IMS Originating to IMS Terminating Call (Caller and Called are IMS Subscribers)

Calling UE	IMS Network					Called UE	EventStudio System Designer 4.0
Caller User Equipment	Visited IMS 1	Home IMS 1	Home IMS 2			Called User Equipment	15-Dec-07 08:49 (Page 1)
Caller	Orig P-CSCF	Orig S-CSCF	Term I-CSCF	Term S-CSCF	Term P-CSCF	Called	

This sequence diagram describes the call setup of a call from one IMS subscriber to another IMS subscriber. The calling subscriber is roaming in another IMS supporting network. The called subscriber is in the home IMS network.

The call flow focuses on the IMS routing of SIP dialog. The major steps in the call flow are:

(1) IMS Routing of Initial SIP INVITE.

(2) IMS Routing of First Response to the SIP Invite.

(3) PDP Context Activation and Audio/Video Path Setup.

IMS Routing of Initial SIP INVITE

Initiate Call → Caller

called@hims2.net

The user initiates a call to called@hims2.net.

[Caller] Prepare a list of supported voice and video codecs

The calling includes all supported codecs. This information is included as the first SDP offer in the initial invite.

INVITE Caller → Orig P-CSCF

```
INVITE called@hims2.net SIP/2.0,
P-Preferred-Identity:
<caller@hims1.net>,
Via: <Calling UE IP> :Port,
Route: <P-CSCF address>,
Route: <S-CSCF address>,
Contact: <Calling UE IP> :Port,
SDP: <Caller Supported Codec List>
```

The SIP phone sends the invite to called@hims2.net. The message contains Route entries for the terminal and the S-CSCF address that was extracted from the Service-Route header in the registration "200 OK" message. Security ports setup for IPSec SA establishment are used. "To" and "From" headers are also included in the message. These headers do not play a role in call processing.

[Orig P-CSCF] Make sure that INVITE was received over the IPSec Security Association

The INVITE was sent using the registration time SA so the P-CSCF accepts the request.

[Orig P-CSCF] Make sure that the preferred public identity is currently registered

P-CSCF verifies that the preferred public identity specified in the INVITE is currently registered.
The S-CSCF address for the user was obtained at the time of registration (Service-Route header in the "200 OK" response to the REGISTER message.)

[Orig P-CSCF] Use DNS to translate from scscf1.hims1.net to 'Orig S-CSCF' IP address

The originating P-CSCF queries the DNS to obtain the IP address of the S-CSCF in the called subscriber's home network. The S-CSCF address for the user was obtained at the time of registration (Service-Route header in the "200 OK" response to the REGISTER message).

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Calling UE	IMS Network					Called UE	EventStudio System Designer 4.0
Caller User Equipment	Visited IMS 1	Home IMS 1	Home IMS 2			Called User Equipment	15-Dec-07 08:49 (Page 2)
Caller	Orig P-CSCF	Orig S-CSCF	Term I-CSCF	Term S-CSCF	Term P-CSCF	Called	

INVITE (Orig P-CSCF → Orig S-CSCF)

```
INVITE called@hims2.net SIP/2.0,
P-Asserted-Identity:
<caller@hims1.net>,
Via: <Orig P-CSCF> <Calling-UE>,
Record-Route: <Orig P-CSCF>,
Route: <Orig S-CSCF>,
Contact: <Calling UE IP> :Port,
SDP: <Caller Supported Codec List>
```

The P-CSCF replaces the preferred identity header with the asserted identity header and forwards the message to the S-CSCF in the home network. It adds a Record-Route header with its own address.

100 Trying (Orig P-CSCF → Caller)

The P-CSCF just acknowledges the INVITE to the UE. The "100 Trying" message indicates that the call setup is in progress.

Use DNS to translate from hims2.net to 'Term I-CSCF' IP address

The originating S-CSCF queries the DNS to obtain the IP address of the I-CSCF in the called subscriber's home network.

INVITE (Orig S-CSCF → Term I-CSCF)

```
INVITE called@hims2.net SIP/2.0,
P-Asserted-Identity:
<caller@hims1.net>,
<tel:+13015556666>,
Via: <Orig S-CSCF> <Orig P-CSCF>
<Calling-UE>,
Record-Route: <Orig S-CSCF> <Orig
P-CSCF>,
Contact: <Calling UE IP> :Port,
SDP: <Caller Supported Codec List>
```

The S-CSCF removes the Route header and routes the INVITE to the I-CSCF IP address obtained from the DNS query. Note that the S-CSCF has added the telephone URL to the P-Asserted-Identity. The Via and Record-Route headers are also updated with self address.

Query the SLF to locate HSS

The I-CSCF queries the Subscription Location Function (SLF) to identify the HSS that needs to be queried.

100 Trying (Orig S-CSCF → Orig P-CSCF)

The S-CSCF acknowledges the INVITE that was received from P-CSCF.

Query HSS to identify the S-CSCF for this SIP Dialog

Query the HSS to obtain the S-CSCF for the user.

INVITE (Term I-CSCF → Term S-CSCF)

```
INVITE called@hims2.net SIP/2.0,
P-Asserted-Identity:
<caller@hims1.net>,
<tel:+13015556666>,
Via: <Term I-CSCF> <Orig S-CSCF>
<Orig P-CSCF> <Calling-UE>,
Route: <Term S-CSCF>,
Record-Route: <Orig S-CSCF> <Orig
P-CSCF>,
Contact: <Calling UE IP> :Port,
SDP: <Caller Supported Codec List>
```

As a part of the message processing, a route entry is added for the Term S-CSCF. A new Via header is added to record that the message traversed this I-CSCF. The message is forwarded to the first route header (in this case, the "Term S-CSCF").

Map from public request URI to the registered address

Map from the public URI to the called subscriber's registered IP address and port number.

INVITE (Term S-CSCF → Term P-CSCF)

```
INVITE CALLED-IP SIP/2.0,
P-Asserted-Identity:
<caller@hims1.net>,
<tel:+13015556666>,
Via: <Term S-CSCF> <Term I-CSCF>
<Orig S-CSCF> <Orig P-CSCF>
<Calling-UE>,
Route: <Term P-CSCF>,
Record-Route: <Term S-CSCF> <Orig
S-CSCF> <Orig P-CSCF>,
Contact: <Calling UE IP> :Port,
```

The public URI in the SIP INVITE is replaced with the called subscriber's registered IP address and port number. The message is routed to the P-CSCF IP address that was recorded at the time of registration. The Via and Record-Route headers are updated.

IMS Originating to IMS Terminating Call (Caller and Called are IMS Subscribers)

Calling UE	IMS Network					Called UE	**EventStudio System Designer 4.0**
Caller User Equipment	Visited IMS 1	Home IMS 1	Home IMS 2			Called User Equipment	15-Dec-07 08:49 (Page 3)
Caller	Orig P-CSCF	Orig S-CSCF	Term I-CSCF	Term S-CSCF	Term P-CSCF	Called	

Term P-CSCF: Obtain a media authorization token from the PDF

The terminating P-CSCF requests the Policy Decision Function (PDF) to generate a media authorization token. The token will be included in the INVITE sent to the terminating UE.

Term P-CSCF → Called: INVITE

```
INVITE CALLED-IP SIP/2.0,
P-Asserted-Identity:
<caller@hims1.net>,
<tel:+13015556666>,
Via: <Term P-CSCF>;port <Term
S-CSCF> <Term I-CSCF> <Orig
S-CSCF> <Orig P-CSCF>
<Calling-UE>,
Route: <Term P-CSCF>;port,
Record-Route: <Term S-CSCF> <Orig
S-CSCF> <Orig P-CSCF>,
Contact: <Called UE IP> :Port,
SDP: <Caller Supported Codec
List>,
P-Media-Authorization
```

The P-CSCF updates the Via and Route-Record headers and forwards the request to the Called UE. Note that the secure port is included in the Via address specification. The message also includes the media authorization token. This token will have to be passed to the GGSN in the PDP context activation request.

Term S-CSCF → Term I-CSCF: 100 Trying

Term P-CSCF → Term S-CSCF: 100 Trying

Term I-CSCF → Orig S-CSCF: 100 Trying

Called: Prepare a list of Codecs common between the Caller and the Called subscriber

The Caller examines the SDP list of available codec. It prunes the list by excluding codecs that are not supported by the called subscriber. This list will be included in the 183 message sent to the caller.

IMS Routing of First Response to the SIP Invite

Called → Term P-CSCF: 183 Session Progress

```
Via: <Term P-CSCF>;port <Term
S-CSCF> <Term I-CSCF> <Orig
S-CSCF> <Orig P-CSCF>
<Calling-UE>,
Record-Route: <Term S-CSCF>;port
<Orig S-CSCF> <Orig P-CSCF>,
Contact: <Calling UE IP> :Port,
SDP: <Codecs supported by Caller
and Called>
```

The UE replies indicating that the session is in progress. The contact address is set its own IP address. The Via and the Record-Route headers are copied from the received INVITE.

Term P-CSCF → Term S-CSCF: 183 Session Progress

```
Via: <Term S-CSCF> <Term I-CSCF>
<Orig S-CSCF> <Orig P-CSCF>
<Calling-UE>,
Record-Route: <Term S-CSCF> <Orig
S-CSCF> <Orig P-CSCF>,
Contact: <Calling UE IP> :Port,
SDP: <Codecs supported by Caller
and Called>
```

The P-CSCF removes its own Via header entry and addresses the message to the top via header (Term S-CSCF in this case). The P-CSCF also removes the secure port from the Record-Route.

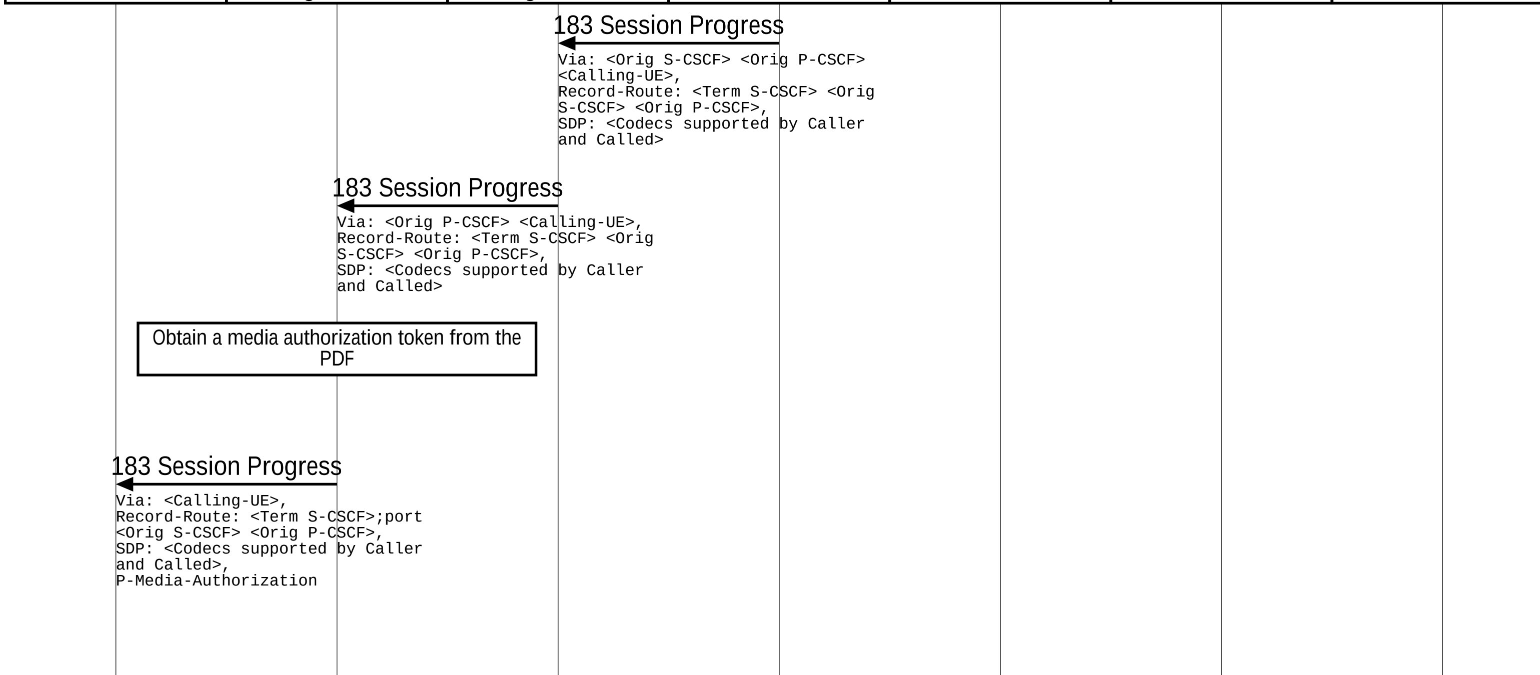
Term S-CSCF → Term I-CSCF: 183 Session Progress

```
Via: <Term I-CSCF> <Orig S-CSCF>
<Orig P-CSCF> <Calling-UE>,
Record-Route: <Term S-CSCF> <Orig
S-CSCF> <Orig P-CSCF>,
Contact: <Calling UE IP> :Port,
SDP: <Codecs supported by Caller
and Called>
```

183 message just retraces the path of the original INVITE. Each note removes its down entry from the via header and forwards the message to the Via entry at the top. The Record-Route header is not touched.

IMS Originating to IMS Terminating Call (Caller and Called are IMS Subscribers)

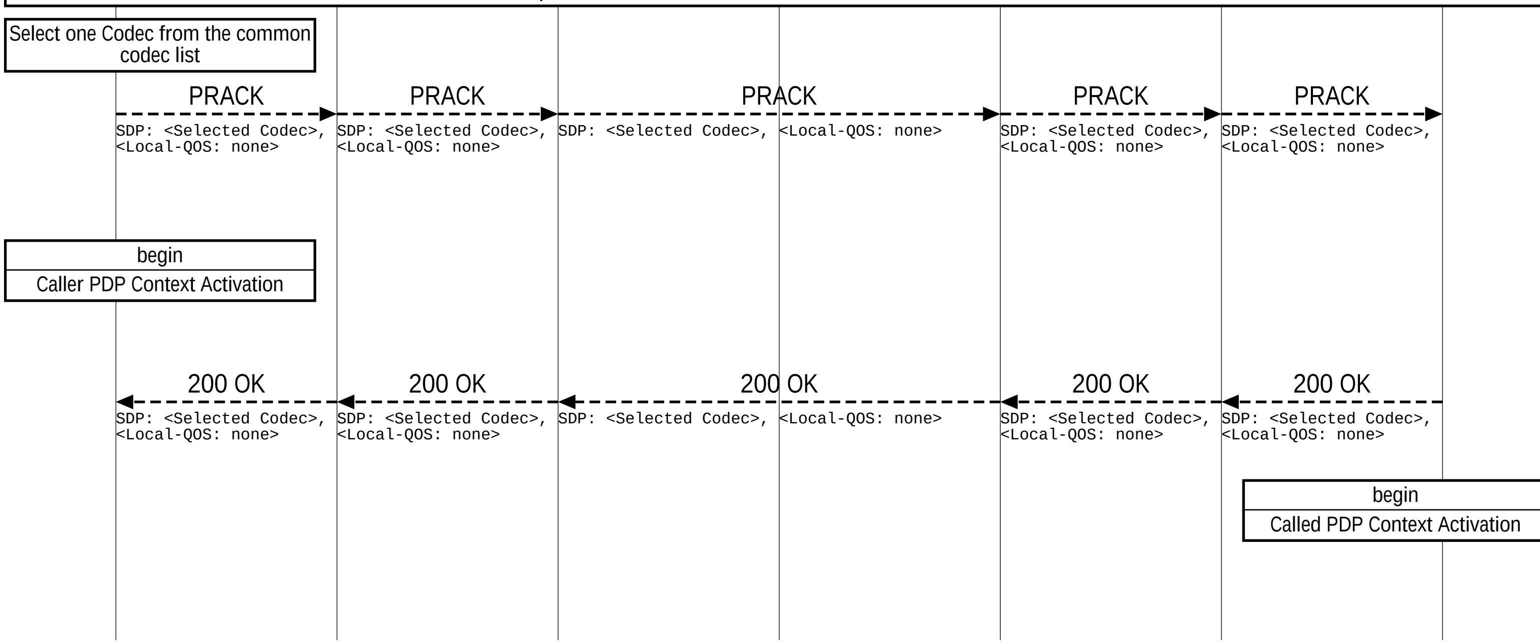
Calling UE	IMS Network					Called UE	**EventStudio System Designer 4.0**
Caller User Equipment	Visited IMS 1	Home IMS 1	Home IMS 2			Called User Equipment	15-Dec-07 08:49 (Page 4)
Caller	Orig P-CSCF	Orig S-CSCF	Term I-CSCF	Term S-CSCF	Term P-CSCF	Called	



The originating P-CSCF requests the Policy Decision Function (PDF) to generate a media authorization token. The token will be included in the "183 Session Progress" sent to the originating UE.

Just like other nodes, the Orig P-CSCF removes its own entry from the Via header. The P-CSCF also updates the Record-Route header to include the protected port number in its entry. This forces the terminal to send all responses using the protected IPSec SA. The message also includes the media authorization token. This token will have to be passed to the GGSN in the PDP context activation request.

PDP Context Activation and Audio/Video Path Setup



The Caller examines the received common codec list and selects the codec to activate.

The Caller now sends a PRACK to inform the called subscriber about the selected Codec. The message also indicates that currently the resources needed for meeting the quality of service requiements of the session are not available.

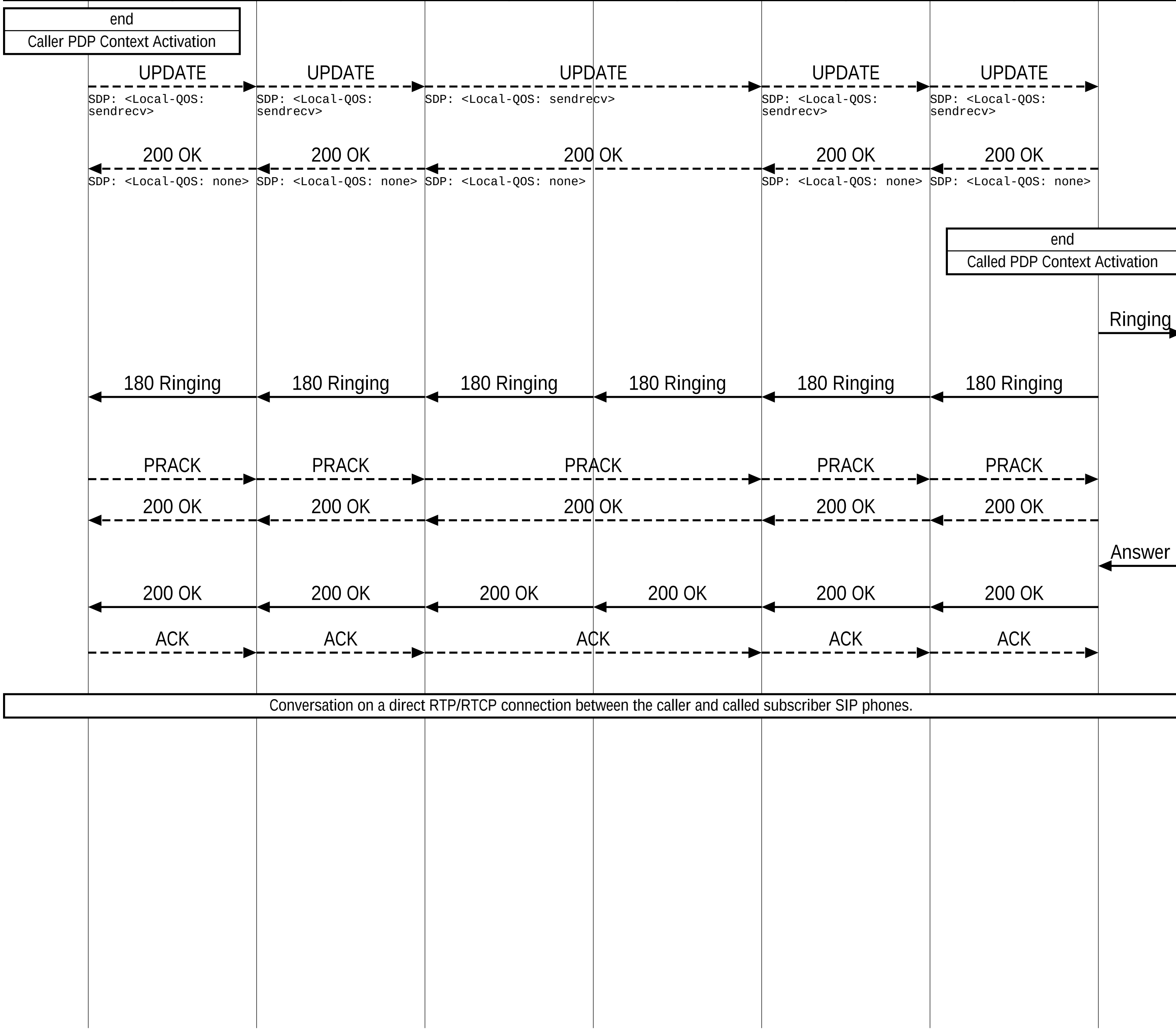
Now that the codec to be used has been selected, the PDP context activation is initiated for allocating resources for meeting the Quality of Service (QoS) requirements for the codec.

The called subscriber acknowledges the PRACK. The message also indicates that quality of service for the session is not met for the called subscriber.

The final codec at the called side is decided. So initiate the PDP context activation to allocate resources for meeting the QoS of the terminating leg of the call.

IMS Originating to IMS Terminating Call (Caller and Called are IMS Subscribers)

Calling UE	IMS Network					Called UE	EventStudio System Designer 4.0
Caller User Equipment	Visited IMS 1	Home IMS 1	Home IMS 2			Called User Equipment	15-Dec-07 08:49 (Page 5)
Caller	Orig P-CSCF	Orig S-CSCF	Term I-CSCF	Term S-CSCF	Term P-CSCF	Called	



The caller PDP context activation has been completed.

Since the caller PDP context has been activated, notify the called end that the caller can now meet the quality of service in the send and receive direction.

The caller replies back to the called user. Note that the Local QoS is still set to none as the called PDP context activation has not been completed.

The called PDP context activation has been completed. At this point, the caller and the called PDP contexts are both active. The QoS for the call can now be met.

Now all the resources for the call are in place. Ring the called subscriber to notify the user about the incoming call.

Inform the caller that the called subscriber is being rung. This serves as an implicit indication to the caller that the QoS at the called side has also been met.

The caller acknowledges the ringing message.

The called subscriber acknowledges the PRACK.

The called subscriber answers the call.

Notify the caller that that the call has been answered.

The caller acknowledges the "200 OK" message. The call is now ready to enter conversation mode.