xxxxCMSt Sequence ID AA02 Event Message Time and Date YYYYMMDDHHMMSS.MMM Called_Party_Number +1-212-555-3333 Routing_Number +1-212-555-3333 Charged_Number +1-212-555-1111 Location_Routing_Number +1-212-555-3333
12 (ESP)	DF_F sends LEA an Answer message PCES Message-Type Answer Case-ID Sub-2222 Accessing_Element_ID xxxxCMSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Answering_Party_ID +1-212-555-3333
13 (EM)	On receipt of the COMMIT message from MTA_T (which indicates the desire to start a media flow), $CMTS_T$ sends DF_T a QoS_Start Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMTSCCCC Event Message Type QoS_Start Element Type CMTS Element ID xxxCMTSt Sequence ID BB01 Event Message Time and Date YYYYMMDDHHMMSS.MMM QoS_Descriptor Status Bitmask 0x000000FF service_flow_scheduling_type UGS nominal_grant_interval 10,000 tolerated_grant_jitter 2,000 grants_per_interval 1 unsolicited_grant_size 161 traffic_priority 5 MTA_Port_ID MTAt_PORT_NUMBER SDP-Downstream v=0

Flow	Flow Description	
		o=- 4723891 7428910 IN IP4 128.96.67.25 s=- c=IN IP4 128.96.67.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	SDP-Upstream	v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	CCC-ID	9106
14 (ESP)	DF_T sends LEA a CCOpen message	
	PCES Message-Type	CCOpen
	Case-ID	Sub-3333
	Accessing_Element_ID	xxxCMTSt
	Event_Time	YYYYMMDDHHMMSS.MMM
	Call_ID	TTTTxxxxCMSoCCCC
	Terminating-SDP	v=0 o=- 4723891 7428910 IN IP4 128.96.63.25 s=- c=IN IP4 128.96.63.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	Originating-SDP	v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV
	CCC-ID	22
15 (EM)	DF_T sends DF_F a QoS_Start Event Message.	
	RADIUS Message Header	Accounting-Request
	PacketCable Event Message Header	
	Billing Correlation ID	TTTTxxxxCMTSCCCC
	Event Message Type	QoS_Start
	Element Type	CMTS
	Element ID	xxxCMTSt
	Sequence ID	BB01
	Event Message Time and Date	YYYYMMDDHHMMSS.MMM
	QoS_Descriptor	
	Status Bitmask	0x000000FF
	service_flow_scheduling_type	UGS
	nominal_grant_interval	10,000
	tolerated_grant_jitter	2,000

Flow	Flow Description
	grants_per_interval 1 unsolicited_grant_size 161 traffic_priority 5 MTA_Port_ID MTAt_PORT_NUMBER SDP-Downstream v=0 o=- 4723891 7428910 IN IP4 128.96.67.25 s=- c=IN IP4 128.96.67.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV SDP-Upstream v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV CCC-ID 57
16 (ESP)	DF_F sends LEA a CCOpen message PCES Message-Type CCOpen Case-ID Sub-2222 Accessing_Element_ID xxxCMTSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC Terminating-SDP v=0 o=- 4723891 7428910 IN IP4 128.96.67.25 s=- c=IN IP4 128.96.67.25 t=0 0 m=audio 1296 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 a=X-pc-spi-rtcp: 453A78F1 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV Originating-SDP v=0 o=- 25678 753849 IN IP4 128.96.41.1 s=- c=IN IP4 128.96.41.1 t=0 0 m=audio 3456 RTP/AVP 0 a=X-pc-csuites-rtp: 62/51 a=X-pc-csuites-rtcp: 02/03 01/03 a=X-pc-spi-rtcp: A7843B2 a=X-pc-secret:base64:pV6BIIHWt+0gDkpgnuxgTf ROxYAemhYJTHWgHNt1crTtEUKFatJfSdEFV CCC-ID 17
17	MTA_T sends Voice payload packet to MTA_O, intercepted by $CMTS_T$, duplicated, and the duplicate is passed to DF_T. CCC-ID 9106 Intercepted-Information <RTP/UDP/IP Packet as sent by/to MTA_T>
18 (ESP)	DF_T sends LEA a CCC packet CCC-ID 22 Intercepted-Information <RTP/UDP/IP Packet as sent by/to MTA_T>

Flow	Flow Description
19	DF_T passes the Voice payload packet to DF_F. CCC-ID 57 Intercepted-Information <RTP/UDP/IP Packet as sent by/to MTA_T>
20 (ESP)	DF_F sends LEA a CCC packet CCC-ID 17 Intercepted-Information <RTP/UDP/IP Packet as sent by/to MTA_T>
21 (EM)	CMS_T sends DF_T a Call-Disconnect Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Disconnect Element Type CMS Element ID xxxxCMSt Sequence ID AA03 Event Message Time and Date YYYYMMDDHHMMSS.MMM Call_Termination_Cause any
22 (ESP)	DF_T sends LEA a Release message PCES Message-Type Release Case-ID Sub-3333 Accessing_Element_ID xxxxCMSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC
23 (EM)	DF_T sends DF_F a Call-Disconnect Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type Call-Disconnect Element Type CMS Element ID xxxxCMSt Sequence ID AA03 Event Message Time and Date YYYYMMDDHHMMSS.MMM Call_Termination_Cause any
24 (ESP)	DF_F sends LEA a Release message PCES Message-Type Release Case-ID Sub-2222 Accessing_Element_ID xxxxCMSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC
25 (EM)	$CMTS_T$ sends DF_T a QoS_Stop Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type QoS_Stop Element Type CMTS Element ID xxxCMTSt Sequence ID BB02 Event Message Time and Date YYYYMMDDHHMMSS.MMM SF_ID SFID CCC-ID 9106
26 (ESP)	DF_T sends LEA a CCClose message PCES Message-Type CCClose Case-ID Sub-3333 Accessing_Element_ID xxxCMTSt

Flow	Flow Description
	Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC CCC-ID 22
27 (EM)	DF_T sends DF_F a QoS_Stop Event Message. RADIUS Message Header Accounting-Request PacketCable Event Message Header Billing Correlation ID TTTTxxxxCMSoCCCC Event Message Type QoS_Stop Element Type CMTS Element ID xxxCMTSt Sequence ID BB02 Event Message Time and Date YYYYMMDDHHMMSS.MMM SF_ID SFID CCC-ID 57
28 (ESP)	DF_F sends LEA a CCClose message PCES Message-Type CCClose Case-ID Sub-2222 Accessing_Element_ID xxxCMTSt Event_Time YYYYMMDDHHMMSS.MMM Call_ID TTTTxxxxCMSoCCCC CCC-ID 17