Troubleshooting the Session Initiation Protocol (SIP)

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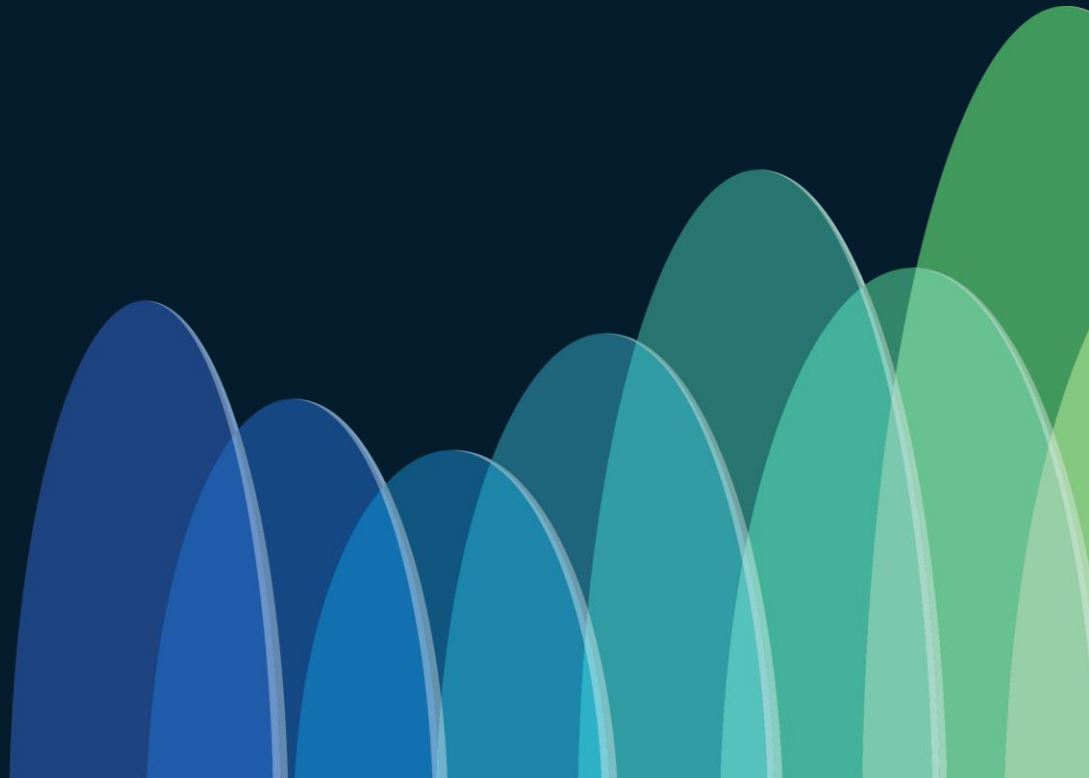
Agenda

- Session Initiation Protocol (SIP) Overview
  - User Agents
  - Requests and Responses
  - Headers
  - Session Description Protocol
  - Offer / Answer Model
  - DTMF Relay
  - SIP Session ID
  - ICE Overview
- Troubleshooting Tools
- Troubleshooting Methodology & Case Studies
- Additional Resources

SIP Protocol Overview



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What is SIP?

- Signaling protocol used to establish, manage, and terminate sessions over an IP network
- Core protocol defined in RFC 3261
- Relies heavily on RFC 3262, RFC 3263, RFC 3264, and RFC 3265
- Extended in many, many other RFCs
- ASCII-based messages

User Agents

- **User Agent Clients** (UAC) send **requests** to **User Agent Servers** (UAS)
- **User Agent Servers** send **responses** to the **requests**
- Nearly all SIP devices are **both a UAC and a UAS** (they both initiate and accept requests)
- Call Control devices can be a Proxy, a Back-to-Back User Agent (B2BUA), or sometimes both

SIP Request Methods defined in RFC 3261

- **INVITE** – A user or service is being invited to participate in a multimedia session (e.g., set up a new call)
- **ACK** – Confirms that a client has received a final response to an INVITE request
- **BYE** – Terminates an existing session
- **CANCEL** – Cancels pending requests; does not terminate sessions that have been accepted
- **OPTIONS** – Queries the capabilities of servers (Also used as a keepalive)
- **REGISTER** – Registers the user agent with the registrar server of a domain

Additional SIP Request Methods

- **PRACK** (RFC 3262) – to acknowledge a provisional response
- **SUBSCRIBE** (RFC 3265) – to tell a remote node to look for a certain event
- **NOTIFY** (RFC 3265) – to respond when that certain event occurs
- **UPDATE** (RFC 3311) – to update parameters of a session set-up
- **REFER** (RFC 3515) – to “refer” one UA to communicate with another UA
- **INFO** (RFC 2976) – to send more information within an established dialog
- **PUBLISH** (RFC 3903) – to push UA state information to a compositor/presence server

SIP INVITE Method

```
INVITE sip:918008001180@12013670.us10.bcld.webex.com SIP/2.0
Via: SIP/2.0/TLS 192.168.1.107:62580;branch=z9hG4bK86686aef70059660;alias;rport
Max-Forwards: 70
To: sip:918008001180@12013670.us10.bcld.webex.com
From: sip:c4628b59bp_GDWYMXEZAXNN_1@12013670.us10.bcld.webex.com;tag=660dba695714ad08e
CSeq: 2121402554 INVITE
Call-ID: d16f2f19634f0e84532da13c4ed4f741
Contact: <sip:c4628b59bp_GDWYMXEZAXNN_1@192.168.1.107:8933;transport=tls>
accept: application/sdp
accept-contact: *
allow-events: hold, talk, mute, unmute
p-preferred-identity: sip:c4628b59bp_GDWYMXEZAXNN_1@12013670.us10.bcld.webex.com
recv-info: x-broadworks-client-session-info
session-id: 0f4c9bcc0120500080005cf6dad3c2e0;remote=00000000000000000000000000000000
User-Agent: bc-uc teams (sparkmac/45.3.0.31637 (15.3.0) (en-US) (Native Desktop) (Purple))
Supported: timer, replaces, 100rel
Session-Expires: 3600;refresher=uac
Allow: INVITE, BYE, ACK, PRACK, CANCEL, OPTIONS, NOTIFY, INFO, UPDATE
Content-Type: application/sdp
Content-Length: 1394
```

SIP INVITE Method

```
INVITE sip:918008001180@12013670.us10.bcld.webex.com SIP/2.0
Via: SIP/2.0/TLS 192.168.1.107:62580;branch=z9hG4bK86686aef70059660;alias;rport
Max-Forwards: 70
To: sip:918008[illegible]us10.bcld.we[illegible]
From: sip:c462[illegible]ZAXNN_1@12[illegible]webex.com;tag=660dba695714ad08e
CSeq: 2121402554 INVITE
Call-ID: [illegible]532da13c4ed4f741
Contact: [illegible]GDWYMXEZAXNN_1@192.168.1.107:8933;transport=tls>
accept: application/sdp
accept-contact: *
allow-events: hold, talk, mute, unmute
p-preferred-identity: sip:c4628b59bp_GDWYMXEZAXNN_1@12013670.us10.bcld.webex.com
recv-info: x-broadworks-client-session-info
session-id: 0f4c9bcc0120500080005cf6dad3c2e0;remote=00000000000000000000000000000000
User-Agent: bc-uc teams (sparkmac/45.3.0.31637 (15.3.0) (en-US) (Native Desktop) (Purple))
Supported: timer, replaces, 100rel
Session-Expires: 3600;refresher=uac
Allow: INVITE, BYE, ACK, PRACK, CANCEL, OPTIONS, NOTIFY, INFO, UPDATE
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Content-Length: 1394
```

Request URI

SIP Version

SIP Method

SIP Headers

INVITE sip:918008001180@12013670.us10.bcld.webex.com SIP/2.0
Via: SIP/2.0/TLS 192.168.1.107:62580;branch=z9hG4bK86686aef70059660;alias;rport
Max-Forwards: 70
To: sip:918008001180@12013670.us10.bcld.webex.com
From: sip:c4628b59bp_GDWYMXEZAXNN_1@12013670.us10.bcld.webex.com;tag=660dba695714ad08e
CSeq: 2121402554 INVITE
Call-ID: d16f2f19634f0e84532da13c4ed4f741
Contact: <sip:c4628b59bp_GDWYMXEZAXNN_1@192.168.1.107:8933;transport=tls>
accept: application/sdp
accept-contact: *
allow-events: hold, talk, mute, unmute
p-preferred-identity: sip:c4628b59bp_GDWYMXEZAXNN_1@12013670.us10.bcld.webex.com
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session-id: 0f4c9bcc0120500080005cf6dad3c2e0;remote=00000000000000000000000000000000
User-Agent: bc-uc teams (sparkmac/45.3.0.31637 (15.3.0) (en-US) (Native Desktop) (Purple))
Supported: timer, replaces, 100rel
Session-Expires: 3600;refresher=uac
Allow: INVITE, BYE, ACK, PRACK, CANCEL, OPTIONS, NOTIFY, INFO, UPDATE
Content-Type: application/sdp
Content-Length: 1394

SIP Mandatory Headers – RFC 3261 Section 20

- Where column:
  - R: header field may only appear in requests;
  - r: header field may only appear in responses;
  - 2xx, 4xx, etc.: A numerical value or range indicates response codes with which the header field can be used;
  - c: header field is copied from the request to the response.
- Requirements:
  - c: Conditional; requirements on the header field depend on the context of the message.
  - m: The header field is mandatory.
  - m*: The header field SHOULD be sent, but clients/servers need to be prepared to receive messages without that header field.
  - o: The header field is optional.
  - t: The header field SHOULD be sent, but clients/servers need to be prepared to receive messages without that header field. If a stream-based protocol (such as TCP) is used as a transport, then the header field MUST be sent.
  - *: The header field is required if the message body is not empty. See Sections 20.14, 20.15 and 7.4 for details.

Header field	where	proxy	ACK	BYE	CAN	INV	OPT	REG
Accept	R		-	o	-	o	m*	o
Accept	2xx		-	-	-	o	m*	o
Accept	415		-	c	-	c	c	c
Accept-Encoding	R		-	o	-	o	o	o
Accept-Encoding	2xx		-	-	-	o	m*	o
Accept-Encoding	415		-	c	-	c	c	c
Accept-Language	R		-	o	-	o	o	o
Accept-Language	2xx		-	-	-	o	m*	o
Accept-Language	415		-	c	-	c	c	c
Alert-Info	R	ar	-	-	-	o	-	-
Alert-Info	180	ar	-	-	-	o	-	-
Allow	R		-	o	-	o	o	o
Allow	2xx		-	o	-	m*	m*	o
Allow	r		-	o	-	o	o	o
Allow	405		-	m	-	m	m	m
Authentication-Info	2xx		-	o	-	o	o	o
Authorization	R		o	o	o	o	o	o
Call-ID	c	r	m	m	m	m	m	m
Call-Info		ar	-	-	-	o	o	o
Contact	R		o	-	-	m	o	o
Contact	1xx		-	-	-	o	-	-
Contact	2xx		-	-	-	m	o	o
Contact	3xx	d	-	o	-	o	o	o
Contact	485		-	o	-	o	o	o
Content-Disposition			o	o	-	o	o	o
Content-Encoding			o	o	-	o	o	o
Content-Language			o	o	-	o	o	o
Content-Length		ar	t	t	t	t	t	t
Content-Type			*	*	-	*	*	*
CSeq	c	r	m	m	m	m	m	m

SIP Response

SIP Response

```
SIP/2.0 200 OK
Via: SIP/2.0/TLS 192.168.1.107:62580; branch=z9hG4bK3b6fa283d026c87f;alias;rport
Max-Forwards: 70
To: sip:918008001180@12013670.us10.bcld.webex.com;tag=994605466-1738354282585
From: sip:c4628b59bp_GDWYMXEZAXNN_1@12013670.us10.bcld.webex.com;tag=660dba695...
CSeq: 2121402555 INVITE
Call-ID: d16f2f19634f0e84532da13c4ed4f741
Contact: <sip:23.89.40.102:8934;transport=tls>
accept: application/media_control+xml,application/sdp
call-info: <sip:10.21.0.192>;appearance-index=1
content-disposition: session;handling=required
recv-info: x-cisco-mute-status,x-broadworks-client-session-info
session-id: 0b0ad62f609f590d801ad0948a1a88d3;remote=0f4c9bcc0120500080005cf6dad3c2e0
x-broadworks-correlation-info: 720a4e4e-0e4e-4d80-9299-bcf8a362c914
Privacy: none
P-Asserted-Identity: <sip:+18008001180@10.21.0.192;user=phone>
Allow: ACK, BYE, CANCEL, INFO, INVITE, OPTIONS, PRACK, REFER, NOTIFY, UPDATE
Content-Type: application/sdp
Content-Length: 629
```

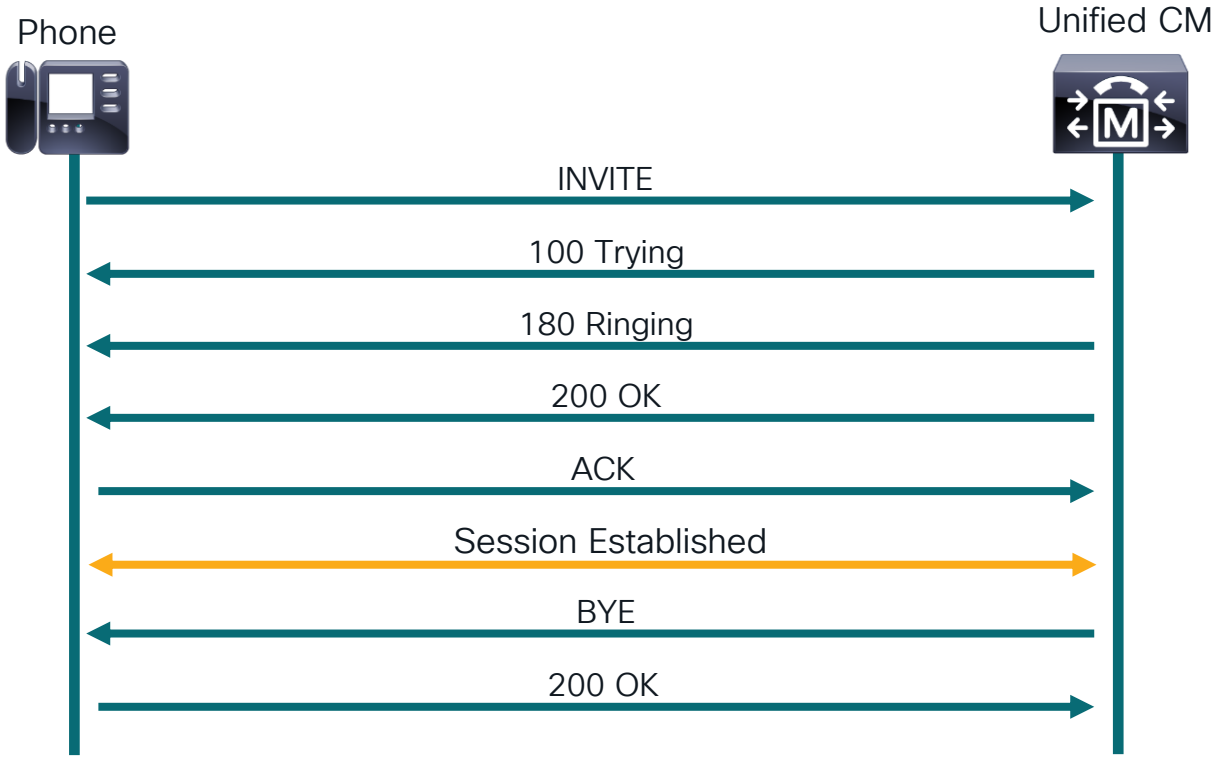
SIP Responses

Response Code	Description	Example
1XX	**Informational** – Request Received and Continuing to Process Request	100 Trying 180 Ringing 183 Session Progress
2XX	**Success** – Action was successfully received, understood, and accepted	200 OK 202 Acceptable
3XX	**Redirection** – Another SIP Element needs to be contacted to complete the request	300 Multiple Choices 302 Moved Temporarily
4XX	**Client Error** – The server cannot fulfill the request based on the information contained in the request. Could indicate malformed data or a request the server cannot process based on the data in the request.	401 Unauthorized 404 Not Found 406 Not Acceptable 486 Busy Here 488 Not Acceptable Here
5XX	**Server Error** – Server failed to fulfill an apparently valid request	500 Internal Server Error 503 Service Unavailable
6XX	**Global Failure** – Request is invalid at any server. Usually like 4XX errors but indicate no server can process the request.	600 Busy Everywhere 603 Decline 604 Does Not Exist Anywhere

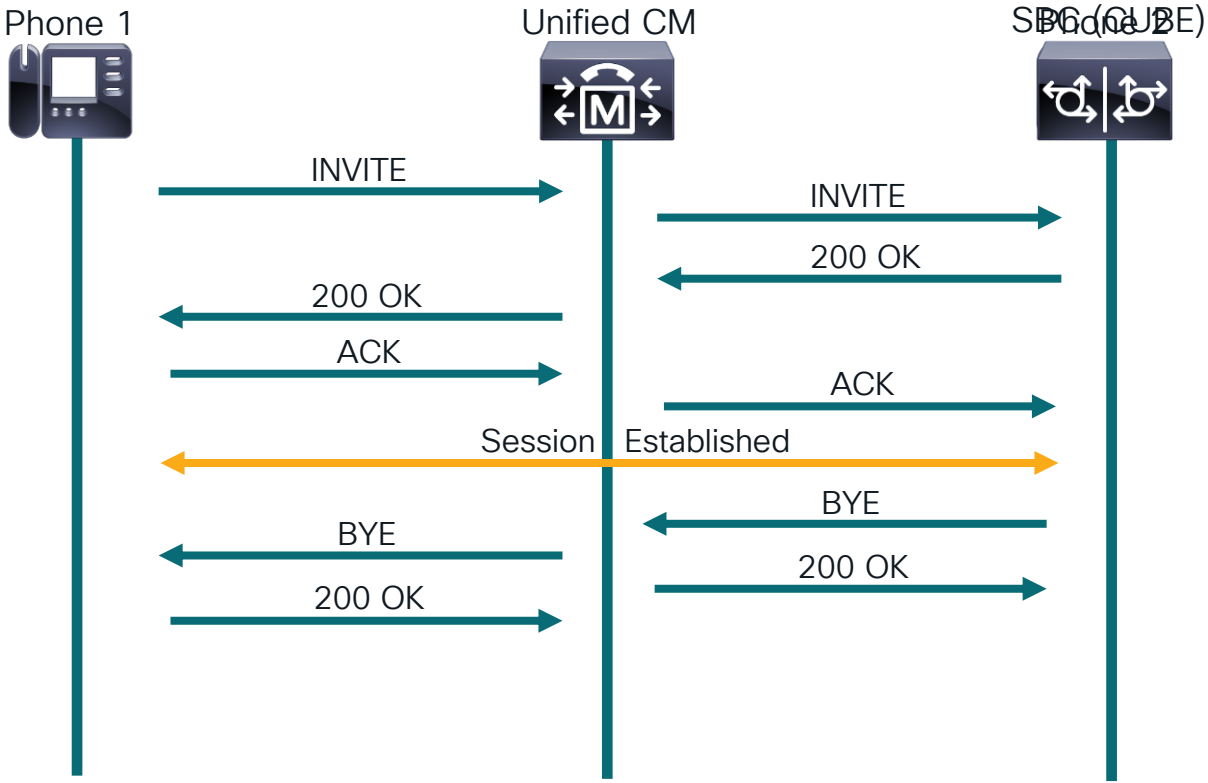
SIP Transactions and Dialogs

- **Transactions**: A request and any related responses to that request. Ensures reliable transmission of a request
- **Dialog**: All transactions related to a session
  - INVITE starts a dialog and BYE or CANCEL ends it
  - SUBSCRIBE can start a dialog and all NOTIFY are part of the dialog
  - Uniquely identified by Call-ID + To tag + From tag
- Not all Transactions are part of a Dialog (e.g., REGISTER, OPTIONS, out-of-dialog REFER)

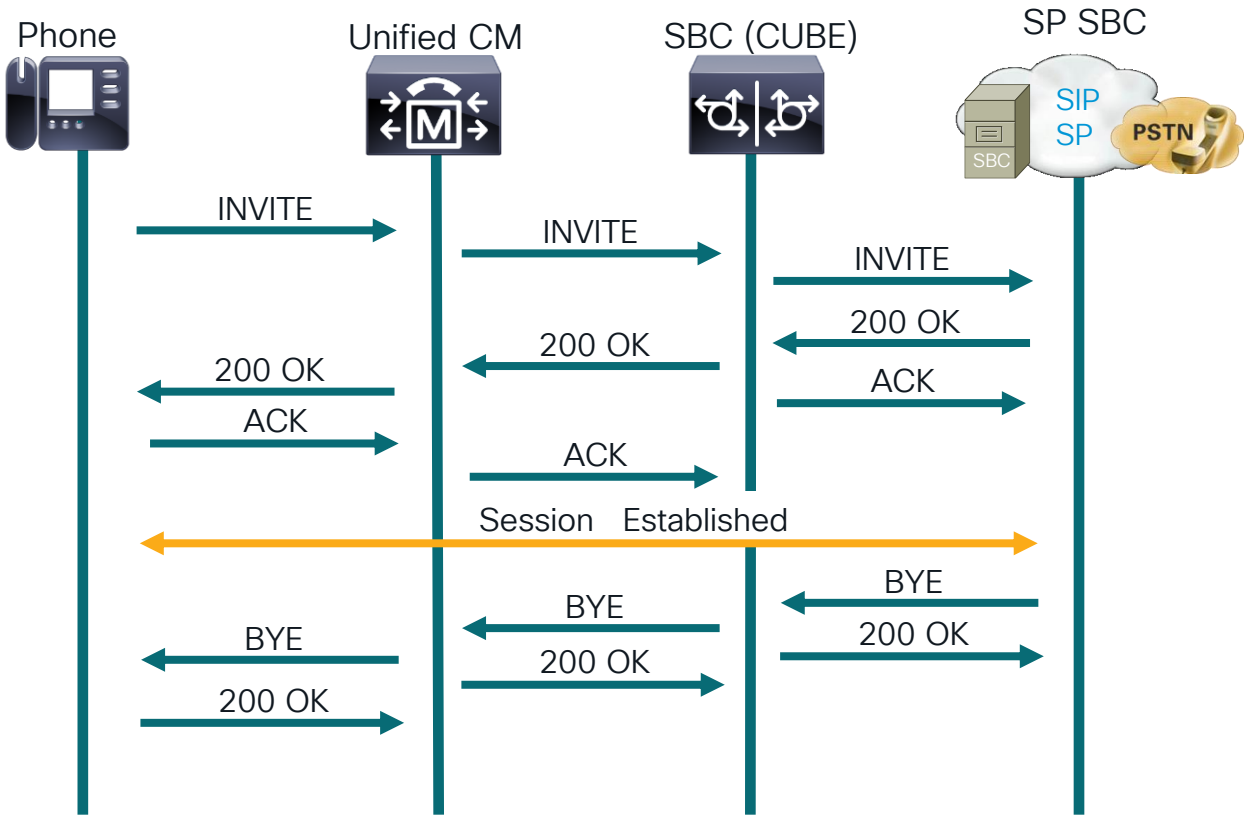
Basic SIP Call Setup



Basic SIP Call Setup with B2BUA (Unified CM)



Basic SIP Call Setup with Unified CM and CUBE



Media Negotiation

- SIP leverages the Session Description Protocol (SDP) (RFC 4566/3266/2327) to communicate media information.
- SIP uses the offer/answer model described in RFC 3264 to negotiate media using SDP

```
v=0
o=xmserver 3782060655 3782060656 IN IP4 172.31.175.196
s=xmserver
c=IN IP4 172.31.175.196
b=AS:80
t=0 0
m=audio 19436 RTP/AVP 0 101
b=AS:80
a=sendrecv
a=rtcp-mux
a=ssrc:3806853901 cname:77YAVdIFx9N7
a=rtpmap:0 pcmu/8000
a=rtpmap:101 telephone-event/8000
a=fmtp:101 0-15
```

```
v=0
o=CiscoSystemsSIP-GW-UserAgent 636 1650 IN IP4 10.81.225.210
s=SIP Call
c=IN IP4 10.81.225.210
t=0 0
m=audio 24106 RTP/AVP 0 101
c=IN IP4 10.81.225.210
a=rtpmap:0 PCMU/8000
a=rtpmap:101 telephone-event/8000
a=fmtp:101 0-16
a=ptime:20
```

Offer/Answer Model (RFC 3264)

- One endpoint sends an offer SDP containing all the capabilities the endpoint wishes to negotiate.
- SDP contains m lines for each media stream being negotiated (i.e. audio, video, content channel, etc...)
- Receiving endpoint sends an answer SDP that contains the same or a subset of capabilities received in the offer.
- Per RFC 3264, “For each "m=" line in the offer, there MUST be a corresponding "m=“ line in the answer. The answer MUST contain exactly the same number of "m=" lines as the offer.”

Session Description Protocol (SDP) - Offer

```
v=0
o=BroadWorks 30594492 1738354280029 IN IP4 139.177.65.158
c=IN IP4 139.177.65.158
t=0 0
a=cisco-mari:v1
a=cisco-mari-rate
a=cisco-mari-rtx:v0
a=cisco-mari-hybrid-resilience:v0
m=audio 30024 RTP/SAVP 99 105 9 0 8 18 102 101 111 112
a=sendrecv
a=rtpmap:99 opus/48000/2
a=rtpmap:105 xcodec/48000
a=fmtp:105 performance=HP;encode-versions=1;decode-versions=1
a=rtpmap:9 G722/8000
a=rtpmap:0 PCMU/8000
a=rtpmap:8 PCMA/8000
a=rtpmap:18 G729/8000
a=fmtp:18 annexb=no
a=rtpmap:102 iLBC/8000
a=fmtp:102 mode=30
a=rtpmap:101 telephone-event/8000
a=rtpmap:111 x-ulpfecuc/8000
a=fmtp:111 max_esel=1400;max_n=255;m=8;multi_ssrc=1;FEC_ORDER=FEC_SRTP;non_seq=1;feedback=0
a=rtpmap:112 mari-rtx/90000
a=fmtp:112 RTX_ORDER=RTX_SRTP;rtx-time=180
```

Session Description Protocol (SDP) - Offer

```
a=extmap:4/sendrecv http://protocols.cisco.com/timestamp#100us
a=extmap:9/sendrecv http://www.webrtc.org/experiments/rtp-hdrext/abs-capture-time
a=rtcp-xr:rcvr-rtt=all voip-metrics
a=ice-ufrag:Xo3F
a=ice-pwd:8qUtOBXZvcs43hpqMc0dkPtCVQpnZA57
a=candidate:1 1 UDP 2113935615 192.168.1.107 8560 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8561 typ host
a=candidate:3 1 UDP 1677727999 136.56.9.218 8560 typ srflx raddr 192.168.1.107 rport 8560
a=candidate:3 2 UDP 1677727998 136.56.9.218 25567 typ srflx raddr 192.168.1.107 rport 8561
a=candidate:mse 1 UDP 16777215 139.177.65.158 30024 typ relay
a=candidate:mse 2 UDP 16777214 139.177.65.158 30025 typ relay
a=crypto:1 AES_CM_128_HMAC_SHA1_80 inline:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
m=video 8600 RTP/SAVP 109 111 112
b=AS:2500
a=sendrecv
a=rtpmap:109 H264/90000
a=fmtp:109 profile-level-id=42801f; packetization-mode=0
a=rtcp-fb:109 ccm fir
a=rtcp-fb:109 nack pli
a=rtcp-fb:109 nack
a=ice-ufrag:f1mh
a=ice-pwd:urqVaa2MTz5gKx0W0rk+Xad8X/nq41Qp
a=candidate:1 1 UDP 2113935615 192.168.1.107 8600 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8601 typ host
```

Session Description Protocol (SDP) - Offer

```
v=0
o=BroadWorks 30594492 1738354280029 IN IP4 139.177.65.158
c=IN IP4 139.177.65.158
t=0 0
a=cisco-mari:v1
a=cisco-mari-rate
a=cisco-mari-rtx:v0
a=cisco-mari-hybrid-resilience:v0
m=audio 30024 RTP/SAVP 99 105 9 0 8 18 102 101 111 112
a=sendrecv
a=rtpmap:99 opus/48000/2
a=rtpmap:105 xcodec/48000
a=fmtp:105 performance=HP;encode-versions=1;decode-versions=1
a=rtpmap:9 G722/8000
a=rtpmap:0 PCMU/8000
a=rtpmap:8 PCMA/8000
a=rtpmap:18 G729/8000
a=fmtp:18 annexb=no
a=rtpmap:102 iLBC/8000
a=fmtp:102 mode=30
a=rtpmap:101 telephone-event/8000
a=rtpmap:111 x-ulpfecuc/8000
a=fmtp:111 max_esel=1400;max_n=255;m=8;multi_ssrc=1;FEC_ORDER=FEC_SRTP;non_seq=1;feedback=0
a=rtpmap:112 mari-rtx/90000
a=fmtp:112 RTX_ORDER=RTX_SRTP;rtx-time=180
```

Session Description Protocol (SDP) – Offer

```
v=0
o=BroadWorks 30594492 1738354280029 IN IP4 139.177.65.158
c=IN IP4 139.177.65.158
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a=fmtp:105 performance=HP;encode-versions=1;decode-versions=1
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a=rtpmap:8 PCMA/8000
a=rtpmap:18 G729/8000
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a=rtpmap:102 iLBC/8000
a=fmtp:102 mode=30
a=rtpmap:101 telephone-event/8000
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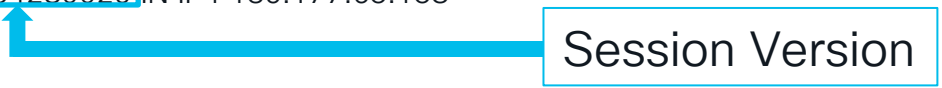
a=fmtp:111 max_esel=1400;max_n=255;m=8;multi_ssrc=1;FEC_ORDER=FEC_SRTP;non_seq=1;feedback=0
a=rtpmap:112 mari-rtx/90000
a=fmtp:112 RTX_ORDER=RTX_SRTP;rtx-time=180
```



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c=IN IP4 139.177.65.158
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a=cisco-mari-rate
a=cisco-mari-rtx:v0
a=cisco-mari-hybrid-resilience:v0
m=audio 30024 RTP/SAVP 99 105 9 0 8 18 102 101 111 112
a=sendrecv
a=rtpmap:99 opus/48000/2
a=rtpmap:105 xcodec/48000
a=fmtp:105 performance=HP;encode-versions=1;decode-versions=1
a=rtpmap:9 G722/8000
a=rtpmap:0 PCMU/8000
a=rtpmap:8 PCMA/8000
a=rtpmap:18 G729/8000
a=fmtp:18 annexb=no
a=rtpmap:102 iLBC/8000
a=fmtp:102 mode=30
a=rtpmap:101 telephone-event/8000
a=rtpmap:111 x-ulpfecuc/8000
a=fmtp:111 max_esel=1400;max_n=255;m=8;multi_ssrc=1;FEC_ORDER=FEC_SRTP;non_seq=1;feedback=0
a=rtpmap:112 mari-rtx/90000
a=fmtp:112 RTX_ORDER=RTX_SRTP;rtx-time=180
```

Connection Data

Session Description Protocol (SDP) – Offer

```
v=0
o=BroadWorks 30594492 1738354280029 IN IP4 139.177.65.158
c=IN IP4 139.177.65.158
t=0 0
a=cisco-mari:v1
a=cisco-mari-rate
a=cisco-mari-rtx:v0
a=cisco-mari-hybrid-resilience:v0
m=audio 30024 RTP/SAVP 99 105 9 0 8 18 102 101 111 112
a=sendrecv
a=rtpmap:99 opus/48000/2
a=rtpmap:105 xcodec/48000
a=fmtp:105 performance=HP;encode-versions=1;decode-versions=1
a=rtpmap:9 G722/8000
a=rtpmap:0 PCMU/8000
a=rtpmap:8 PCMA/8000
a=rtpmap:18 G729/8000
a=fmtp:18 annexb=no
a=rtpmap:102 iLBC/8000
a=fmtp:102 mode=30
a=rtpmap:101 telephone-event/8000
a=rtpmap:111 x-ulpfecuc/8000
a=fmtp:111 max_esel=1400;max_n=255;m=8;multi_ssrc=1;FEC_ORDER=FEC_SRTP;non_seq=1;feedback=0
a=rtpmap:112 mari-rtx/90000
a=fmtp:112 RTX_ORDER=RTX_SRTP;rtx-time=180
```

Session Description Protocol (SDP) - Offer

```
v=0
o=BroadWorks 30594492 1738354280029 IN IP4 139.177.65.158
c=IN IP4 139.177.65.158
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a=cisco-mari-rtx:v0
a=cisco-mari-hybrid-resilience:v0
m=audio 30024 RTP/SAVP 99 105 9 0 8 18 102 101 111 112
a=sendrecv
a=rtpmap:99 opus/48000/2
a=rtpmap:105 xcodec/48000
a=fmtp:105 performance=HP;encode-versions=1;decode-versions=1
a=rtpmap:9 G722/8000
a=rtpmap:0 PCMU/8000
a=rtpmap:8 PCMA/8000
a=rtpmap:18 G729/8000
a=fmtp:18 annexb=no
a=rtpmap:102 iLBC/8000
a=fmtp:102 mode=30
a=rtpmap:101 telephone-event/8000
a=rtpmap:111 x-ulpfecuc/8000
a=fmtp:111 max_esel=1400;max_n=255;m=8;multi_ssrc=1;FEC_ORDER=FEC_SRTP;non_seq=1;feedback=0
a=rtpmap:112 mari-rtx/90000
a=fmtp:112 RTX_ORDER=RTX_SRTP;rtx-time=180
```

Audio m-line

Session Description Protocol (SDP) - Offer

```
v=0
o=BroadWorks 30594492 1738354280029 IN IP4 139.177.65.158
c=IN IP4 139.177.65.158
t=0 0
a=cisco-mari:v1
a=cisco-mari-rate
a=cisco-mari-rtx:v0
a=cisco-mari-hybrid-resilience:v0
m=audio 30024 RTP/SAVP 99 105 9 0 8 18 102 101 111 112
a=sendrecv
a=rtpmap:99 opus/48000/2
a=rtpmap:105 xcodec/48000
a=fmtp:105 performance=HP;encode-versions=1;decode-versions=1
a=rtpmap:9 G722/8000
a=rtpmap:0 PCMU/8000
a=rtpmap:8 PCMA/8000
a=rtpmap:18 G729/8000
a=fmtp:18 annexb=no
a=rtpmap:102 iLBC/8000
a=fmtp:102 mode=30
a=rtpmap:101 telephone-event/8000
a=rtpmap:111 x-ulpfecuc/8000
a=fmtp:111 max_esel=1400;max_n=255;m=8;multi_ssrc=1;FEC_ORDER=FEC_SRTP;non_seq=1;feedback=0
a=rtpmap:112 mari-rtx/90000
a=fmtp:112 RTX_ORDER=RTX_SRTP;rtx-time=180
```

Audio m-line

UDP Port

Session Description Protocol (SDP) - Offer

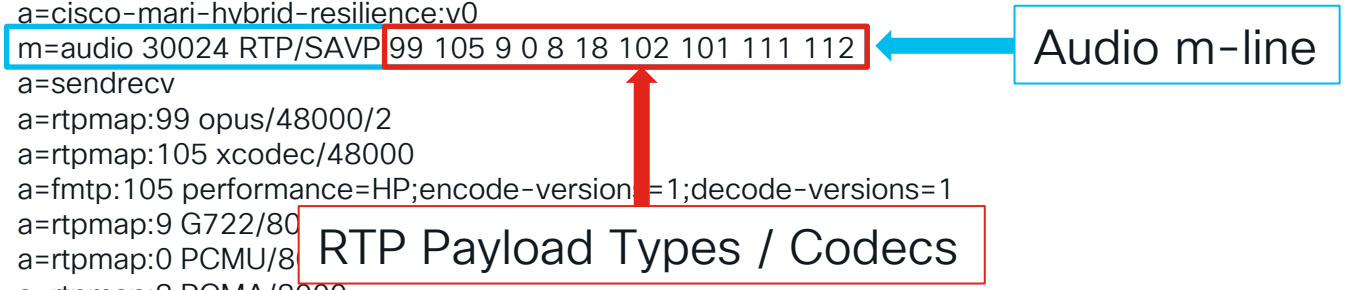
```
v=0
o=BroadWorks 30594492 1738354280029 IN IP4 139.177.65.158
c=IN IP4 139.177.65.158
t=0 0
a=cisco-mari:v1
a=cisco-mari-rate
a=cisco-mari-rtx:v0
a=cisco-mari-hybrid-resilience:v0
m=audio 30024 RTP/SAVP 99 105 9 0 8 18 102 101 111 112
a=sendrecv
a=rtpmap:99 opus/48000/2
a=rtpmap:105 xcodec/48000
a=fmtp:105 performance=HP;encode-versions=1;decode-versions=1
a=rtpmap:8 PCMA/8000
a=rtpmap:18 G729/8000
a=fmtp:18 annexb=no
a=rtpmap:102 iLBC/8000
a=fmtp:102 mode=30
a=rtpmap:101 telephone-event/8000
a=rtpmap:111 x-ulpfecuc/8000
a=fmtp:111 max_esel=1400;max_n=255;m=8;multi_ssrc=1;FEC_ORDER=FEC_SRTP;non_seq=1;feedback=0
a=rtpmap:112 mari-rtx/90000
a=fmtp:112 RTX_ORDER=RTX_SRTP;rtx-time=180
```

Audio m-line

Transport Protocol: AVP=RTP, SAVP=SRTP

Session Description Protocol (SDP) - Offer

```
v=0
o=BroadWorks 30594492 1738354280029 IN IP4 139.177.65.158
c=IN IP4 139.177.65.158
t=0 0
a=cisco-mari:v1
a=cisco-mari-rate
a=cisco-mari-rtx:v0
a=cisco-mari-hybrid-resilience:v0
m=audio 30024 RTP/SAVP 99 105 9 0 8 18 102 101 111 112
a=sendrecv
a=rtpmap:99 opus/48000/2
a=rtpmap:105 xcodec/48000
a=fmtp:105 performance=HP;encode-version=1;decode-versions=1
a=rtpmap:9 G722/80
a=rtpmap:0 PCMU/8
a=rtpmap:8 PCMA/8000
a=rtpmap:18 G729/8000
a=fmtp:18 annexb=no
a=rtpmap:102 iLBC/8000
a=fmtp:102 mode=30
a=rtpmap:101 telephone-event/8000
a=rtpmap:111 x-ulpfecuc/8000
a=fmtp:111 max_esel=1400;max_n=255;m=8;multi_ssrc=1;FEC_ORDER=FEC_SRTP;non_seq=1;feedback=0
a=rtpmap:112 mari-rtx/90000
a=fmtp:112 RTX_ORDER=RTX_SRTP;rtx-time=180
```



Session Description Protocol (SDP) – Offer

```
v=0
o=BroadWorks 30594492 1738354280029 IN IP4 139.177.65.158
c=IN IP4 139.177.65.158
t=0 0
a=cisco-mari:v1
a=cisco-mari-rate
a=cisco-mari-rtx:v0
a=cisco-mari-hybrid-resilience:v0
m=audio 30024 RTP/SAVP 99 105 9 0 8 18 102 101 111 112
a=sendrecv
a=rtpmap:99 opus/48000/2
a=rtpmap:105 xcodec/48000
a=fmtp:105 performance=HP;encode-versions=1;decode-versions=1
a=rtpmap:9 G722/8000
a=rtpmap:0 PCMU/8000
a=rtpmap:8 PCMA/8000
a=rtpmap:18 G729/8000
a=fmtp:18 annexb=no
a=rtpmap:102 iLBC/8000
a=fmtp:102 mode=30
a=rtpmap:101 telephone-event/8000
a=rtpmap:111 x-ulpfecuc/8000
a=fmtp:111 max_esel=1400;max_n=255;m=8;multi_ssrc=1;FEC_ORDER=FEC_SRTP;non_seq=1;feedback=0
a=rtpmap:112 mari-rtx/90000
a=fmtp:112 RTX_ORDER=RTX_SRTP;rtx-time=180
```

Media Attributes

Session Description Protocol (SDP) - Offer

```
a=extmap:4/sendrecv http://protocols.cisco.com/timestamp#100us
a=extmap:9/sendrecv http://www.webrtc.org/experiments/rtp-hdrext/abs-capture-time
a=rtcp-xr:rcvr-rtt=all voip-metrics
a=ice-ufrag:Xo3F
a=ice-pwd:8qUtOBXZvcs43hpqMc0dkPtCVQpnZA57
a=candidate:1 1 UDP 2113935615 192.168.1.107 8560 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8561 typ host
a=candidate:3 1 UDP 1677727999 136.56.9.219 8560 typ srflx raddr 192.168.1.107 rport 8560
a=candidate:3 2 UDP 1677727998 136.56.9.219 25567 typ srflx raddr 192.168.1.107 rport 8561
a=candidate:mse 1 UDP 16777215 139.177.65.158 30024 typ relay
a=candidate:mse 2 UDP 16777214 139.177.65.158 30025 typ relay
a=crypto:1 AES_CM_128_HMAC_SHA1_80 inline:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
m=video 8600 RTP/SAVP 109 111 112
b=AS:2500
a=sendrecv
a=rtpmap:109 H264/90000
a=fmtp:109 profile-level-id=42801f; packetization-mode=0
a=rtcp-fb:109 ccm fir
a=rtcp-fb:109 nack pli
a=rtcp-fb:109 nack
a=ice-ufrag:f1mh
a=ice-pwd:urqVaa2MTz5gKx0W0rk+Xad8X/nq41Qp
a=candidate:1 1 UDP 2113935615 192.168.1.107 8600 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8601 typ host
```

RTP Header Extensions

Session Description Protocol (SDP) - Offer

```
a=extmap:4/sendrecv http://protocols.cisco.com/timestamp#100us
a=extmap:9/sendrecv http://www.webrtc.org/experiments/rtp-hdrext/abs-capture-time
a=rtcp-xr:rcvr-rtt=all voip-metrics
a=ice-ufrag:Xo3F
a=ice-pwd:8qUtOBXZvcs43hpqMc0dkPtCVQpnZA57
a=candidate:1 1 UDP 2113935615 192.168.1.107 8560 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8561 typ host
a=candidate:3 1 UDP 1677727999 136.56.9.219 8560 typ srflx raddr 192.168.1.107 rport 8560
a=candidate:3 2 UDP 1677727998 136.56.9.219 25567 typ srflx raddr 192.168.1.107 rport 8561
a=candidate:mse 1 UDP 16777215 139.177.65.158 30024 typ relay
a=candidate:mse 2 UDP 16777214 139.177.65.158 30025 typ relay
a=crypto:1 AES_CM_128_HMAC_SHA1_80 inline:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
m=video 8600 RTP/SAVP 109 111 112
b=AS:2500
a=sendrecv
a=rtpmap:109 H264/90000
a=fmtp:109 profile-level-id=42801f; packetization-mode=0
a=rtcp-fb:109 ccm fir
a=rtcp-fb:109 nack pli
a=rtcp-fb:109 nack
a=ice-ufrag:f1mh
a=ice-pwd:urqVaa2MTz5gKx0W0rk+Xad8X/nq41Qp
a=candidate:1 1 UDP 2113935615 192.168.1.107 8600 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8601 typ host
```

RTP Control Protocol
Extended Reports (RFC 3611)

Session Description Protocol (SDP) – Offer

```
a=extmap:4/sendrecv http://protocols.cisco
a=extmap:9/sendrecv http://www.webrtc.or
a=rtcp-xr:rcvr-rtt=all voip-metrics
a=ice-ufrag:Xo3F
a=ice-pwd:8qUtOBXZvcs43hpqMc0dkPtCVQpnZA57
a=candidate:1 1 UDP 2113935615 192.168.1.107 8560 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8561 typ host
a=candidate:3 1 UDP 1677727999 136.56.9.219 8560 typ srflx raddr 192.168.1.107 rport 8560
a=candidate:3 2 UDP 1677727998 136.56.9.219 25567 typ srflx raddr 192.168.1.107 rport 8561
a=candidate:mse 1 UDP 16777215 139.177.65.158 30024 typ relay
a=candidate:mse 2 UDP 16777214 139.177.65.158 30025 typ relay
a=crypto:1 AES_CM_128_HMAC_SHA1_80 inline:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
m=video 8600 RTP/SAVP 109 111 112
b=AS:2500
a=sendrecv
a=rtpmap:109 H264/90000
a=fmtp:109 profile-level-id=42801f; packetization-mode=0
a=rtcp-fb:109 ccm fir
a=rtcp-fb:109 nack pli
a=rtcp-fb:109 nack
a=ice-ufrag:f1mh
a=ice-pwd:urqVaa2MTz5gKx0W0rk+Xad8X/nq41Qp
a=candidate:1 1 UDP 2113935615 192.168.1.107 8600 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8601 typ host
```

Interactive Connectivity Establishment (ICE)

Session Description Protocol (SDP) – Offer

a=extmap:4/sendrecv http://protocols.cisco
a=extmap:9/sendrecv http://www.webrtc.or
a=rtcp-xr:rcvr-rtt=all voip-metrics
a=ice-ufrag:Xo3F
a=ice-pwd:8qUtOBXZvcs43hpqMc0dkPtCVQpnZA57
a=candidate:1 1 UDP 211[illegible]935615 192.168.1.107 8560 typ host
a=candidate:1 2 UDP 211[illegible]935614 192.168.1.107 8561 typ host
a=candidate:3 1 UDP 167[illegible]727999 136.56.9.219 8560 typ srflx raddr 192.168.1.107 rport 8560
a=candidate:3 2 UDP 167[illegible]727998 136.56.9.219 25567 typ srflx raddr 192.168.1.107 rport 8561
a=canc[illegible]5.158 30024 typ relay
a=canc[illegible]5.158 30025 typ relay
a=crypto:1 AES_CM_128_HMAC_SHA1_80 inline:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
m=video 8600 RTP/SAVP 109 111 112
b=AS:2500
a=sendrecv
a=rtpmap:109 H264/90000
a=fmtp:109 profile-level-id=42801f; packetization-mode=0
a=rtcp-fb:109 ccm fir
a=rtcp-fb:109 nack pli
a=rtcp-fb:109 nack
a=ice-ufrag:f1mh
a=ice-pwd:urqVaa2MTz5gKx0W0rk+Xad8X/nq41Qp
a=candidate:1 1 UDP 2113935615 192.168.1.107 8600 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8601 typ host

Interactive Connectivity Establishment (ICE)

Username / Password

Session Description Protocol (SDP) – Offer

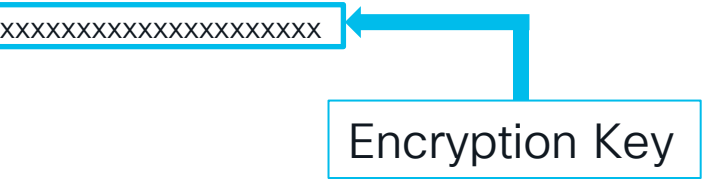
```
a=extmap:4/sendrecv http://protocols.cisco
a=extmap:9/sendrecv http://www.webrtc.or
a=rtcp-xr:rcvr-rtt=all voip-metrics
a=ice-ufrag:Xo3F
a=ice-pwd:8qUtOBXZvcs43hpqMc0dkPtCVQpnZA57
a=candidate:1 1 UDP 2113935615 192.168.1.107 8560 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8561 typ host
a=candidate:3 1 UDP 1677727999 136.56.9.219 8560 typ srflx raddr 192.168.1.107 rport 8560
a=candidate:3 2 UDP 1677727998 136.56.9.219 25567 typ srflx raddr 192.168.1.107 rport 8561
a=candidate:mse 1 UDP 16777215 139.177.65.158 30024 typ relay
a=candidate:mse 2 UDP 16777214 139.177.65.158 30025 typ relay
a=crypto:1 AES_CM_128_HMAC_SHA1_8 inline:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
m=video 8600 RTP/SAVP 109 111 112
b=AS:2500
a=sendrecv
a=rtpmap:109 H264/90000
a=fmtp:109 profile-level-id= =0
a=rtcp-fb:109 ccm fir
a=rtcp-fb:109 nack pli
a=rtcp-fb:109 nack
a=ice-ufrag:f1mh
a=ice-pwd:urqVaa2MTz5gKx0W0rk+Xad8X/nq41Qp
a=candidate:1 1 UDP 2113935615 192.168.1.107 8600 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8601 typ host
```

Interactive Connectivity Establishment (ICE)

ICE Candidates

Session Description Protocol (SDP) - Offer

```
a=extmap:4/sendrecv http://protocols.cisco.com/timestamp#100us
a=extmap:9/sendrecv http://www.webrtc.org/experiments/rtp-hdrext/abs-capture-time
a=rtcp-xr:rcvr-rtt=all voip-metrics
a=ice-ufrag:Xo3F
a=ice-pwd:8qUtOBXZvcs43hpqMc0dkPtCVQpnZA57
a=candidate:1 1 UDP 2113935615 192.168.1.107 8560 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8561 typ host
a=candidate:3 1 UDP 1677727999 136.56.9.219 8560 typ srflx raddr 192.168.1.107 rport 8560
a=candidate:3 2 UDP 1677727998 136.56.9.219 25567 typ srflx raddr 192.168.1.107 rport 8561
a=candidate:mse 1 UDP 16777215 139.177.65.158 30024 typ relay
a=candidate:mse 2 UDP 16777214 139.177.65.158 30025 typ relay
a=crypto:1 AES_CM_128_HMAC_SHA1_80 inline:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
m=video 8600 RTP/SAVP 109 111 112
b=AS:2500
a=sendrecv
a=rtpmap:109 H264/90000
a=fmtp:109 profile-level-id=42801f; packetization-mode=0
a=rtcp-fb:109 ccm fir
a=rtcp-fb:109 nack pli
a=rtcp-fb:109 nack
a=ice-ufrag:f1mh
a=ice-pwd:urqVaa2MTz5gKx0W0rk+Xad8X/nq41Qp
a=candidate:1 1 UDP 2113935615 192.168.1.107 8600 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8601 typ host
```



Session Description Protocol (SDP) - Offer

```
a=extmap:4/sendrecv http://protocols.cisco.com/timestamp#100us
a=extmap:9/sendrecv http://www.webrtc.org/experiments/rtp-hdrext/abs-capture-time
a=rtcp-xr:rcvr-rtt=all voip-metrics
a=ice-ufrag:Xo3F
a=ice-pwd:8qUtOBXZvcs43hpqMc0dkPtCVQpnZA57
a=candidate:1 1 UDP 2113935615 192.168.1.107 8560 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8561 typ host
a=candidate:3 1 UDP 1677727999 136.56.9.219 8560 typ srflx raddr 192.168.1.107 rport 8560
a=candidate:3 2 UDP 1677727998 136.56.9.219 25567 typ srflx raddr 192.168.1.107 rport 8561
a=candidate:mse 1 UDP 16777215 139.177.65.158 30024 typ relay
a=candidate:mse 2 UDP 16777214 139.177.65.158 30025 typ relay
a=crypto:1 AES_CM_128_HMAC_SHA1_80 inline:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
m=video 8600 RTP/SAVP 109 111 112
b=AS:2500
a=sendrecv
a=rtpmap:109 H264/90000
a=fmtp:109 profile-level-id=42801f; packetization-mode=0
a=rtcp-fb:109 ccm fir
a=rtcp-fb:109 nack pli
a=rtcp-fb:109 nack
a=ice-ufrag:f1mh
a=ice-pwd:urqVaa2MTz5gKx0W0rk+Xad8X/nq41Qp
a=candidate:1 1 UDP 2113935615 192.168.1.107 8600 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8601 typ host
```

Video m-line

Session Description Protocol (SDP) - Offer

```
a=extmap:4/sendrecv http://protocols.cisco.com/timestamp#100us
a=extmap:9/sendrecv http://www.webrtc.org/experiments/rtp-hdrext/abs-capture-time
a=rtcp-xr:rcvr-rtt=all voip-metrics
a=ice-ufrag:Xo3F
a=ice-pwd:8qUtOBXZvcs43hpqMc0dkPtCVQpnZA57
a=candidate:1 1 UDP 2113935615 192.168.1.107 8560 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8561 typ host
a=candidate:3 1 UDP 1677727999 136.56.9.219 8560 typ srflx raddr 192.168.1.107 rport 8560
a=candidate:3 2 UDP 1677727998 136.56.9.219 25567 typ srflx raddr 192.168.1.107 rport 8561
a=candidate:mse 1 UDP 16777215 139.177.65.158 30024 typ relay
a=candidate:mse 2 UDP 16777214 139.177.65.158 30025 typ relay
a=crypto:1 AES_CM_128_HMAC_SHA1_80 inline:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
m=video 8600 RTP/SAVP 109 111 112
b=AS:2500
a=sendrecv
a=rtpmap:109 H264/90000
a=fmtp:109 profile-level-id=42801f; packetization-mode=0
a=rtcp-fb:109 ccm fir
a=rtcp-fb:109 nack pli
a=rtcp-fb:109 nack
a=ice-ufrag:f1mh
a=ice-pwd:urqVaa2MTz5gKx0W0rk+Xad8X/nq41Qp
a=candidate:1 1 UDP 2113935615 192.168.1.107 8600 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8601 typ host
```

Bandwidth

Session Description Protocol (SDP) - Offer

```
a=extmap:4/sendrecv http://protocols.cisco.com/timestamp#100us
a=extmap:9/sendrecv http://www.webrtc.org/experiments/rtp-hdrext/abs-capture-time
a=rtcp-xr:rcvr-rtt=all voip-metrics
a=ice-ufrag:Xo3F
a=ice-pwd:8qUtOBXZvcs43hpqMc0dkPtCVQpnZA57
a=candidate:1 1 UDP 2113935615 192.168.1.107 8560 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8561 typ host
a=candidate:3 1 UDP 1677727999 136.56.9.219 8560 typ srflx raddr 192.168.1.107 rport 8560
a=candidate:3 2 UDP 1677727998 136.56.9.219 25567 typ srflx raddr 192.168.1.107 rport 8561
a=candidate:mse 1 UDP 16777215 139.177.65.158 30024 typ relay
a=candidate:mse 2 UDP 16777214 139.177.65.158 30025 typ relay
a=crypto:1 AES_CM_128_HMAC_SHA1_80 inline:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
m=video 8600 RTP/SAVP 109 111 112
b=AS:2500
a=sendrecv
a=rtpmap:109 H264/90000
a=fmtp:109 profile-level-id=42801f; packetization-mode=0
a=rtcp-fb:109 ccm fir
a=rtcp-fb:109 nack pli
a=rtcp-fb:109 nack
a=ice-ufrag:f1mh
a=ice-pwd:urqVaa2MTz5gKx0W0rk+Xad8X/nq41Qp
a=candidate:1 1 UDP 2113935615 192.168.1.107 8600 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8601 typ host
```

Direction Attribute

Session Description Protocol (SDP) - Offer

```
a=extmap:4/sendrecv http://protocols.cisco.com/timestamp#100us
a=extmap:9/sendrecv http://www.webrtc.org/experiments/rtp-hdrext/abs-capture-time
a=rtcp-xr:rcvr-rtt=all voip-metrics
a=ice-ufrag:Xo3F
a=ice-pwd:8qUtOBXZvcs43hpqMc0dkPtCVQpnZA57
a=candidate:1 1 UDP 2113935615 192.168.1.107 8560 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8561 typ host
a=candidate:3 1 UDP 1677727999 136.56.9.219 8560 typ srflx raddr 192.168.1.107 rport 8560
a=candidate:3 2 UDP 1677727998 136.56.9.219 25567 typ srflx raddr 192.168.1.107 rport 8561
a=candidate:mse 1 UDP 16777215 139.177.65.158 30024 typ relay
a=candidate:mse 2 UDP 16777214 139.177.65.158 30025 typ relay
a=crypto:1 AES_CM_128_HMAC_SHA1_80 inline:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
m=video 8600 RTP/SAVP 109 111 112
b=AS:2500
a=sendrecv
a=rtpmap:109 H264/90000
a=fmtp:109 profile-level-id=42801f; packetization-mode=0
a=rtcp-fb:109 ccm fir
a=rtcp-fb:109 nack pli
a=rtcp-fb:109 nack
a=ice-ufrag:f1mh
a=ice-pwd:urqVaa2MTz5gKx0W0rk+Xad8X/nq41Qp
a=candidate:1 1 UDP 2113935615 192.168.1.107 8600 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8601 typ host
```

H.264 Attributes

Session Description Protocol (SDP) - Offer

```
a=extmap:4/sendrecv http://protocols.cisco.com/timestamp#100us
a=extmap:9/sendrecv http://www.webrtc.org/experiments/rtp-hdrext/abs-capture-time
a=rtcp-xr:rcvr-rtt=all voip-metrics
a=ice-ufrag:Xo3F
a=ice-pwd:8qUtOBXZvcs43hpqMc0dkPtCVQpnZA57
a=candidate:1 1 UDP 2113935615 192.168.1.107 8560 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8561 typ host
a=candidate:3 1 UDP 1677727999 136.56.9.219 8560 typ srflx raddr 192.168.1.107 rport 8560
a=candidate:3 2 UDP 1677727998 136.56.9.219 25567 typ srflx raddr 192.168.1.107 rport 8561
a=candidate:mse 1 UDP 16777215 139.177.65.158 30024 typ relay
a=candidate:mse 2 UDP 16777214 139.177.65.158 30025 typ relay
a=crypto:1 AES_CM_128_HMAC_SHA1_80 inline:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
m=video 8600 RTP/SAVP 109 111 112
b=AS:2500
a=sendrecv
a=rtpmap:109 H264/90000
a=fmtp:109 profile-level-id=42801f; packetization-mode=0
a=rtcp-fb:109 ccm fir
a=rtcp-fb:109 nack pli
a=rtcp-fb:109 nack
a=ice-ufrag:f1mh
a=ice-pwd:urqVaa2MTz5gKx0W0rk+Xad8X/nq41Qp
a=candidate:1 1 UDP 2113935615 192.168.1.107 8600 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8601 typ host
```

RTCP Feedback (RFC 4585)

Session Description Protocol (SDP) - Offer

```
a=extmap:4/sendrecv http://protocols.cisco.com/timestamp#100us
a=extmap:9/sendrecv http://www.webrtc.org/experiments/rtp-hdrext/abs-capture-time
a=rtcp-xr:rcvr-rtt=all voip-metrics
a=ice-ufrag:Xo3F
a=ice-pwd:8qUtOBXZvcs43hpqMc0dkPtCVQpnZA57
a=candidate:1 1 UDP 2113935615 192.168.1.107 8560 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8561 typ host
a=candidate:3 1 UDP 1677727999 136.56.9.219 8560 typ srflx raddr 192.168.1.107 rport 8560
a=candidate:3 2 UDP 1677727998 136.56.9.219 25567 typ srflx raddr 192.168.1.107 rport 8561
a=candidate:mse 1 UDP 16777215 139.177.65.158 30024 typ relay
a=candidate:mse 2 UDP 16777214 139.177.65.158 30025 typ relay
a=crypto:1 AES_CM_128_HMAC_SHA1_80 inline:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
m=video 8600 RTP/SAVP 109 111 112
b=AS:2500
a=sendrecv
a=rtpmap:109 H264/90000
a=fmtp:109 profile-level-id=42801f; packet
a=rtcp-fb:109 ccm fir
a=rtcp-fb:109 nack pli
a=rtcp-fb:109 nack
a=ice-ufrag:f1mh
a=ice-pwd:urqVaa2MTz5gKx0W0rk+Xad8X/nq41Qp
a=candidate:1 1 UDP 2113935615 192.168.1.107 8600 typ host
a=candidate:1 2 UDP 2113935614 192.168.1.107 8601 typ host
```

Interactive Connectivity Establishment (ICE)

Session Description Protocol (SDP) - Answer

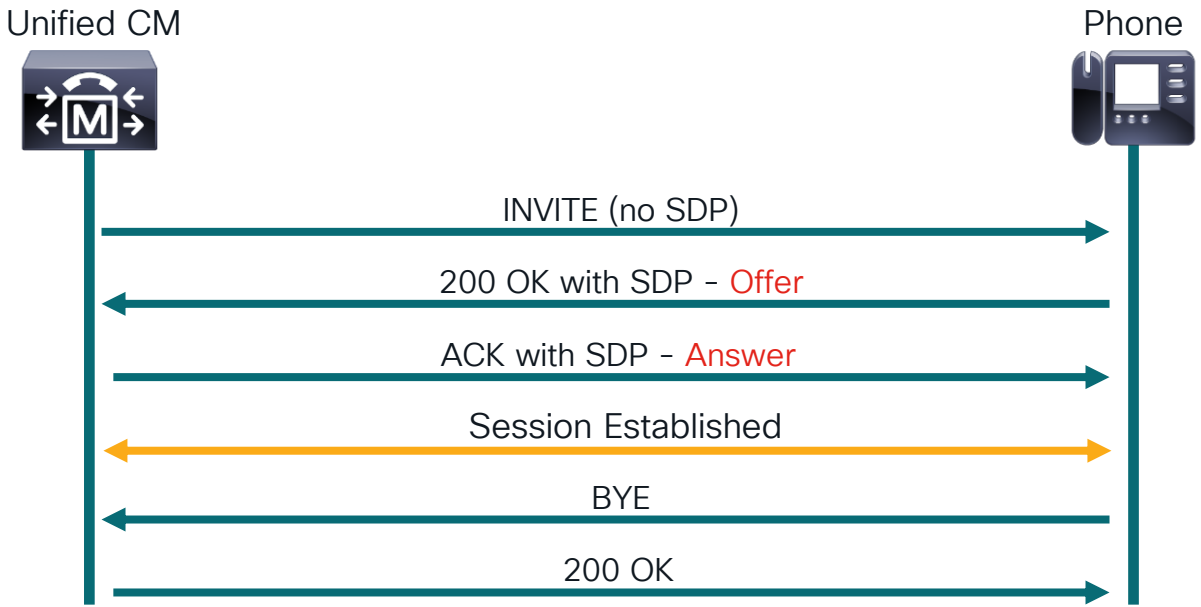
```
v=0
o=Broadworks 30594835 1738354282717 IN IP4 23.89.40.99
s=-
c=IN IP4 23.89.40.99
t=0 0
a=ice-lite
m=audio 28870 RTP/SAVP 0 101
c=IN IP4 23.89.40.99
a=rtpmap:0 PCMU/8000
a=rtpmap:101 telephone-event/8000
a=fmtp:101 0-15
a=ptime:20
a=candidate:1 1 UDP 2130706431 64.102.250.134 11550 typ host
a=candidate:1 2 UDP 2130706430 64.102.250.134 11551 typ host
a=ice-ufrag:QxSQ
a=ice-pwd:weO9wS0bmQ6N36wqAgmnhH
a=crypto:************************************************************************dKDj
a=candidate:mse 1 UDP 16777215 23.89.40.99 28870 typ relay
a=candidate:mse 2 UDP 16777214 23.89.40.99 28871 typ relay
m=video 0 RTP/SAVP 109
```

Media Negotiation – Early Offer and Delayed Offer

- Initiator of the call can send SDP offer in the INVITE – this is called an Early Offer (EO)
- Receiving endpoint can send the SDP offer in a response if the INVITE did not contain an offer – this is called a Delayed Offer (DO)
- For Early Offer, the answer is sent in a response (usually 200 OK).
- For Delayed Offer, the answer is typically sent in the ACK.

Early Offer

Delayed Offer

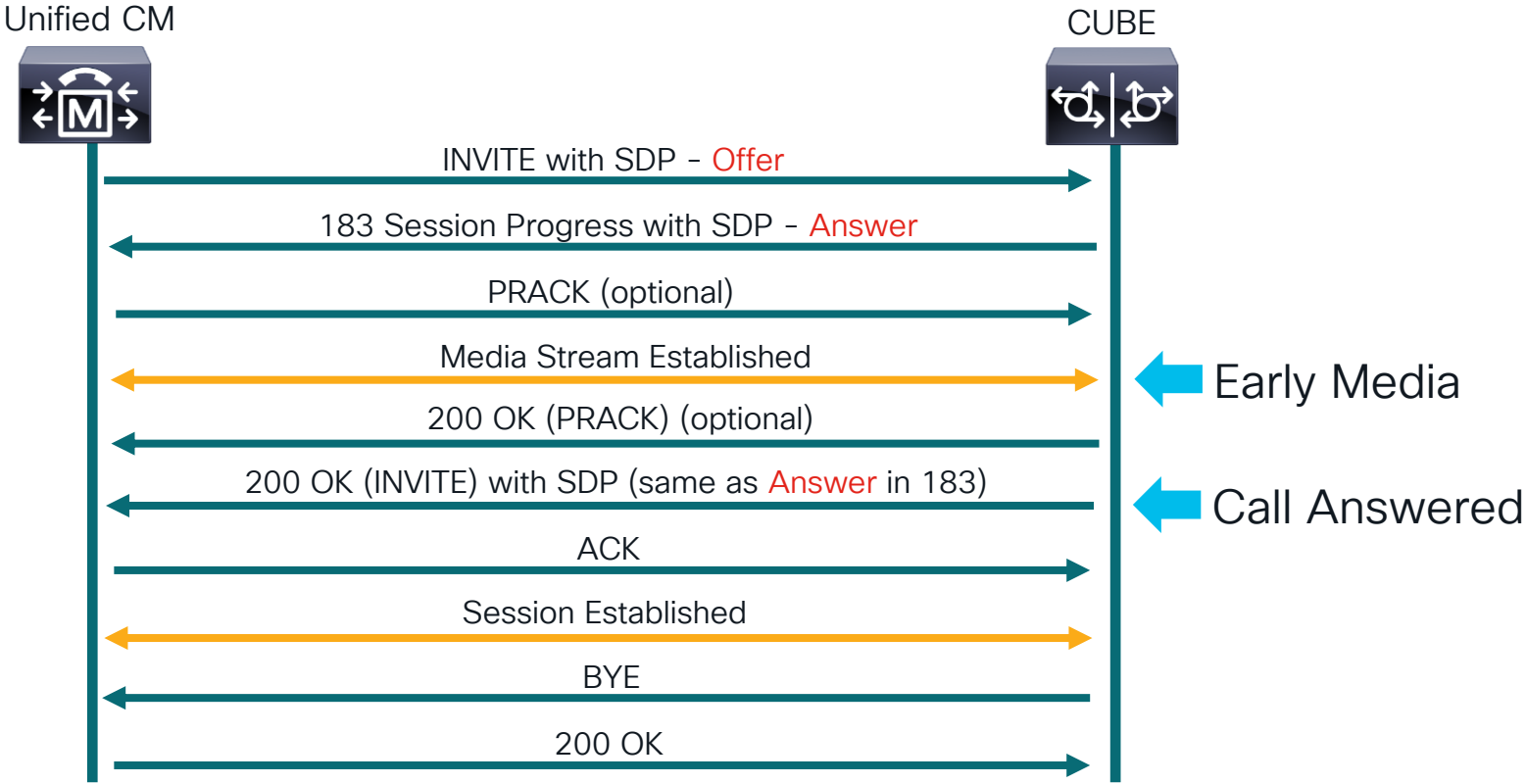


Early Media

- Delayed Offer calls do not set up media until the 200 OK (call is answered)
- If media is required prior to the call being connected, SIP has provisions for Early Media
- With Early Media on a Delayed Offer call, the offer comes from the terminating side in a provisional response (e.g. 183 Session Progress)
- Originating side sends SDP Answer in a PRACK message (defined in RFC 3262)

Early Media

Early Media w/ Early Offer



Media Re-negotiation

Re-INVITE

- Either UA involved in a call can re-INVITE an existing dialog to re-negotiate parameters for the call.
- Cannot re-INVITE until any previous INVITE messages have received a final response.
- UPDATE method can also be used to re-negotiate prior to a final response.

Media Re-negotiation

Re-INVITE w/ sendonly directly

Presence of “tag” in “To” header indicates re-INVITE

```
INVITE sip:23.89.40.102:8934;transport=tls SIP/2.0
Via: SIP/2.0/TLS 192.168.1.107:56281;branch=z9hG4bK955ab044eb0373d4;alias;rport
Max-Forwards: 70
To: sip:+18008001180@12013670.us10.bcld.webex.com;tag=1185912546-1738465877213
From: sip:c4628b59bp_GDWYMXEZAXNN_1@12013670.us10.bcld.webex.com;tag=b13de0ff609ca8acd6a451fc9353ef7d
CSeq: 1770842046 INVITE
Call-ID: 58e5733eab46f997f01185e5f3662785
Contact: <sip:c4628b59bp_GDWYMXEZAXNN_1@192.168.1.107:8933;transport=tls>
allow-events: hold, talk, mute, unmute
authorization: **********************************************************************************************
recv-info: x-broadworks-client-session-info
session-id: ce9bff85012050008000ac5e0b4f6183;remote=168cd19500cd5eed887cb044ce573c81
User-Agent: bc-uc teams (sparkmac/45.3.0.31637 (15.3.0) (en-US) (Native Desktop) (Purple))
Supported: timer, replaces, 100rel
Content-Type: application/sdp
Session-Expires: 3600;refresher=uac
Allow: INVITE, BYE, ACK, PRACK, CANCEL, OPTIONS, NOTIFY, INFO, UPDATE
Content-Length: 1466
```

Media Re-negotiation

Re-INVITE w/ sendonly directly

```
v=0
s=-
c=IN IP4 136.56.9.218
t=0 0
a=cisco-mari:v1
a=cisco-mari-rate
a=cisco-mari-rtx:v0
a=cisco-mari-hybrid-resilience:v0
m=audio 34039 RTP/SAVP 111 112 99 105 9 0 8 18 102 101
a=rtpmap:111 x-ulpfecuc/8000
a=fmtp:111 max_esel=1400;max_n=255;m=8;multi_ssrc=1;FEC_ORDER=FEC_SRTP;non_seq=1;feedback=0
a=rtpmap:112 mari-rtx/90000
a=fmtp:112 RTX_ORDER=RTX_SRTP;rtx-time=180
a=rtcp-xr:rcvr-rtt=all voip-metrics
a=sendonly
a=rtpmap:99 opus/48000/2
a=rtpmap:105 xcodec/48000
a=fmtp:105 performance=HP;encode-versions=1;decode-versions=1
a=rtpmap:9 G722/8000
a=rtpmap:0 PCMU/8000
a=rtpmap:8 PCMA/8000
a=rtpmap:18 G729/8000
```

Media Re-negotiation

Re-INVITE - stop media then re-negotiate

INVITE sip:dbe40e44-0dfe-45f1-bd7f-e652098ca344@10.116.101.41:49833;transport=tls SIP/2.0
Via: SIP/2.0/TLS 172.18.106.59:5061;branch=z9hG4bK901f9c72c19221
From: "Paul Giralt" <sip:89915644@172.18.106.59>;tag=15462272~0d0d25d7-4931-4a07-83c6-b82e2c213ca7-45545776
To: <sip:89915644@172.18.106.59>;tag=0022bdd6843100702aae8e5b-4be253be
Date: Wed, 11 Jan 2025 03:08:51 GMT
Call-ID: 8c045780-f0c1fd34-8d838f-3b6a12ac@172.18.106.59
Supported: timer,resource-priority,replaces
Min-SE: 1800
User-Agent: Cisco-CUCM15.0
Allow: INVITE, OPTIONS, INFO, BYE, CANCEL, ACK, PRACK, UPDATE, REFER, SUBSCRIBE, NOTIFY
CSeq: 104 INVITE
Max-Forwards: 70
Expires: 180
Allow-Events: presence
Call-Info: <urn:x-cisco-remotecc:callinfo>; security= Authenticated; orientation= from; gci= 2-231448; call-instance= 2
Remote-Party-ID: "Paul Giralt" <sip:89915644@172.18.106.59>;party=calling;screen=yes;privacy=off
Contact: <sip:89915644@172.18.106.59:5061;transport=tls>
Content-Type: application/sdp
Content-Length: 489

Media Re-negotiation

Re-INVITE - stop media then re-negotiate

```
v=0
o=CiscoSystemsCCM-SIP 15462272 2 IN IP4 172.18.106.59
s=SIP Call
c=IN IP4 0.0.0.0
t=0 0
m=audio 19594 RTP/SAVP 9 101
a=crypto:XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
a=rtpmap:9 G722/8000
a=ptime:20
a=inactive
a=rtpmap:101 telephone-event/8000
a=fmtp:101 0-15
m=video 19444 RTP/AVP 126
b=TIAS:1000000
a=rtpmap:126 H264/90000
a=fmtp:126 profile-level-id=42801E;packetization-mode=1;level-asymmetry-allowed=1
a=inactive
a=mid:227796888
```

Media Re-negotiation

Re-INVITE – Delayed Offer to Re-establish Media Stream

```
INVITE sip:dbe40e44-0dfe-45f1-bd7f-e652098ca344@10.116.101.41:49833;transport=tls SIP/2.0
Via: SIP/2.0/TLS 172.18.106.59:5061;branch=z9hG4bK901fac34c0fb1b
From: "Paul Giralt" <sip:89915644@172.18.106.59>;tag=15462272~0d0d25d7-4931-4a07-83c6-b82e2c213ca7-45545776
To: <sip:89915644@172.18.106.59>;tag=0022bdd6843100702aae8e5b-4be253be
Date: Wed, 11 Jan 2025 03:08:52 GMT
Call-ID: 8c045780-f0c1fd34-8d838f-3b6a12ac@172.18.106.59
Supported: timer,resource-priority,replaces
Min-SE:  1800
User-Agent: Cisco-CUCM15.0
Allow: INVITE, OPTIONS, INFO, BYE, CANCEL, ACK, PRACK, UPDATE, REFER, SUBSCRIBE, NOTIFY
CSeq: 106 INVITE
Max-Forwards: 70
Expires: 180
Allow-Events: presence
Call-Info: <urn:x-cisco-remotecc:callinfo>; security= NotAuthenticated; orientation= from; gci= 2-231448; call-instance= 2
Remote-Party-ID: "Paul Giralt" <sip:89915644@172.18.106.59>;party=calling;screen=yes;privacy=off
Contact: <sip:89915644@172.18.106.59:5061;transport=tls>
Content-Length: 0
```

Media Re-negotiation

Re-INVITE – Offer in 200 OK

SIP/2.0 200 OK
Via: SIP/2.0/TLS 172.18.106.59:5061;branch=z9hG4bK901fac34c0fb1b
From: "Paul Giralt" <sip:89915644@172.18.106.59>;tag=15462272~0d0d25d7-4931-4a07-83c6-b82e2c213ca7-45545776
To: <sip:89915644@172.18.106.59>;tag=0022bdd6843100702aae8e5b-4be253be
Call-ID: 8c045780-f0c1fd34-8d838f-3b6a12ac@172.18.106.59
Date: Wed, 11 Jan 2025 03:08:52 GMT
CSeq: 106 INVITE
Server: Cisco-8865/12.0.1
Contact: <sip:dbe40e44-0dfe-45f1-bd7f-e652098ca344@10.116.101.41:49833;transport=tls>
Allow: ACK,BYE,CANCEL,INVITE,NOTIFY,OPTIONS,REFER,REGISTER,UPDATE,SUBSCRIBE,INFO
Remote-Party-ID: "Paul Giralt" <sip:89915644@172.18.106.59>;party=called;id-type=subscriber;privacy=off;screen=yes
Supported: replaces,join,sdp-anat,norefersub,extended-refer,X-cisco-callinfo,X-cisco-serviceuri,X-cisco-escapecodes,X-cisco-service-control,X-cisco-srtp-fallback,X-cisco-monrec,X-cisco-config,X-cisco-sis-5.2.0,X-cisco-xsi-8.5.1
Allow-Events: kpml,dialog
Recv-Info: conference
Recv-Info: x-cisco-conference
Content-Length: 788
Content-Type: application/sdp
Content-Disposition: session;handling=optional

Media Re-negotiation

Re-INVITE – Offer in 200 OK

```
v=0
o=Cisco-SIPUA 26259 2 IN IP4 10.116.101.41
s=SIP Call
t=0 0
m=audio 32518 RTP/SAVP 0 8 18 102 9 116 124 101
c=IN IP4 10.116.101.41
a=crypto:XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
a=rtpmap:0 PCMU/8000
a=rtpmap:8 PCMA/8000
a=rtpmap:18 G729/8000
a=rtpmap:102 L16/16000
a=rtpmap:9 G722/8000
a=rtpmap:116 iLBC/8000
a=rtpmap:124 ISAC/16000
a=rtpmap:101 telephone-event/8000
a=fmtp:101 0-15
a=sendrecv
m=video 17614 RTP/AVP 126 97
c=IN IP4 10.116.101.41
b=TIAS:2500000
a=rtpmap:126 H264/90000
a=fmtp:126 profile-level-id=42801F;packetization-mode=1;level-asymmetry-allowed=1
a=rtpmap:97 H264/90000
a=fmtp:97 profile-level-id=42801F;packetization-mode=0;level-asymmetry-allowed=1
a=sendrecv
```

Media Re-negotiation

Re-INVITE – Answer in ACK

```
ACK sip:dbe40e44-0dfe-45f1-bd7f-e652098ca344@10.116.101.41:49833;transport=tls SIP/2.0
Via: SIP/2.0/TLS 172.18.106.59:5061;branch=z9hG4bK901fb064465a06
From: "Paul Giralt" <sip:89915644@172.18.106.59>;tag=15462272~0d0d25d7-4931-4a07-83c6-b82e2c213ca7-45545776
To: <sip:89915644@172.18.106.59>;tag=0022bdd6843100702aae8e5b-4be253be
Date: Wed, 11 Jan 2025 03:08:52 GMT
Call-ID: 8c045780-f0c1fd34-8d838f-3b6a12ac@172.18.106.59
Max-Forwards: 70
CSeq: 106 ACK
Allow-Events: presence
Content-Type: application/sdp
Content-Length: 446
```

Media Re-negotiation

Re-INVITE – Answer in ACK – Decline Video Support

```
v=0
o=CiscoSystemsCCM-SIP 15462272 3 IN IP4 172.18.106.59
s=SIP Call
t=0 0
m=audio 4000 RTP/SAVP 0
c=IN IP4 172.18.106.58
a=crypto:XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
a=rtpmap:0 PCMU/8000
a=ptime:20
a=sendonly
m=video 0 RTP/AVP 126
c=IN IP4 10.116.101.50
b=TIAS:1000000
a=rtpmap:126 H264/90000
a=fmtp:126 profile-level-id=42801E;packetization-mode=1;level-asymmetry-allowed=1
a=mid:227796888
```

DTMF Relay

- 3 Methods for passing DTMF digits over a SIP network:
  - RFC 4733 (a.k.a. RFC 2833)
  - SIP NOTIFY
  - SIP Keypad Markup Language (KPML)

DTMF Relay

RFC 4733 / RFC 2833

- Digits are passed in the RTP stream with a unique payload type
- Capability is negotiated in SDP like any other codec

Offer

```
m=audio 30414 RTP/AVP 0 8 116 18 100 101
c=IN IP4 172.18.106.231
a=rtpmap:0 PCMU/8000
a=rtpmap:8 PCMA/8000
a=rtpmap:116 iLBC/8000
a=fmtp:116 mode=20
a=rtpmap:18 G729/8000
a=fmtp:18 annexb=no
a=rtpmap:100 X-NSE/800
a=fmtp:100 192-194
a=rtpmap:101 telephone-event/8000
a=fmtp:101 0-16
```

Answer

```
m=audio 17236 RTP/AVP 0 101
a=rtpmap:0 PCMU/8000
a=ptime:20
a=rtpmap:101 telephone-event/8000
a=fmtp:101 0-15
```

DTMF Relay

SIP NOTIFY

- Passes DTMF information in a SIP NOTIFY message telephone-event Event
- Negotiated in Call-Info header

```
INVITE sip:+19195553333@172.18.106.231:5060 SIP/2.0
Via: SIP/2.0/UDP 172.18.106.59:5060;branch=z9hG4bK9843c455840434
From: "Paul Giralt" <sip:9195551234@172.18.106.59>;tag=14902469~0d0d25d7-4931-4a07-83c6
To: <sip:+19195553333@172.18.106.231>
Date: Mon, 13 May 2024 14:48:00 GMT
Call-ID: 1a189580-1901fd20-962c99-3b6a12ac@172.18.106.59
... snip ...
Allow-Events: telephone-event
Call-Info: <sip:172.18.106.59:5060>;method="NOTIFY;Event=telephone-event;Duration=500"
Call-Info: <urn:x-cisco-remotecc:callinfo>;x-cisco-video-traffic-class=DESKTOP
... snip ...
Max-Forwards: 69
Content-Length: 0
```

DTMF Relay

SIP NOTIFY

```
SIP/2.0 200 OK
Via: SIP/2.0/UDP 172.18.106.59:5060;branch=z9hG4bK9843c455840434
From: "Paul Giralt" <sip:9195551234@172.18.106.59>;tag=14902469~0d0d25d7-4931-4a07-83c6
To: <sip:+19195553333@172.18.106.231>;tag=4363A830-17FC
Call-ID: 1a189580-1901fd20-962c99-3b6a12ac@172.18.106.59
... snip ...
Allow-Events: telephone-event
Call-Info: <sip:172.18.106.231:5060>;method="NOTIFY;Event=telephone-event;Duration=500”
... snip ...
Content-Length: 601
```

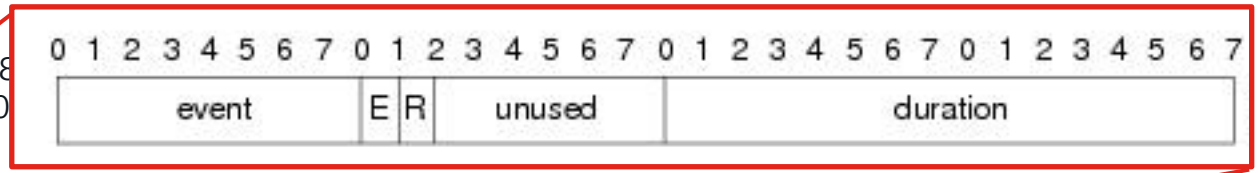
DTMF Relay

SIP NOTIFY

- Digits passed in payload of a NOTIFY message

```
NOTIFY sip:172.18.106.231:5060 SIP/2.0
Via: SIP/2.0/UDP 172.18.106.59:5060;branch=z9hG4bK98443140152a0a
From: "Paul Giralt" <sip:9195551234@172.18.106.59>;tag=14902469~0d0d25d7-4931-4a07-83c6
To: <sip:+19195553333@172.18.106.231>;tag=4363A830-17FC
Call-ID: 1a189580-1901fd20-962c99-3b6a12ac@172.18.106.59
CSeq: 104 NOTIFY
Max-Forwards: 70
Date: Mon, 13 May 2024 14:48
User-Agent: Cisco-CUCM15.0
Event: telephone-event
Subscription-State: active
Contact: <sip:172.18.106.59:5060>
P-Asserted-Identity: "Paul Giralt" <sip:9195551234@172.18.106.59>
Content-Type: audio/telephone-event
Content-Length: 4

.d
```



DTMF Relay

SIP KPML

- Passes DTMF information in a SIP NOTIFY message kpml Event
- Capability advertised in Allow-Events – uses SUBSCRIBE message to subscribe

```
INVITE sip:+19195554444@172.18.106.231:5060 SIP/2.0
Via: SIP/2.0/UDP 172.18.106.59:5060;branch=z9hG4bK986efd6c4e51e4
From: "Paul Giralt" <sip:9195551234@172.18.106.59>;tag=14918970~0d0d25d7-4931-4a07-83c6
To: <sip:+19195554444@172.18.106.231>
Date: Mon, 13 May 2024 15:05:24 GMT
Call-ID: 885e5780-19110134-96567f-3b6a12ac@172.18.106.59
User-Agent: Cisco-CUCM15.0
... snip ...
Allow-Events: presence, kpml
... snip ...
Session-Expires:  18000
Max-Forwards: 69
Content-Length: 0
```

DTMF Relay

SIP KPML

```
SIP/2.0 200 OK
Via: SIP/2.0/UDP 172.18.106.59:5060;branch=z9hG4bK986efd6c4e51e4
From: "Paul Giralt" <sip:9195551234@172.18.106.59>;tag=14918970~0d0d25d7-4931-4a07-83c6
To: <sip:+19195554444@172.18.106.231>;tag=437394E8-2E1
Date: Mon, 13 May 2017 15:05:26 GMT
Call-ID: 885e5780-19110134-96567f-3b6a12ac@172.18.106.59
CSeq: 101 INVITE
Allow: INVITE, OPTIONS, BYE, CANCEL, ACK, PRACK, UPDATE, REFER, SUBSCRIBE, NOTIFY, INFO
Allow-Events: kpml, telephone-event
Remote-Party-ID: <sip:9196247285@172.18.106.231>;party=called;screen=no;privacy=off
Contact: <sip:+19196247285@172.18.106.231:5060>
Supported: replaces
Server: Cisco-SIPGateway/IOS-15.6.2.T
Require: timer
Session-Expires: 18000;refresher=uac
Content-Type: multipart/mixed;boundary=uniqueBoundary
Mime-Version: 1.0
Content-Length: 600
```

DTMF Relay

SIP KPML

Subscribe to KPML

```
SUBSCRIBE sip:9195554444@172.18.106.59:5060 SIP/2.0
Via: SIP/2.0/UDP 172.18.106.231:5060;branch=z9hG4bKBAE27139E
From: <sip:+19195551234@172.18.106.231>;tag=437394E8-2E1
To: "Paul Giralt" <sip:9195554444@172.18.106.59>;tag=14918970~0d0d25d7-4931-4a07-83c6
Call-ID: 885e5780-19110134-96567f-3b6a12ac@172.18.106.59
CSeq: 101 SUBSCRIBE
Max-Forwards: 70
User-Agent: Cisco-SIPGateway/IOS-15.6.2.T
Event: kpml
Expires: 7200
Contact: <sip:172.18.106.231:5060>
Content-Type: application/kpml-request+xml
Content-Length: 327

<?xml version="1.0" encoding="UTF-8"?><kpml-request xmlns="urn:ietf:params:xml:ns:kpml-request"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="urn:ietf:params:xml:ns:kpml-
request kpml-request.xsd" version="1.0"><pattern persist="persist"><regex
tag="dtmf">[x*#ABCD]</regex></pattern></kpml-request>
```

DTMF Relay

SIP KPML

Send a Digit

```
NOTIFY sip:172.18.106.231:5060 SIP/2.0
Via: SIP/2.0/UDP 172.18.106.59:5060;branch=z9hG4bK986f73662cca3b
From: "Paul Giralt" <sip:9195554444@172.18.106.59>;tag=14918970~0d0d25d7-4931-4a07-83c6
To: <sip:+19195551234@172.18.106.231>;tag=437394E8-2E1
Call-ID: 885e5780-19110134-96567f-3b6a12ac@172.18.106.59
CSeq: 104 NOTIFY
Max-Forwards: 70
User-Agent: Cisco-CUCM12.0
Event: kpml
Subscription-State: active;expires=7197
Contact: <sip:9195554444@172.18.106.59:5060>
Content-Type: application/kpml-response+xml
Content-Length: 336

<?xml version="1.0" encoding="UTF-8" ?>
<kpml-response xmlns="urn:ietf:params:xml:ns:kpml-response"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="urn:ietf:params:xml:ns:kpml-response kpml-response.xsd" code="200" digits="1"
forced_flush="false" suppressed="false" tag="dtmf" text="Success" version="1.0"/>
```

SIP Session-ID (RFC 7989)

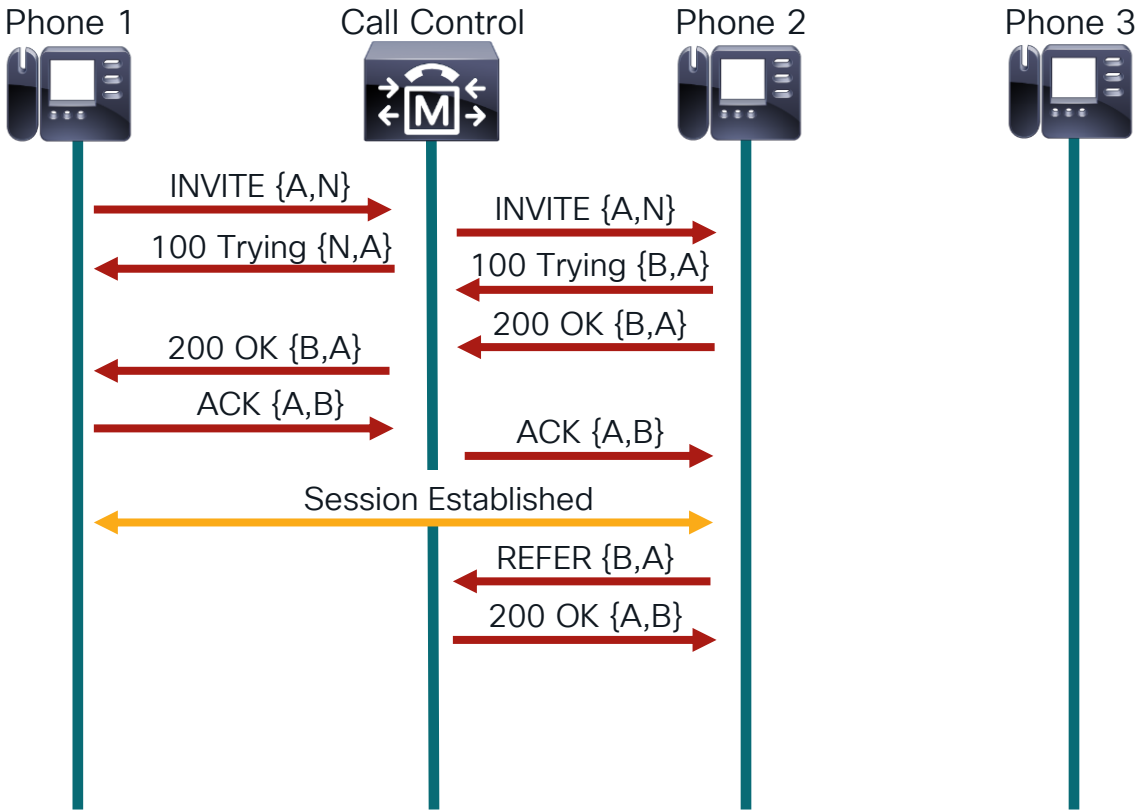
- Session-ID Header carries an end-to-end session identifier
- Allows you to track a call as it traverses through various SIP systems

Session-ID: 65596d4800105000a00074a02fc0d796 remote=747a0ead00105000a00074a02fc0cf3b

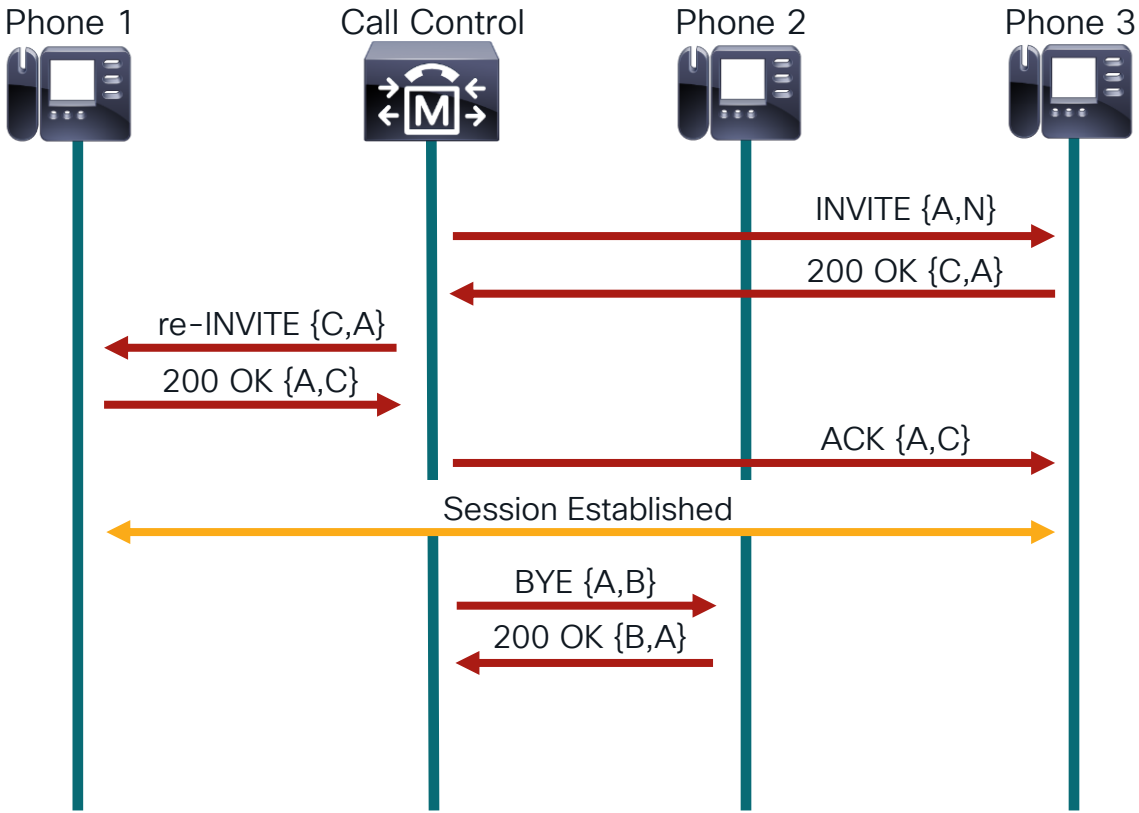
Local UUID | Remote UUID

- Each UUID represents an endpoint in the session
- Session Identifier represented as {A,B} referring to {local,remote} UUIDs
- {A,B} is equivalent to {B,A}
- Initial INVITE starts with the null (all zero) remote UUID represented as {A,N}

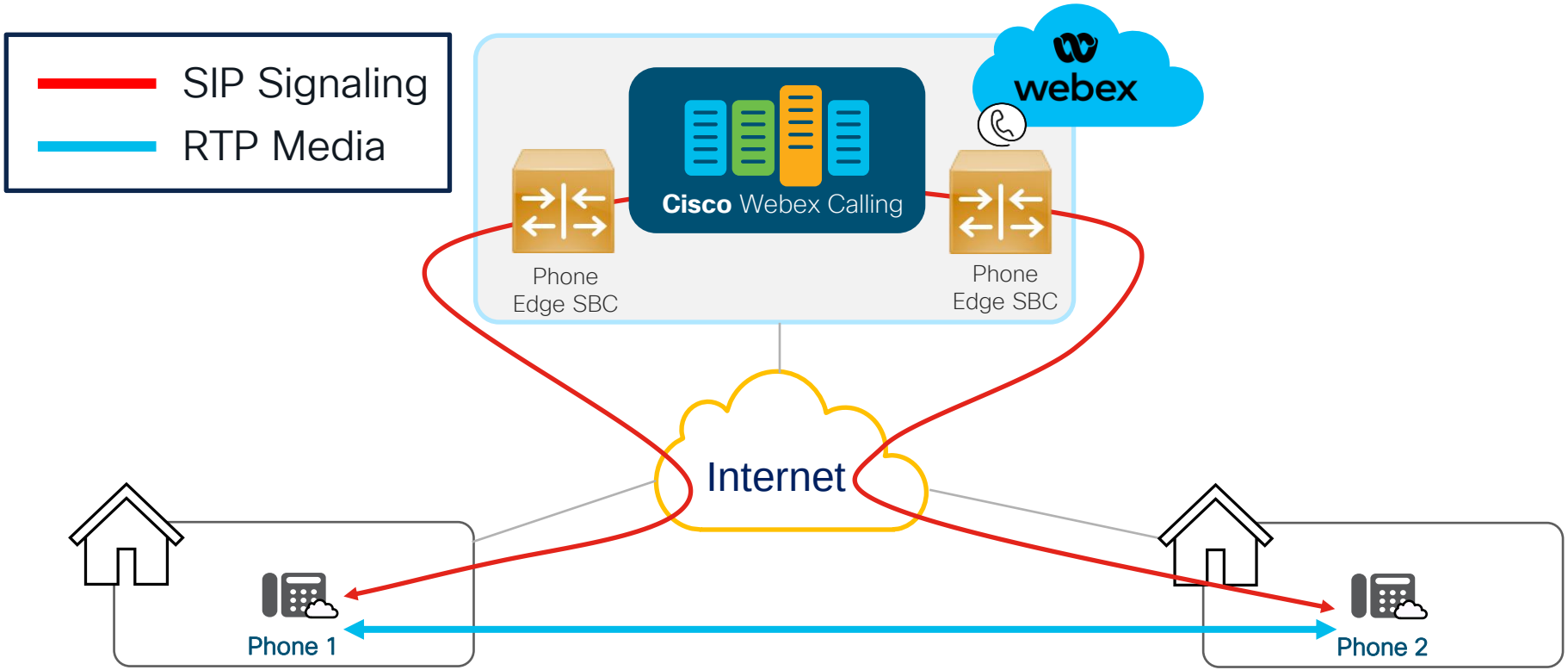
SIP Call with Session-ID Headers



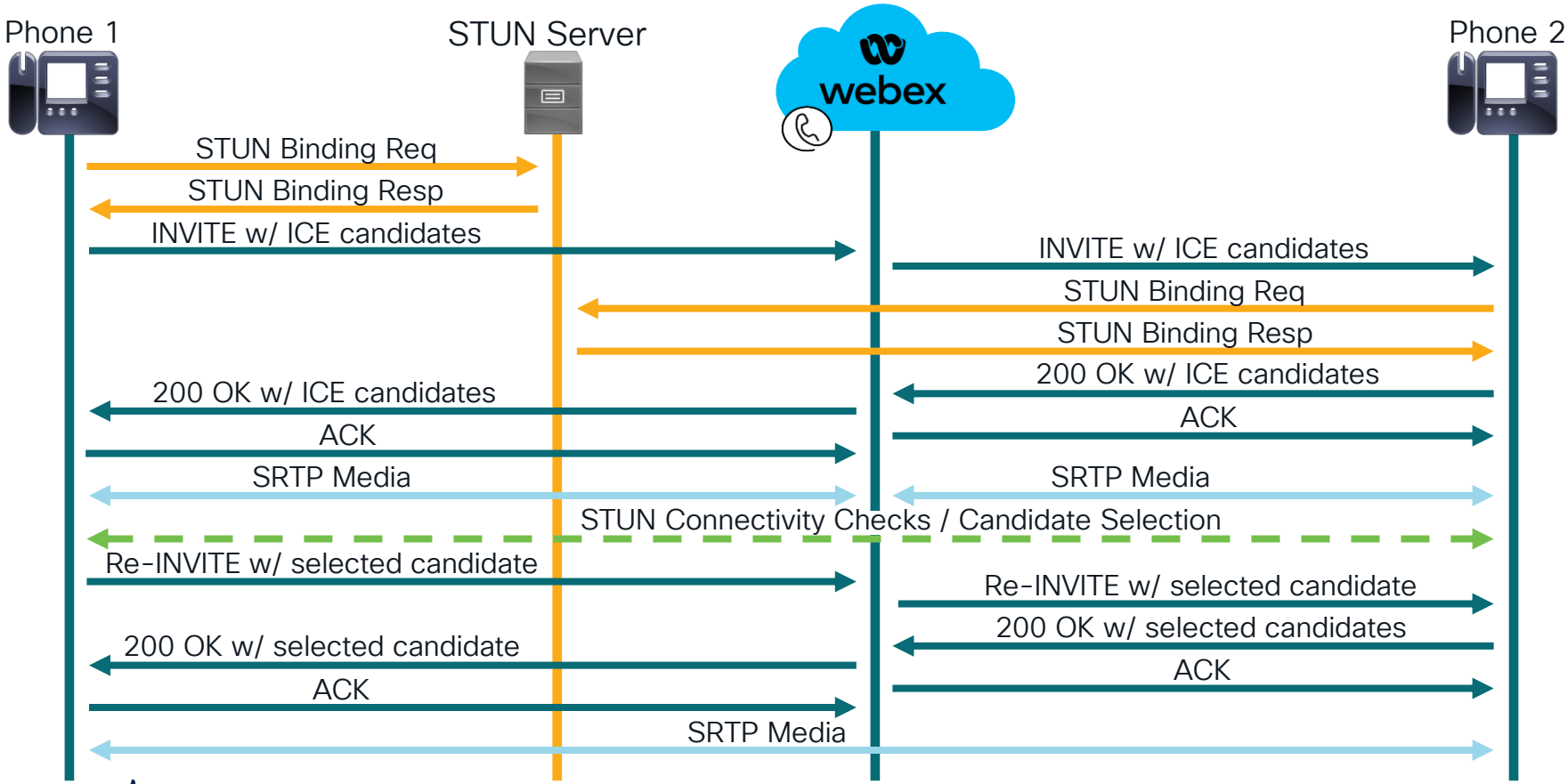
SIP Call with Session-ID Headers



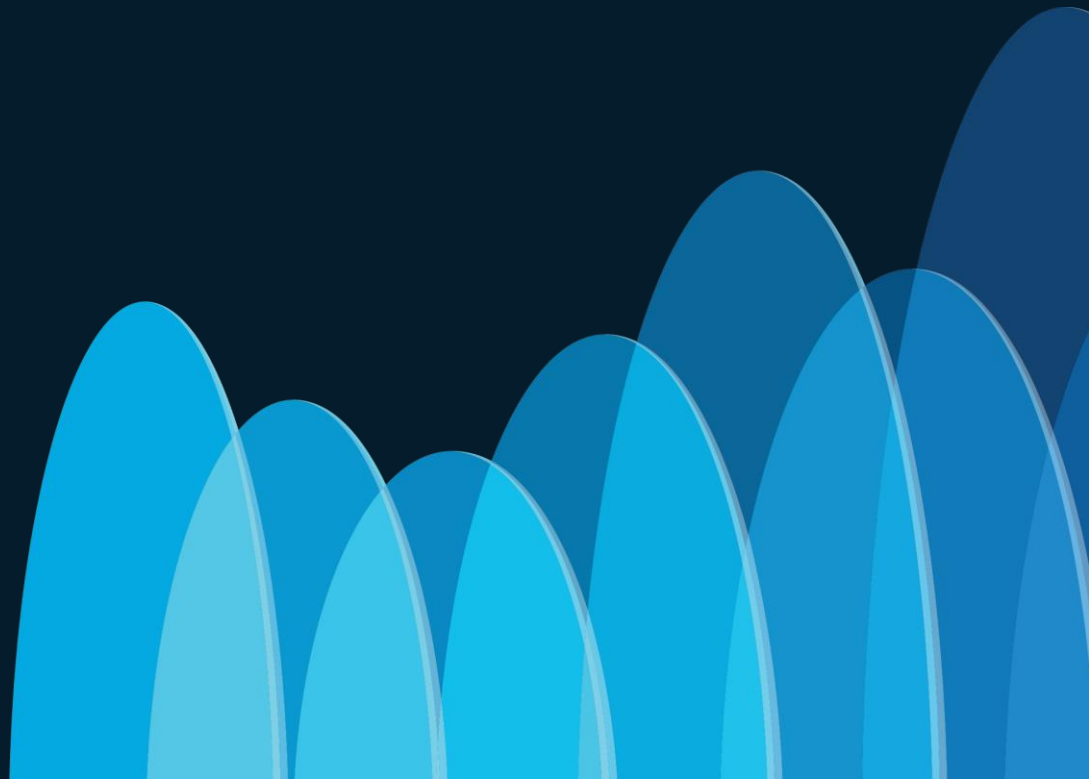
Interactive Connectivity Establishment (ICE)



Call Setup with ICE

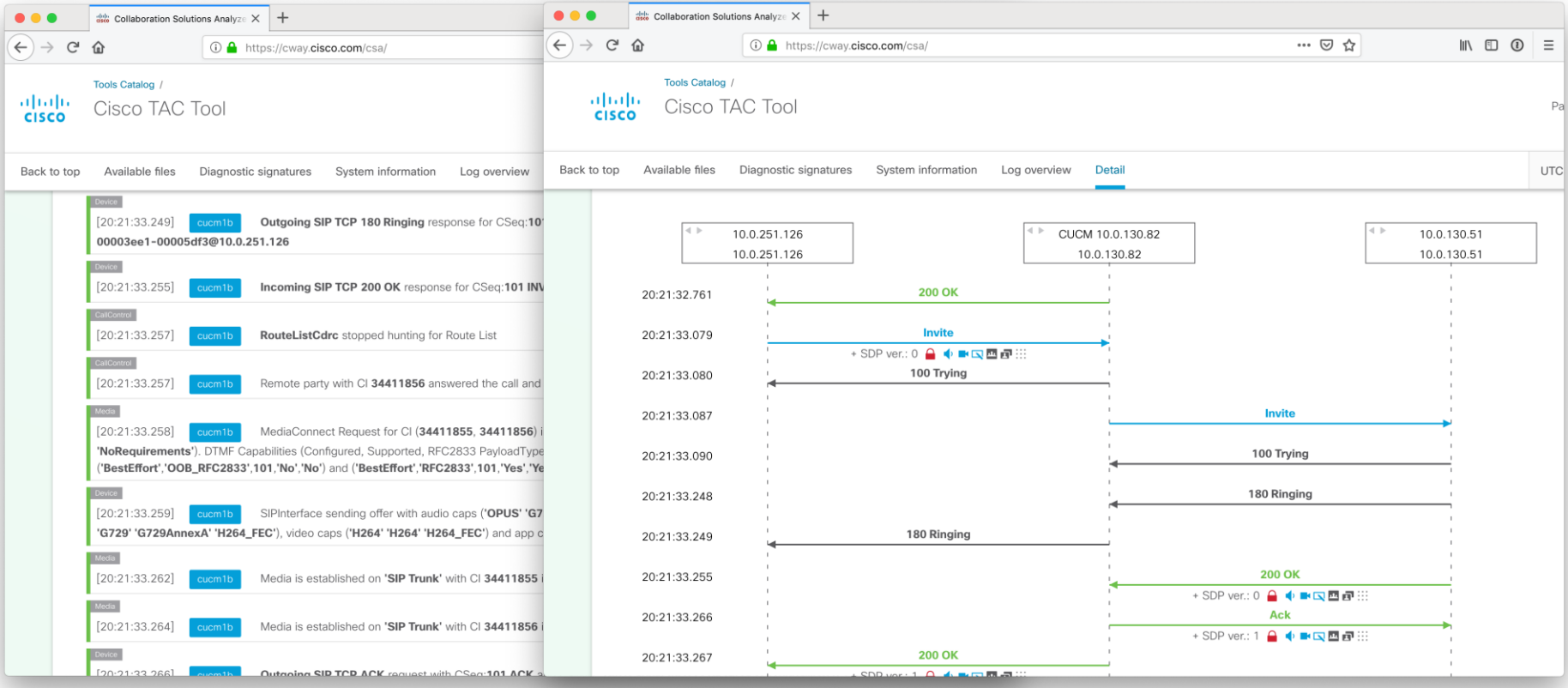


Troubleshooting Tools



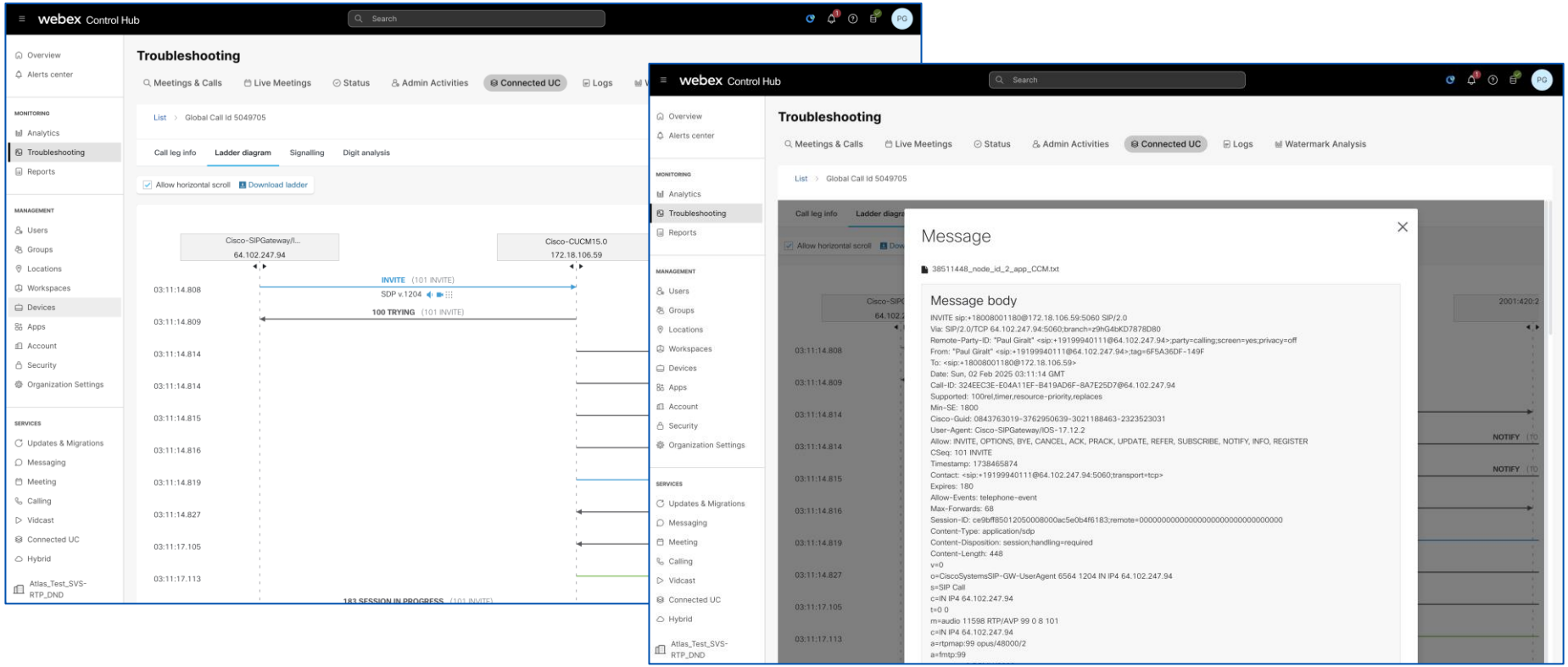
Collaboration Solutions Analyzer

cway.cisco.com/csa



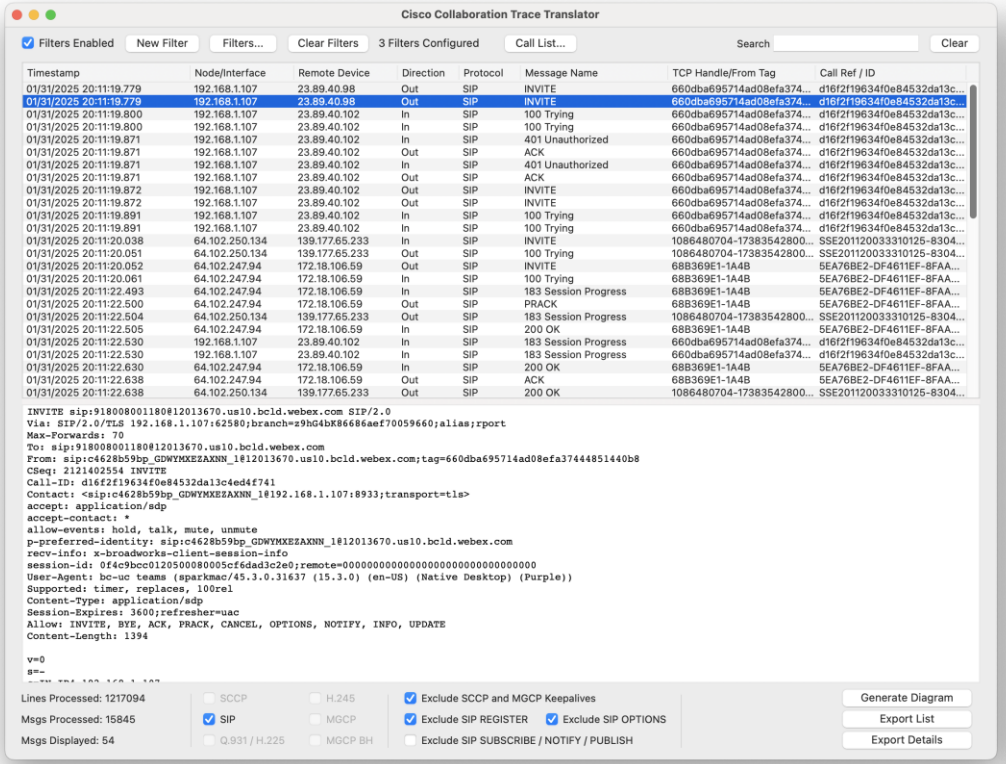
Connected UC Troubleshooting in Control Hub

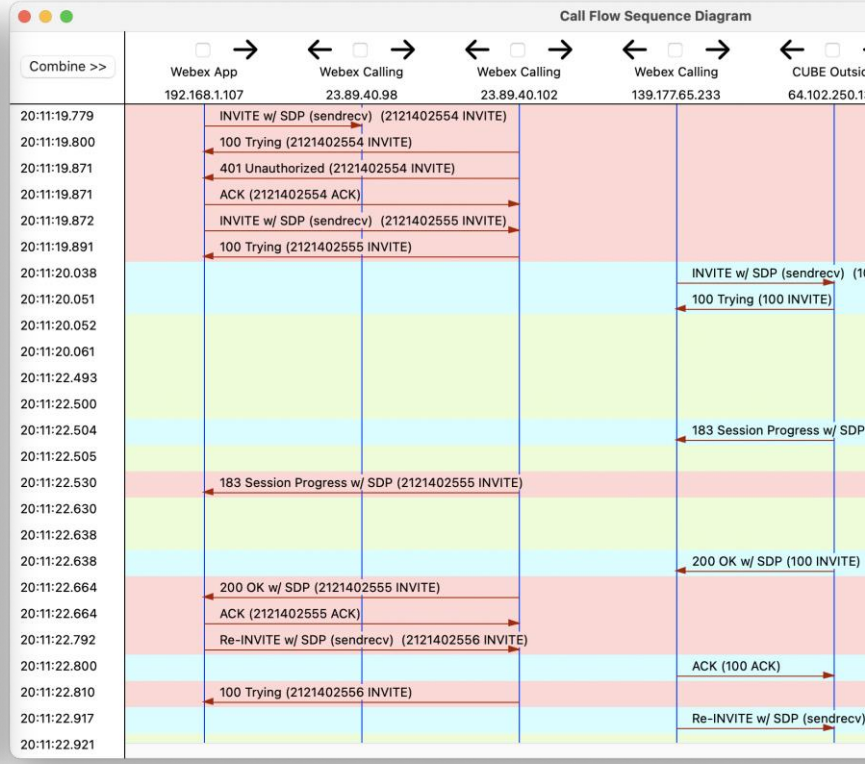
Troubleshooting > Connected UC



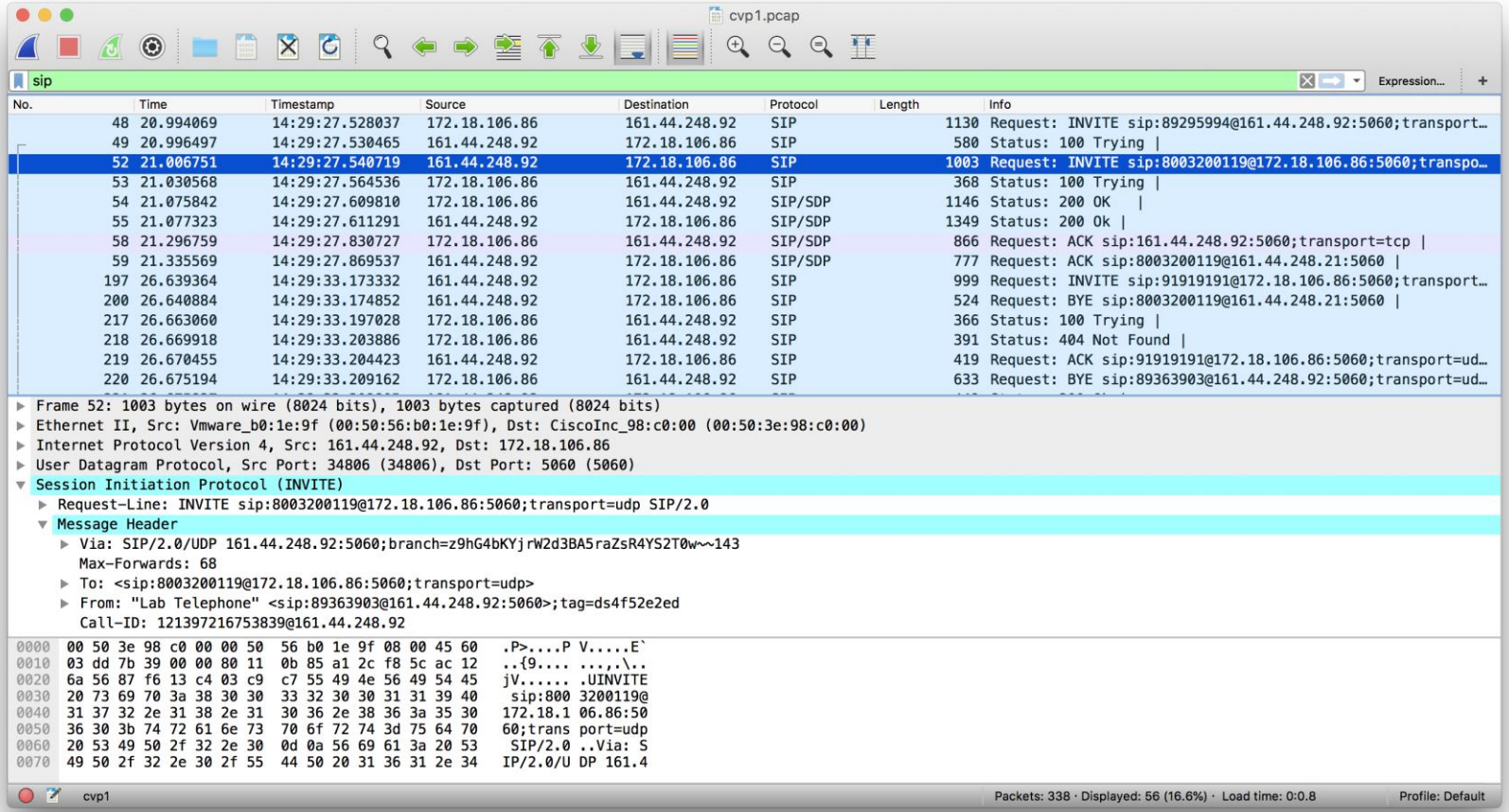
TranslatorX

Download from translatorx.org





Wireshark



SIP Troubleshooting Methodology & Case Studies

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Common SIP Problem Domains

- Call Establishment Failure
- Call Drop
- Mid-call feature failure
- Media-related issues (which may be due to signaling failures)
  - Audio cut-through delay
  - No audio / one-way audio
  - Media optimization issues
- Identity (name, number) Presentation Issues

Finding the Problematic Call(s)

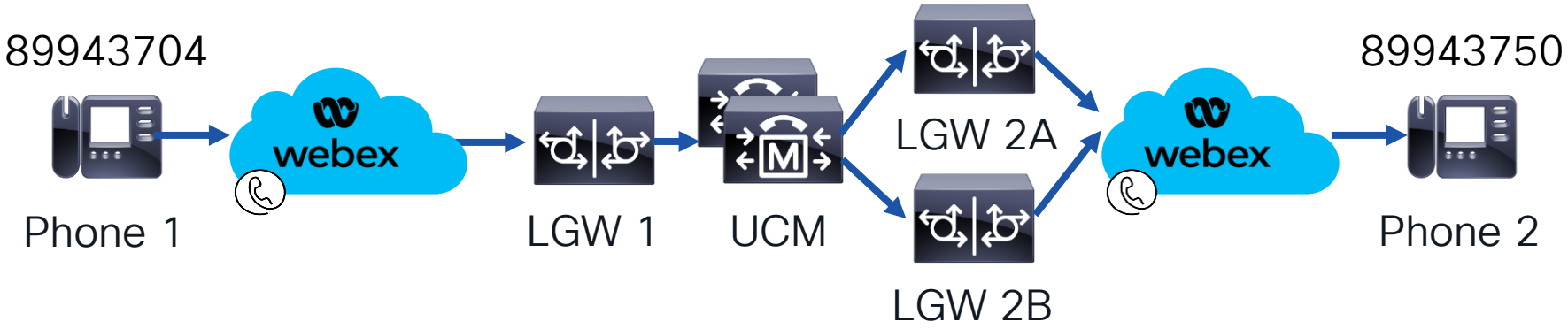
- Search by calling / called number
  - “INVITE sip:<number>”
  - Search on calling number or domain to find in From or PAI/PPI headers
- Search for calls with “bad” disconnect reasons
- Search for a timeframe when problem occurred
- Start a live log tail while reproducing the issue
- Search Call Detail Records
  - Search for calls based on number or disconnect reason
  - Find SIP Session ID, Call ID, Correlation ID and use to search SIP signaling

Call Establishment Failure

- Is the calling / called device registered?
- Does called / calling number match dial plan entries?
- Are calls blocked due to dial plan restrictions?
- Network related issue?
- TLS Handshake issues?
- Authentication issues?
- “Double Calls”

Call Establishment Failure

Calling from Phone 1 to Phone 2 Fails



Call Establishment Failure Demo

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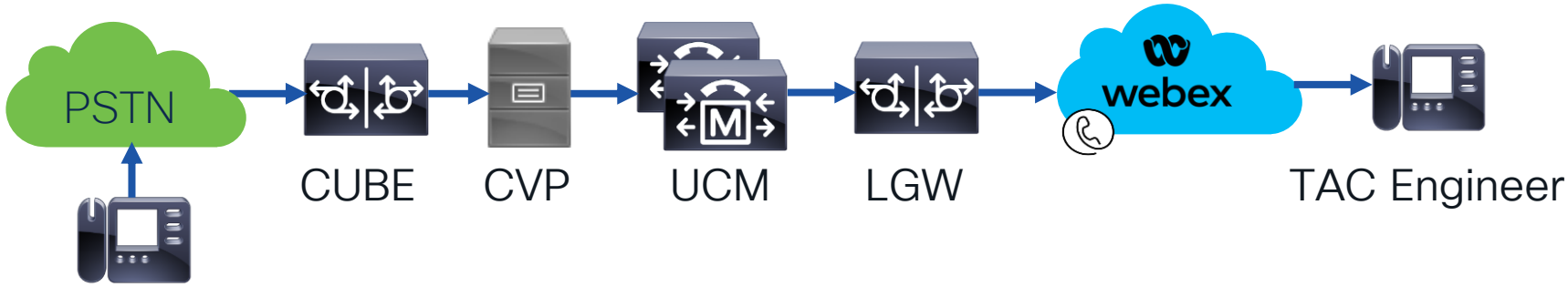
Call Drop

- When did the call drop happen?
- Which side dropped the call?
- Any Reason headers or other indications as to why?
- Any network issues at the time when the drop occurred?

Call Drop

TAC reports intermittent call drops



Call Drop Demo

Mid-Call Feature Failure

- Which side dropped the call?
- Is it reproducible?
- Where in the process of invoking the feature did it fail?

Media Related Issues

- Which IP addresses were negotiated for media?
- Did the call use Early Offer or Delayed Offer? Early Media?
- Was ICE attempted? Did it succeed?
- How long did it take to exchange the media?
- Does media issue start after a mid-call feature invocation?
- Check media direction attributes – stuck in inactive?
- If using SRTP, check for ROC issues

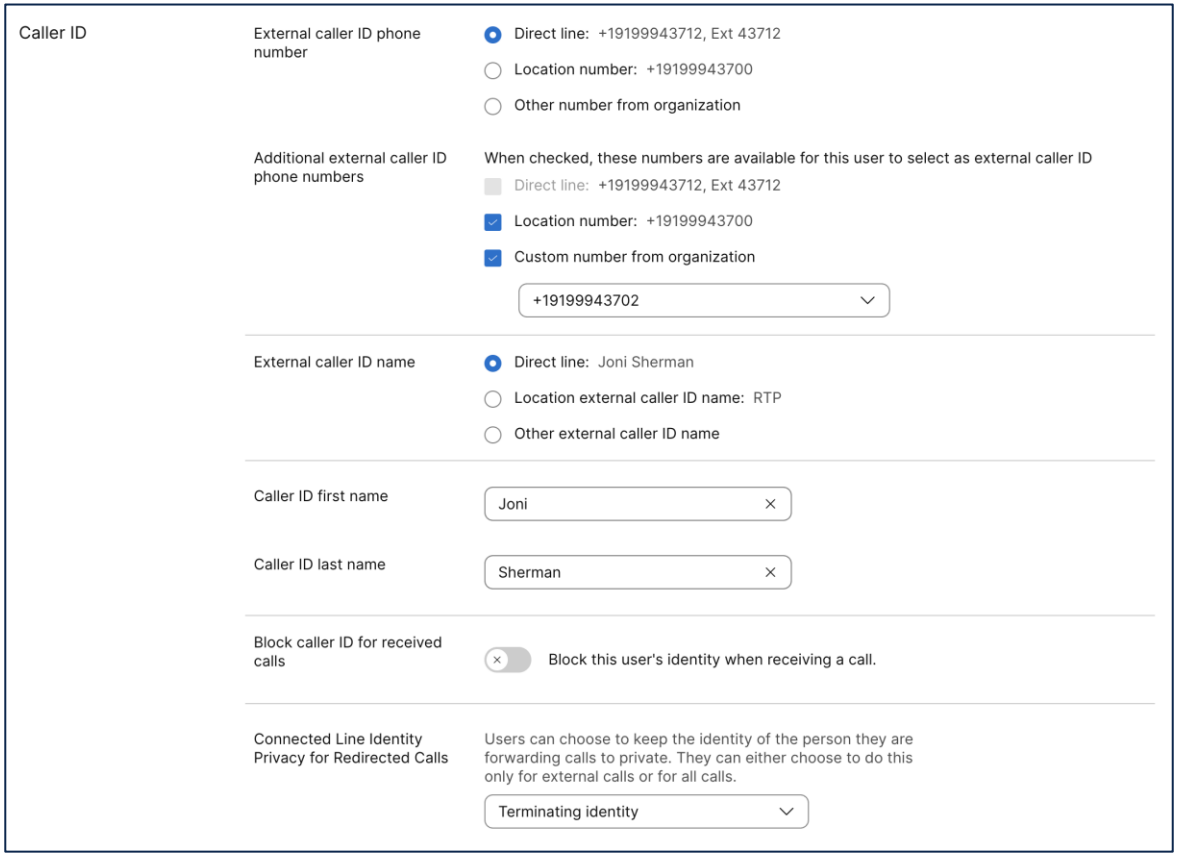
Identity Presentation Issues

- What do Identity Headers say at different points in the call?
  - From
  - P-Asserted-Identity (PAI)
  - P-Preferred-Identity (PPI)
- What transformations might be applied to calling / called name / number?
- Check for translations / transformations along the call path
- Pay attention to forward / transfer scenarios

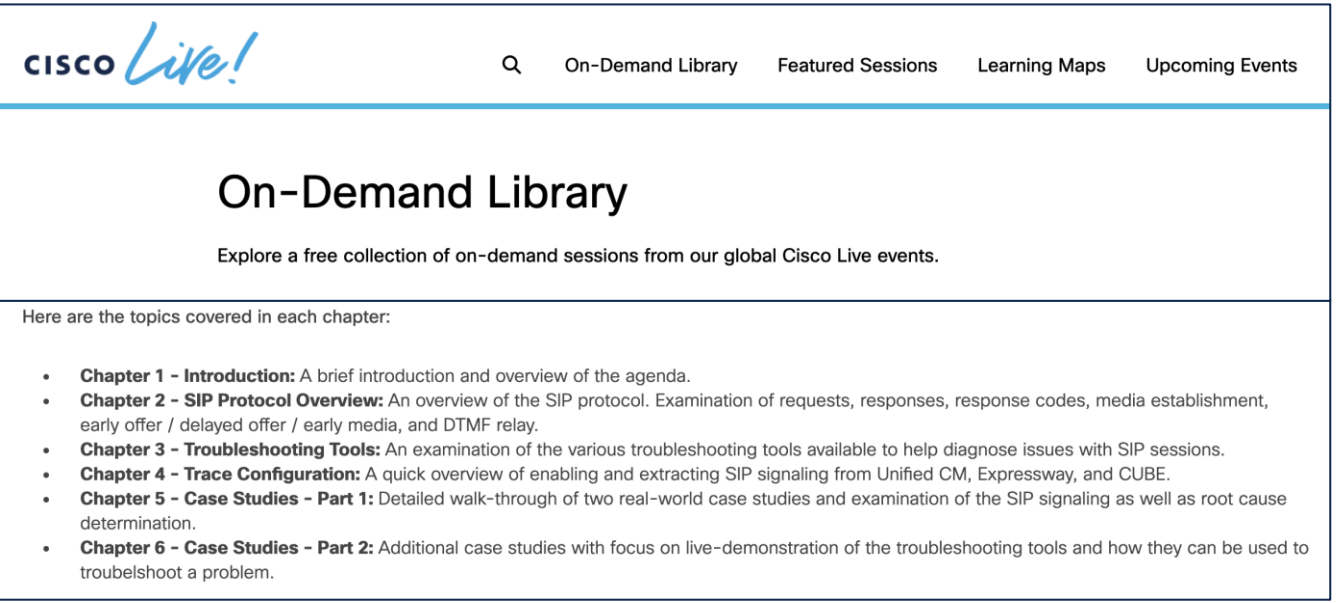
Caller ID for Calls from Webex Calling to Trunks

TN and/or extension configured?			"Caller ID Format for Calls from and to On-premises"	
			+E.164	ESN
TN	Extension	PAI	From	From
Yes	Yes	TN, +E.164	TN, +E.164	Location prefix + extension
Yes	No	TN, +E.164	TN, +E.164	According to user caller ID configuration, +E.164
No	Yes	Location main number, +E.164	According to user caller ID configuration, +E.164	Location prefix + extension
No	No	No calls allowed without either TN or extension configured		

Identity Presentation Issues



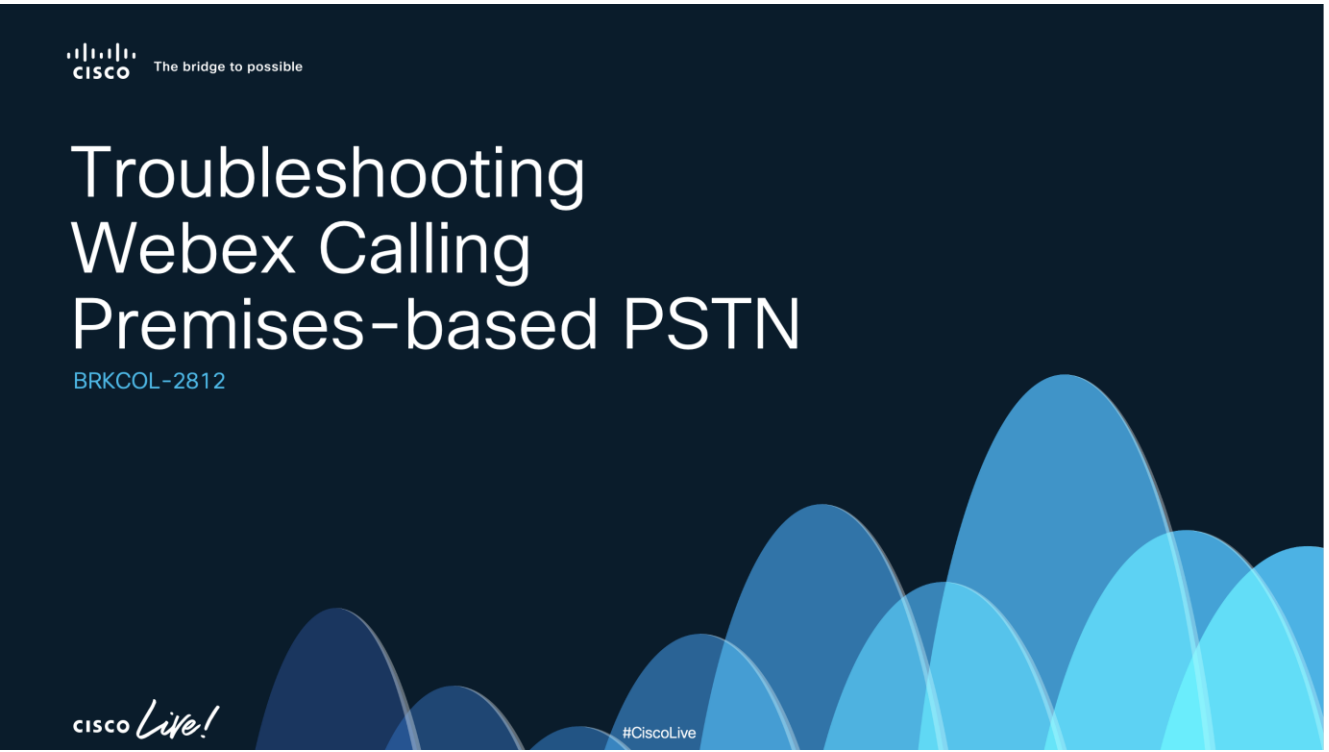
Additional SIP Training and Case Studies



Make sure you log in after going to the above site

https://www.ciscolive.com/on-demand/on-demand-library.html?#/session/1636060178064001 7Giu

Additional SIP Training and Case Studies



Make sure you log in after going to the above site

https://www.ciscolive.com/on-demand/on-demand-library.html?#/session/1717269041261001tKS9

Reference Materials

- Reference Slides at the end of the PDF for this presentation include trace configuration and download details for:
  - UCM
  - Expressway
  - CUBE
  - Webex App
  - PhoneOS / MPP Phones
  - RoomOS Devices

Conclusion

- Session Initiation Protocol (SIP) Overview
  - User Agents
  - Requests and Responses
  - Headers
  - Session Description Protocol
  - Offer / Answer Model
  - DTMF Relay
  - SIP Session ID
  - ICE Overview
- Troubleshooting Tools
- Troubleshooting Methodology & Case Studies
- Additional Resources

Webex App

Questions?

Use the Webex app to chat with the speaker after the session

How

1. Find this session in the Cisco Events mobile app
2. Click “Join the Discussion”
3. Install the Webex app or go directly to the Webex space
4. Enter messages/questions in the Webex space

Webex spaces will be moderated by the speaker until February 28, 2025.

Fill Out Your Session Surveys

Participants who fill out a minimum of 4 session surveys and the overall event survey will get a unique Cisco Live t-shirt.

(from 11:30 on Thursday, while supplies last)

All surveys can be taken in the Cisco Events mobile app or by logging in to the Session Catalog and clicking the ‘Participant Dashboard’

Content Catalog

Continue your education

- Visit the Cisco Showcase for related demos
- Book your one-on-one Meet the Engineer meeting
- Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs
- Visit the On-Demand Library for more sessions at ciscolive.com/on-demand. Sessions from this event will be available from March 3.

Contact me at: pgiralt@cisco.com on Webex


cisco
Thank you
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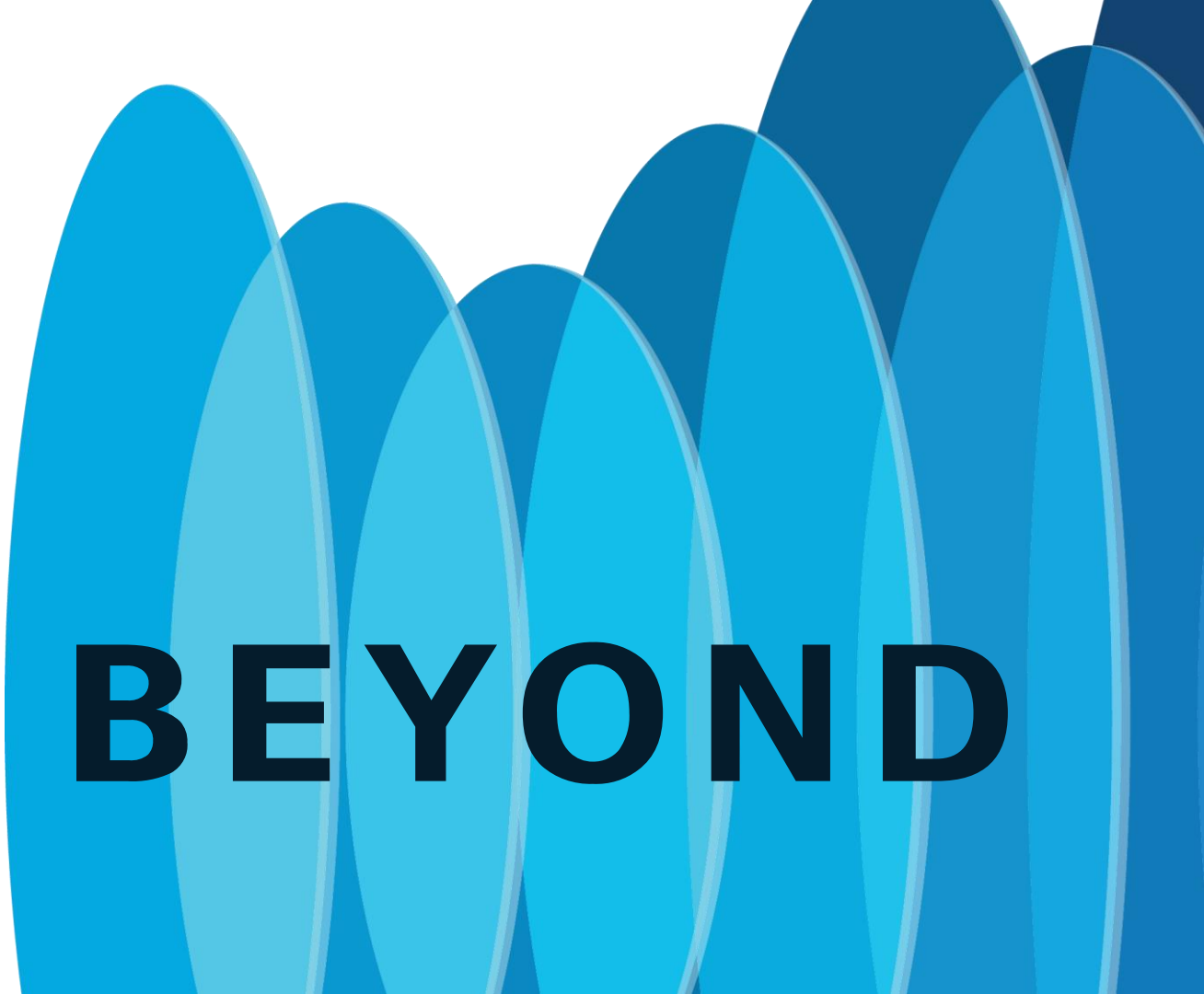

GO BEYOND

Reference Slides

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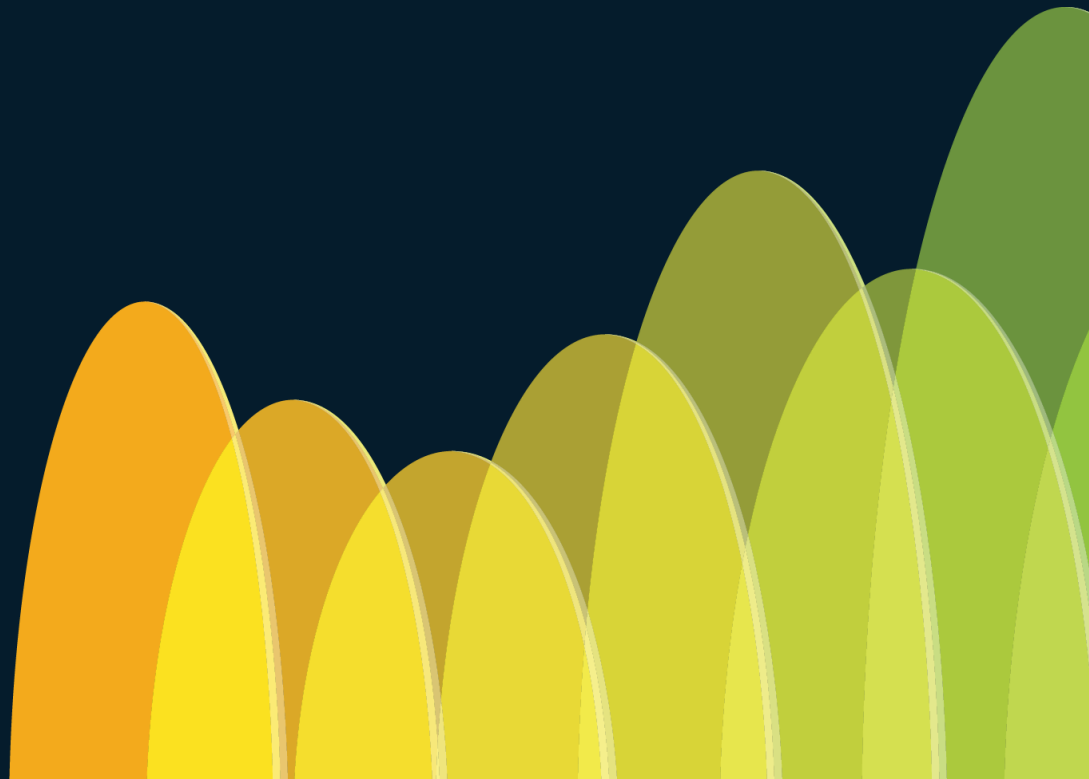
Unified CM Trace Configuration



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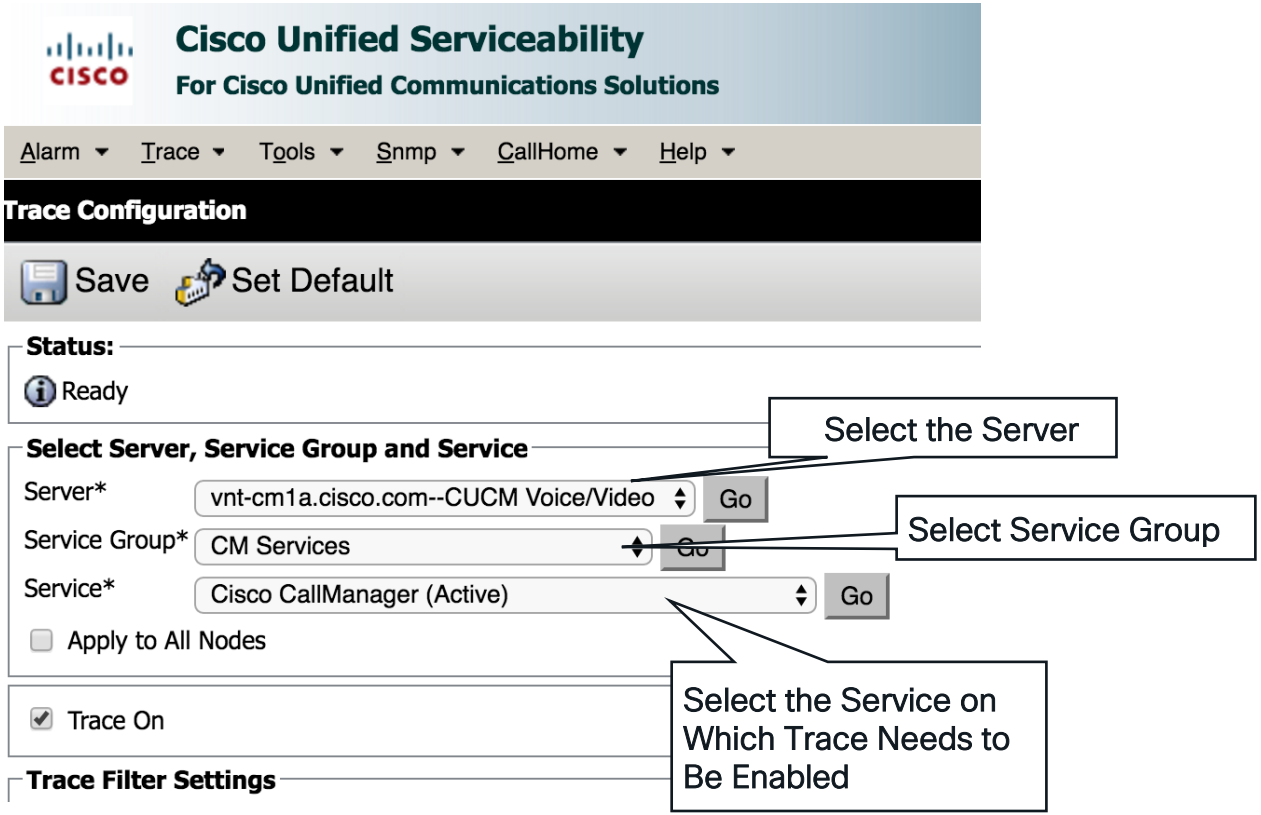
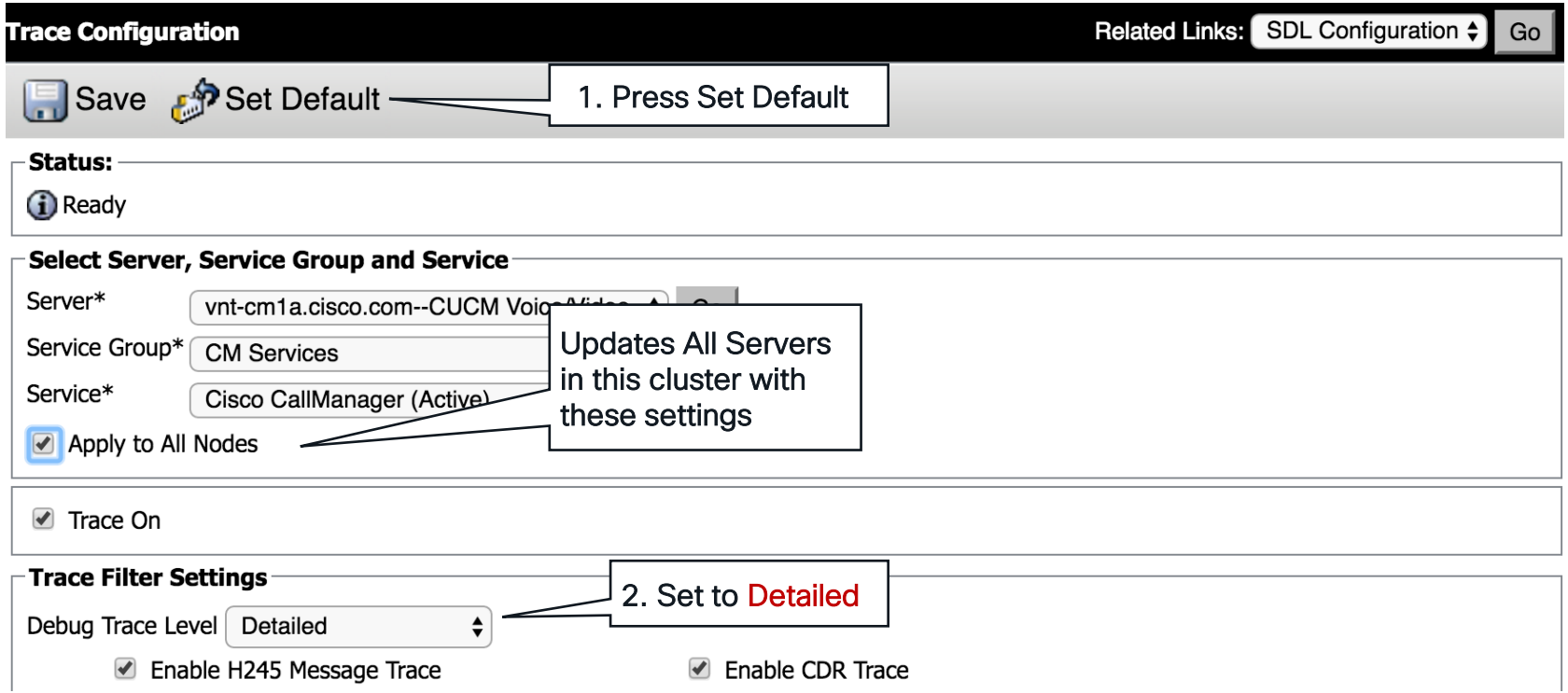
Unified CM Trace Configuration

- SIP messaging in Unified CM is written to the SDL trace file when appropriate trace levels are set
- Configured from **Cisco Unified Serviceability** > **Trace** > **Configuration** or by using Analysis Manager
- Unified CM 9.0 and later **fresh install** and later default to detailed tracing – no need to configure traces.

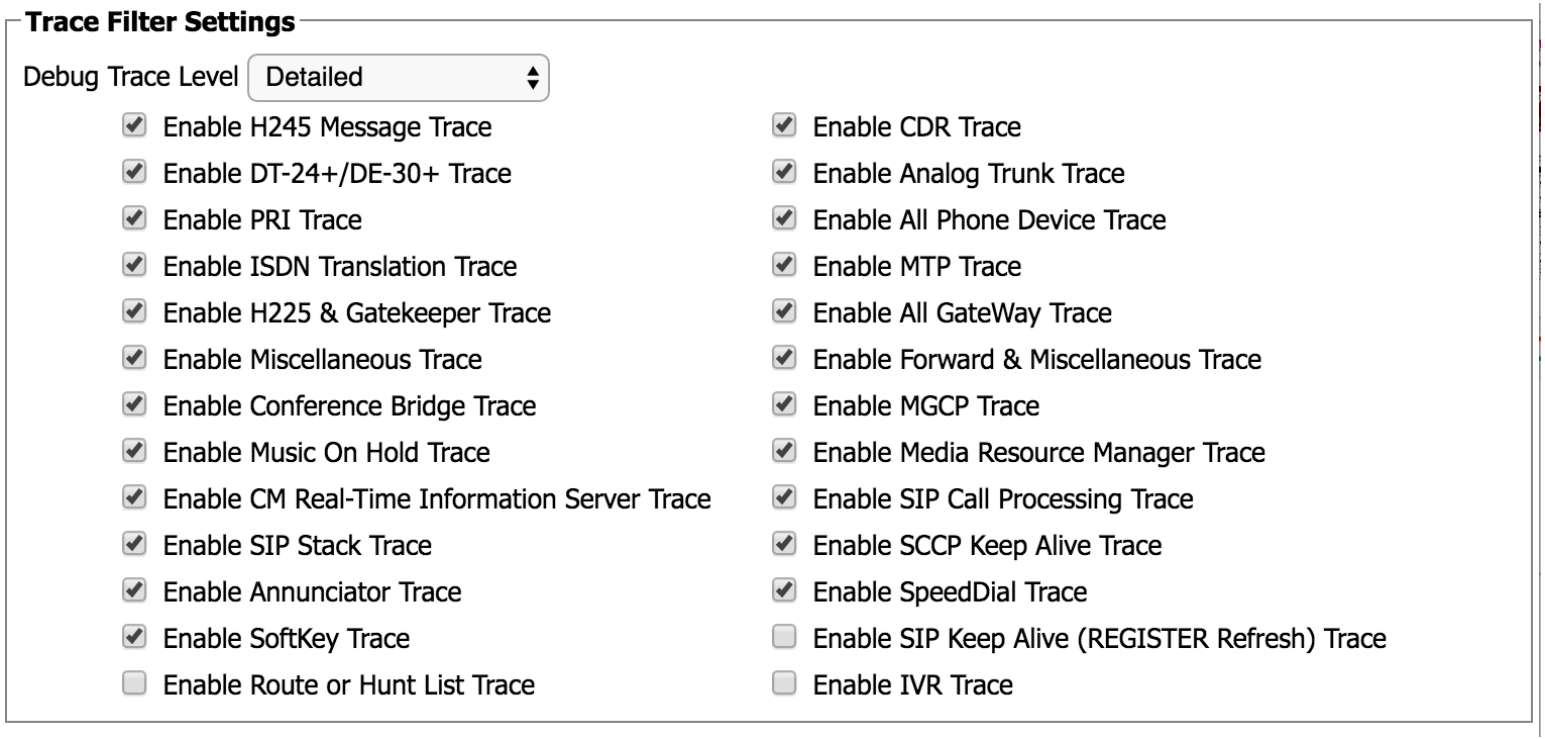
Unified CM Trace Configuration



Unified CM Trace Configuration



Unified CM Trace Configuration



Trace Collection

Various Ways to Collect Trace Files

- RTMT Collect Files ← Recommended
- RTMT Analysis Manager
- RTMT Remote Browse
- RTMT Query Wizard
- OS CLI (file get or file tail)
  - file tail activelog cm/trace/ccm/sdl recent

Gathering a Packet Capture from Unified CM

Use the Platform CLI command ‘utils network capture’

```
admin:utils network capture ? (or utils network capture-rotate)
Syntax:
utils network capture [options]
options  optional    page, numeric, file fname, count num, size bytes, src addr,
dest addr, port num, host protocol addr


admin:utils network capture file capturefile count 100000 size ALL host ip
10.1.1.1
Executing command with options:
 size=ALL                count=100000            interface=eth0
 src=                    dest=                   port=
 ip=10.1.1.1

admin:file list activelog platform/cli
capturefile.cap
dir count = 0, file count = 1

admin:file get activelog platform/cli/capturefile.cap
Please wait while the system is gathering files info ...done.
Sub-directories were not traversed.
Number of files affected: 1
Total size in Bytes: 24
Total size in Kbytes: 0.0234375
Would you like to proceed [y/n]? y
```

Expressway Trace Configuration

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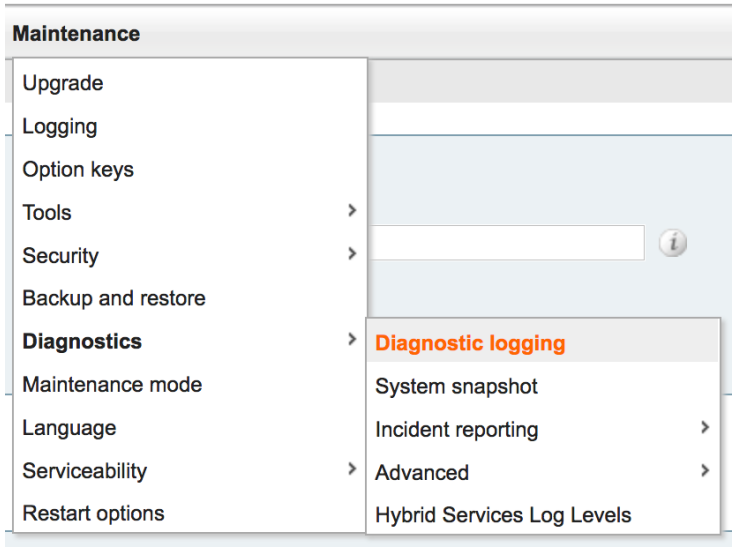
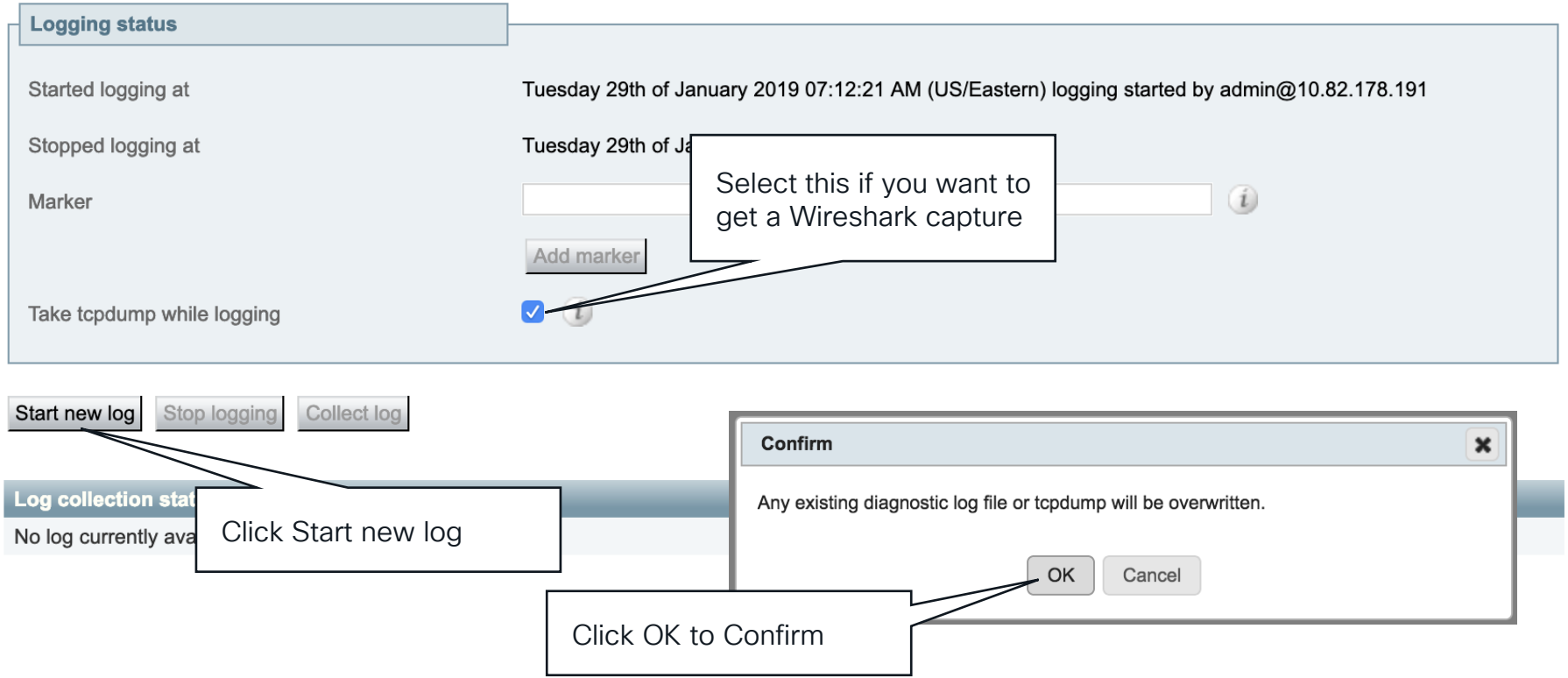
Expressway Trace Configuration

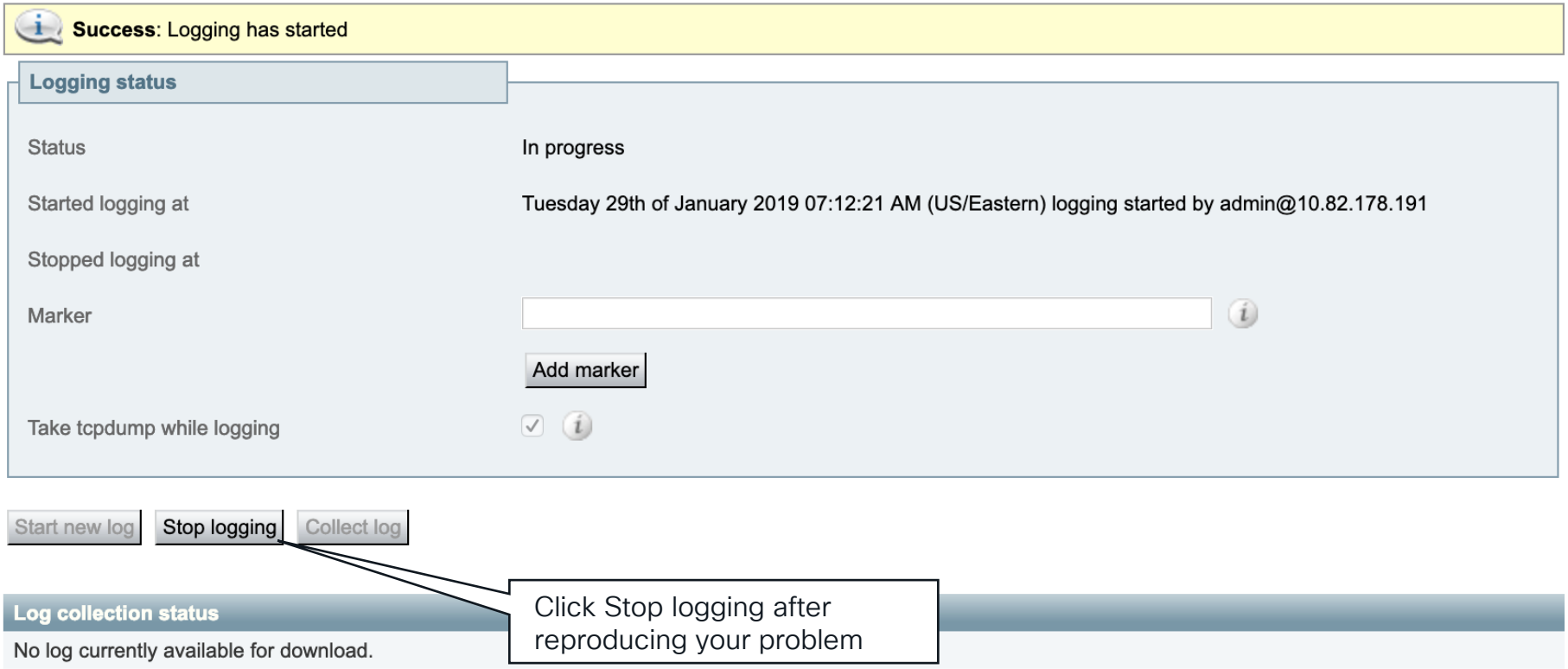
- Expressway-C / Expressway-E can log SIP messages to a diagnostic log file.
- To enable, navigate to **Maintenance** > **Diagnostics** > **Diagnostic logging**



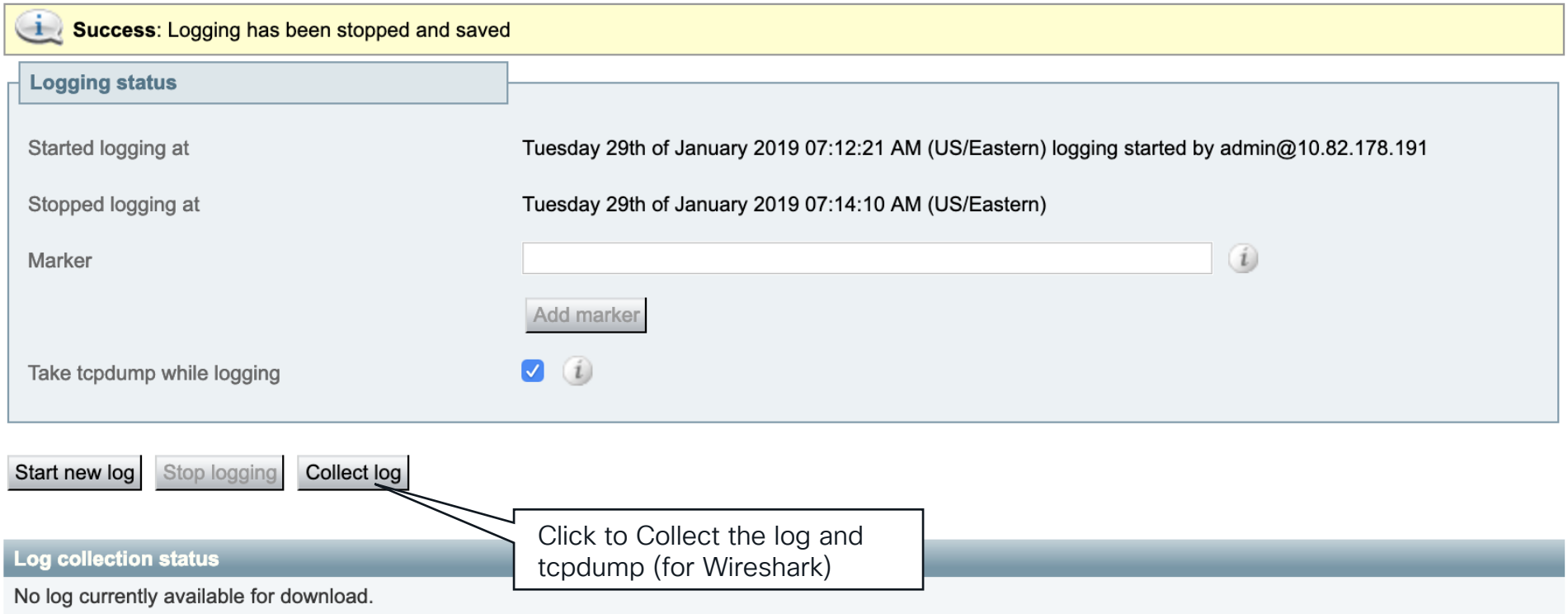
Expressway Trace Configuration



Expressway Trace Configuration

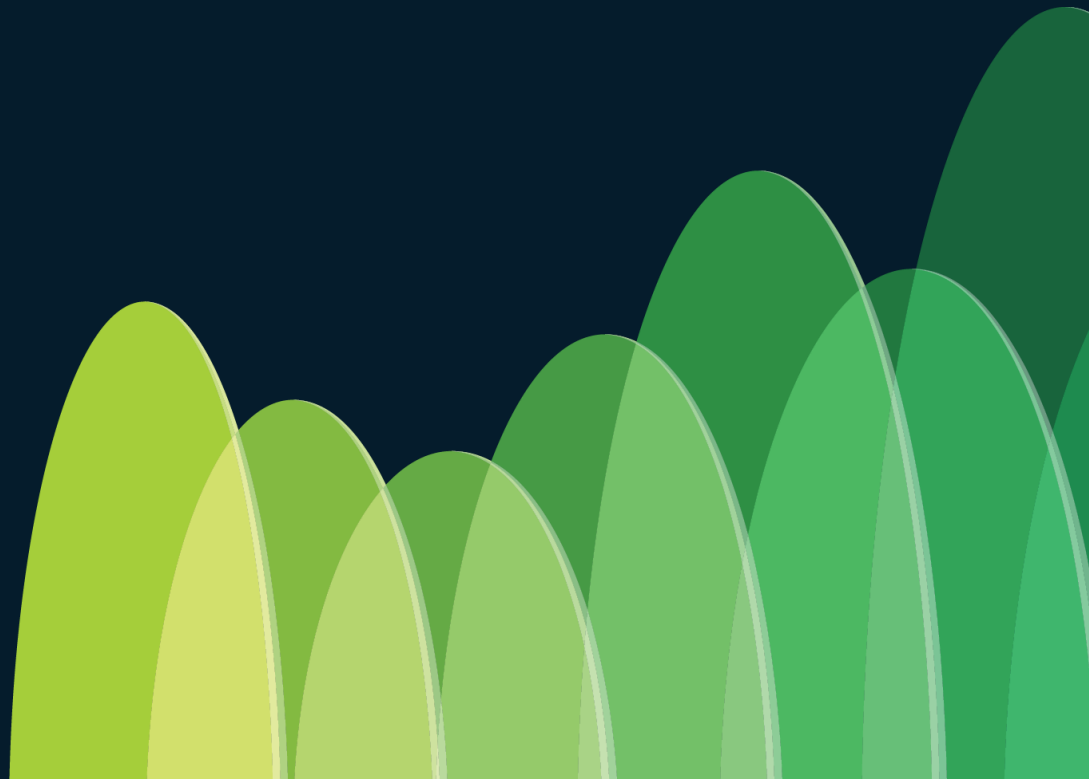


Expressway Trace Configuration



Expressway Trace Configuration

Cisco Unified Border Element (CUBE) Trace Configuration



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CUBE Debugging

- When debugging in IOS, configure logging buffered to a fairly large value (based on available memory)
- Disable logging to the console with command ‘no logging console’
- Enable timestamps for debugs
- Make sure router has NTP enabled

```
service timestamps debug datetime msec localtime
service timestamps log datetime msec localtime

logging buffered 10000000 debugging
no logging console

clock timezone EST -5 0
clock summer-time EDT recurring

ntp server 10.14.1.1
```

CUBE Debugging

Various SIP debugs available

```
CUBE#debug ccsip ?
  all         Enable all SIP debugging traces
  calls       Enable CCSIP SPI calls debugging trace
  dhcp        Enable SIP-DHCP debugging trace
  error       Enable SIP error debugging trace
  events      Enable SIP events debugging trace
  function    Enable SIP function debugging trace
  info        Enable SIP info debugging trace
  media       Enable SIP media debugging trace
  messages    Enable CCSIP SPI messages debugging trace
  non-call    Enable Non-Call-Context trace (OPTIONS, SUBSCRIBE etc)
  preauth     Enable SIP preauth debugging traces
  states      Enable CCSIP SPI states debugging trace
  translate   Enable SIP translation debugging trace
  transport   Enable SIP transport debugging traces
  verbose     Enable verbose mode
```

CUBE VOIP Trace Feature

```
voice sevice voip
  trace
```

- Logs debugs for **all SIP calls automatically**
- VOIP Trace is enabled by default from IOS-XE 17.4.1, 17.3.2
- VOIP Trace captures:
  - SIP messages for SIP Trunk to Trunk calls
  - Events and API calls from SIP layer to other layers in CUBE
  - SIP Errors
  - Call Control (unified communication call flows processed by CUBE)
  - FSM (Finite State Machines) states and events
  - Dial peer matched
  - RTP ports allocated
- Will not log REGISTER, OPTIONS, SUBSCRIBE/NOTIFY, INFO

VOIP Trace – show commands

CUBE#**show voip trace ?**
all Display all VoIP Traces
call-id Filter traces based on Internal Call Id
correlator Filter traces based on FPI Correlator
cover-buffers Display the summary of all cover buffers
session-id Filter traces based on SIP Session ID
sip-call-id Filter traces based on SIP Call Id
statistics Display statistics for VoIP Trace

CUBE#**sh voip trace all**  Don't do this
Displaying 11858 cover buffers
This may severely impact system performance.
Continue? [yes/no] no

VOIP Trace - Cover Buffer - Search-Key

```
CUBE# show voip trace cover-buffers
------------------ Cover Buffer ---------------
Search-key    = +19195552653:+19195550050:44669
 Timestamp     = Mar 17 00:16:28.136
 Buffer-Id     = 12
 CallID        = 44669
 Peer-CallID   = 44670
 Correlator    = 1
 Called-Number  = +19195550050
 Calling-Number = +19195552653
 SIP CallID    = BW001626946170324-1056393246@152.188.44.31
 SIP Session ID = 4b8cf36c00105000a000ac7e8ab697e8
 GUID          = 6E12C492AEA1
 Tenant        = 0
 Cause-code    = normal call clearing (16)
-------------------------------------------------
------------------ Cover Buffer ---------------
Search-key    = +19195552653:+19195550050:44670
 Timestamp     = Mar 17 00:16:28.138
 Buffer-Id     = 13
 CallID        = 44670
 Peer-CallID   = 44669
 Correlator    = 1
 Called-Number  = +19195550050
 Calling-Number = +19195552653
 SIP CallID    = 6E1360BA-E32A11EE-AEA7B1B7-8E2179A6@64.102.247.82
 SIP Session ID = e59da4baa9f45d60979613901ad09af2
 GUID          = 6E12C492AEA1
 Tenant        = 0
 Cause-code    = normal call clearing (16)
-------------------------------------------------
```

- Each call leg is assigned a “search key”
- Search key is a combination of Calling number, Called number and call-id

Inbound Call Leg Search-key:
+19195552653 : +19195550050 : 44669

Outbound Call Leg Search-key:
+19195552653 : +19195550050 : 44670

VOIP Trace

- To find a call, search for calling or called number

  show voip trace cover-buffer | section <calling or called number>

- To view debugs for the call

  show voip trace call-id <call-id>

VOIP Trace - Tip!

alias exec **fc** show voip trace cover-buffer | section
alias exec **sc** show voip trace call-id

- To find a call by calling / called number:

CUBE#**fc 9195552653**

- To show the call details based on call-id:

CUBE#**sc 44669**

```
CUBE# fc 9195552653
------------------ Cover Buffer ---------------
Search-key    = +19195552653:+19195550050:44669
 Timestamp     = Mar 17 00:16:28.136
 Buffer-Id     = 12
 CallID        = 44669
 Peer-CallID   = 44670
 Correlator    = 1
 Called-Number  = +19195550050
 Calling-Number = +19195552653
 SIP CallID    = BW001626946170324-1056393246@152
 SIP Session ID = 4b8cf36c00105000a000ac7e8ab697e8
 GUID          = 6E12C492AEA1
 Tenant        = 0
 Cause-code    = normal call clearing (16)
-------------------------------------------------
```

Reference

CUBE – IOS-XE Embedded Traffic Capture

Export Packet Data in PCAP Format

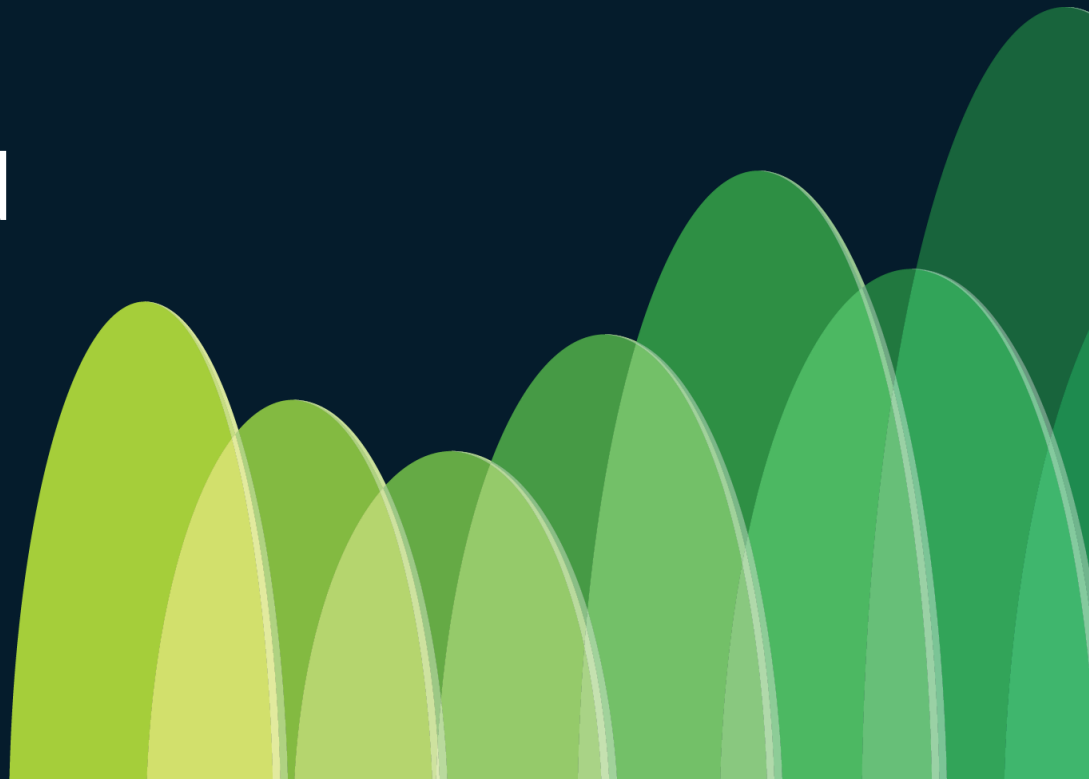
- IP Traffic Export feature allows export of packets on an interface
- Configuration (From Enable mode, not Config mode):

```
monitor capture capture-name access-list access-list-name
monitor capture capture-name limit duration seconds
monitor capture capture-name interface interface-name both
monitor capture capture-name buffer circular size bytes
```

- Usage:

```
monitor capture capture-name start
monitor capture capture-name export file-location/file-name
monitor capture capture-name stop
```

IP Phone, Webex App, and RoomOS / Device Logging



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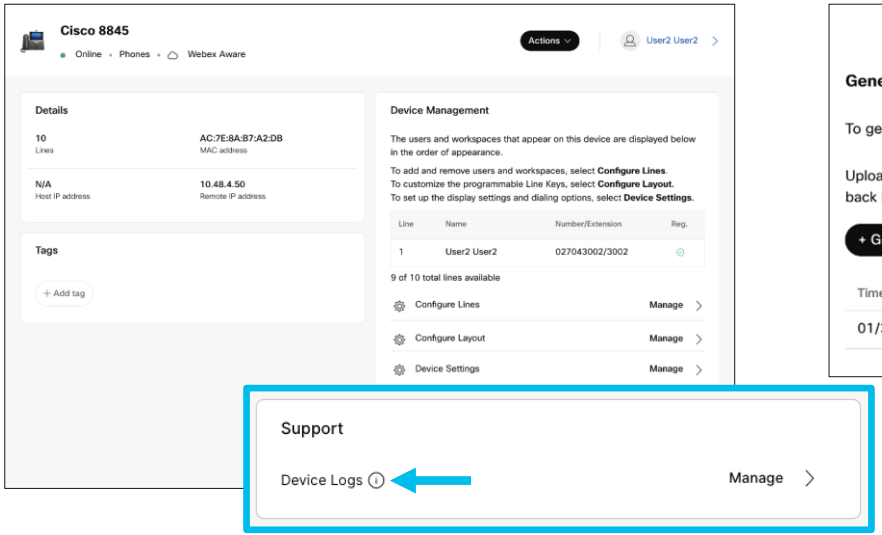
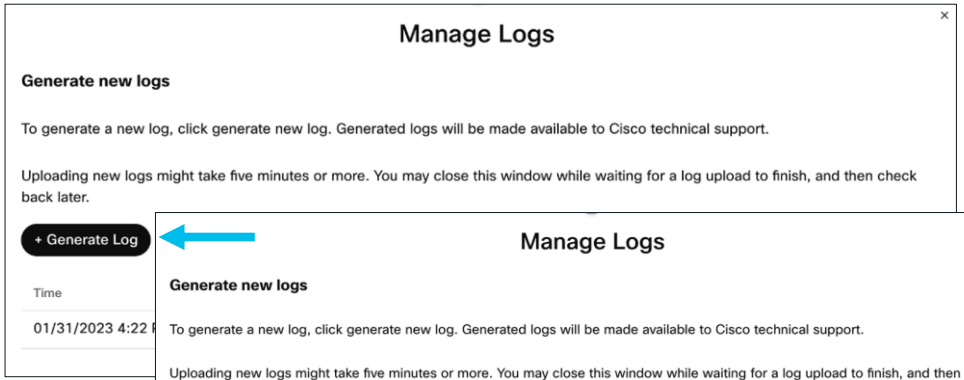
Collecting Logs from IP Phones

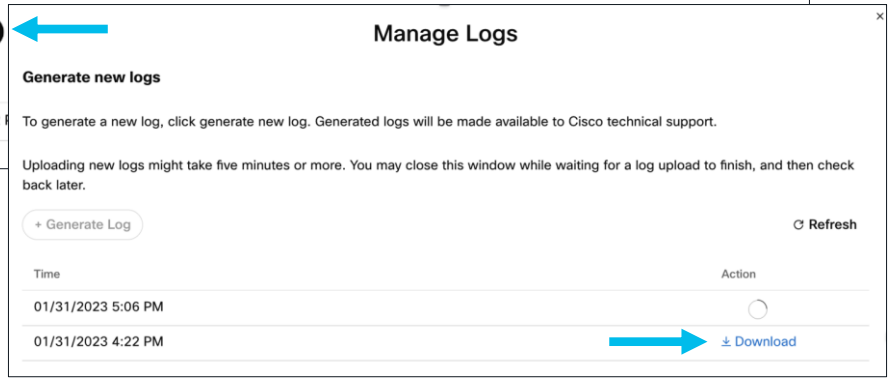
Problem Report Tool (PRT)

Method 1 – Generate and Collect *Obfuscated* Problem Report (PRT) from **Control Hub**

- Devices > Select Device > Device Logs
- From **Manage Logs** you can **Generate** and **Download** PRT logs





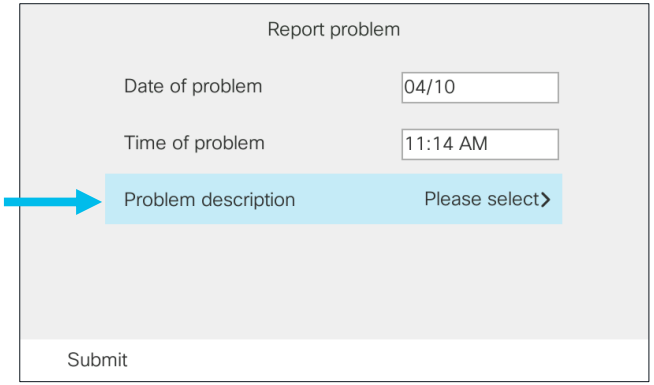


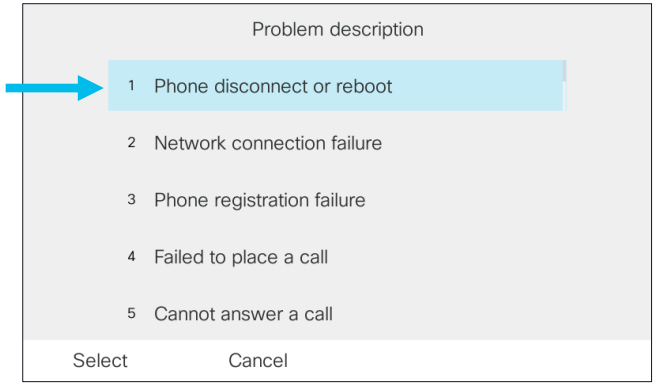
Collecting Logs from IP Phones

Problem Report Tool (PRT)

Method 2 – Generate *Obfuscated* Problem Report (PRT) from **Phone menu**

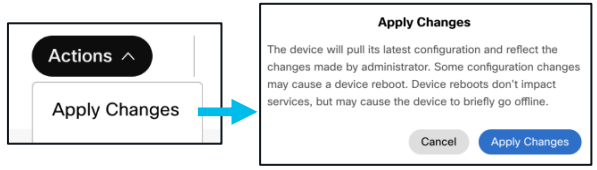
- Settings > Status > Report Problem > Problem description > Submit
- Uploaded PRT can be downloaded from Webex Control Hub





Collecting Logs from IP Phones

Problem Report Tool (PRT)



Always Apply Changes

Method 3 – Generate and Collect PRT from **Phone web menu**

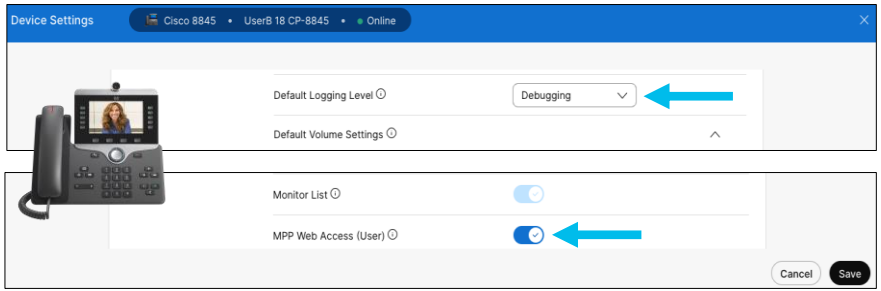
- Enable MPP **Web Access** (User) & **Logging Level**

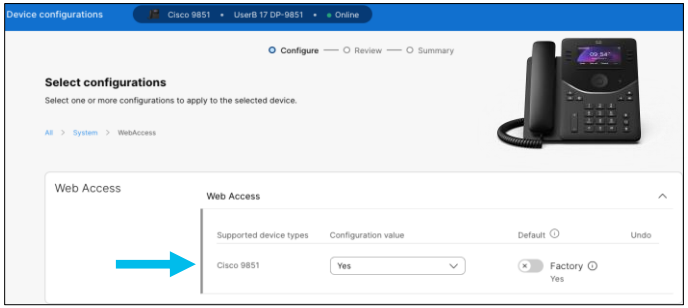
For 7800/8800 Cisco Phones

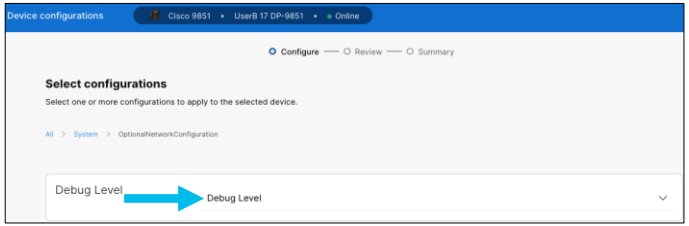
- Devices > Select Device > Device Settings
- Locations > Select Location > Calling > Device Settings
- Calling > Service Settings > Configure Default Device Settings

For 9800 Cisco Desk Phones

- Devices > Select Device > All configurations
- Devices > Template > Create template





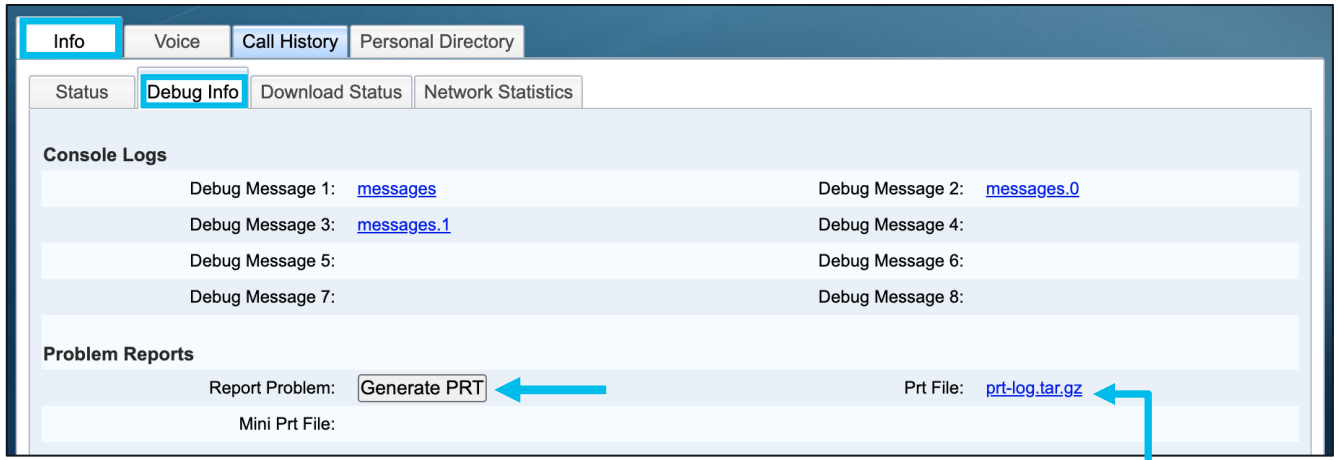


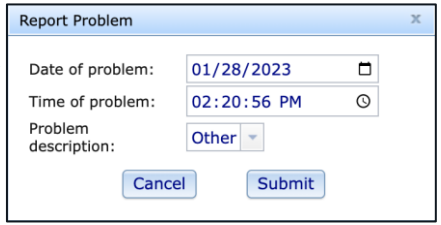
Collecting Logs from IP Phones

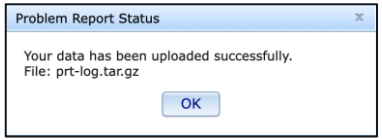
Problem Report Tool (PRT)

Method 3 – Generate and Collect from **Phone web menu**

- Navigate to **Info** tab then **Debug Info** tab
- Click **Generate PRT & Submit**
- Download PRT



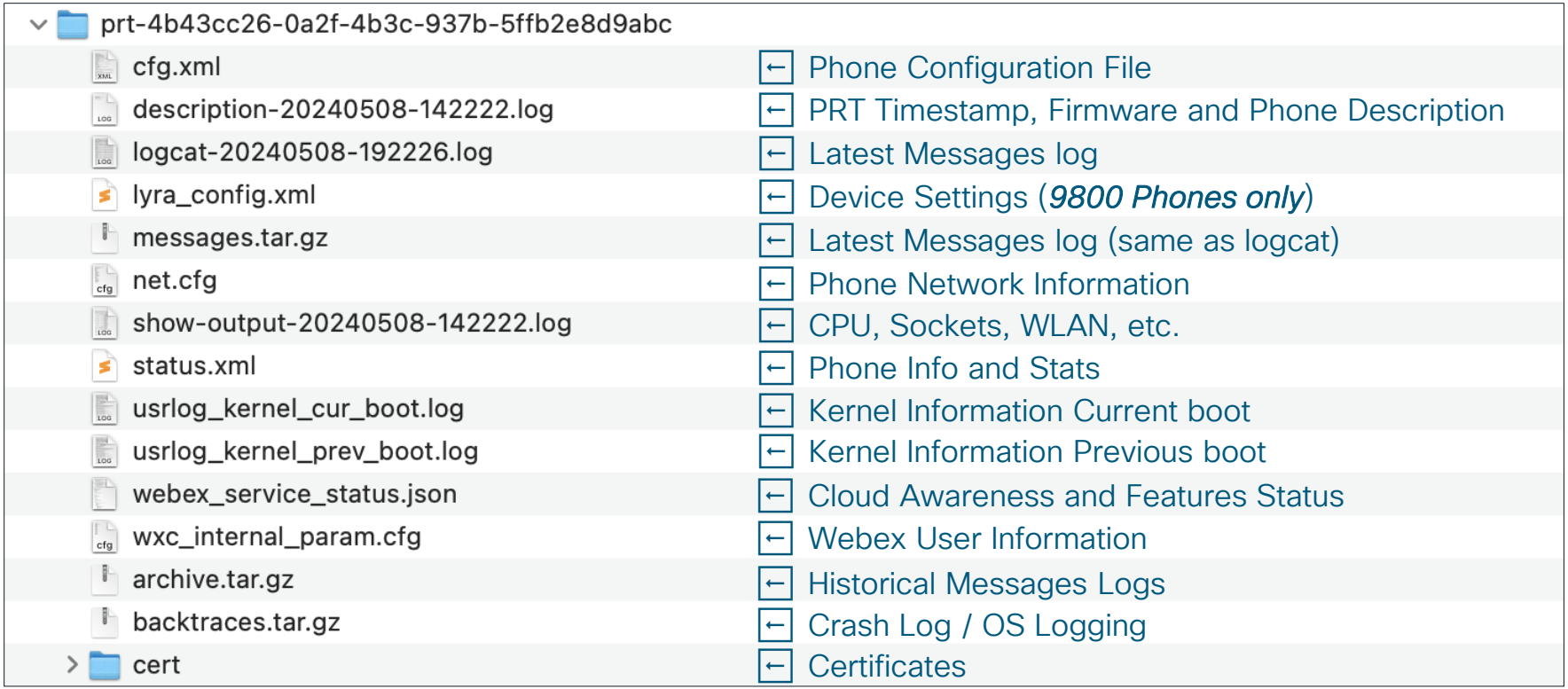




Click link to download **prt.log.tar.gz**

Collecting Logs from IP Phones

Problem Report Tool (PRT)

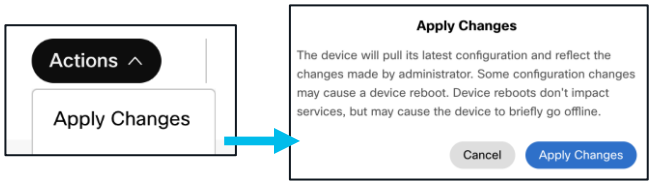


Collecting Packet Capture from IP Phones

Enable PC **Passthrough Port** from Control Hub

For Cisco Phones

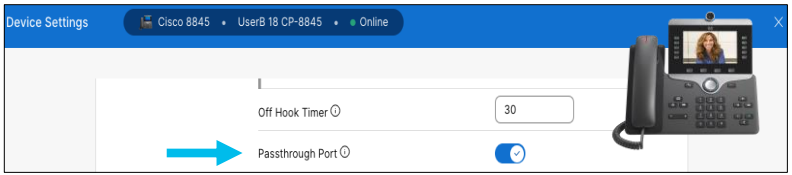
- Devices > Select Device > Device Settings

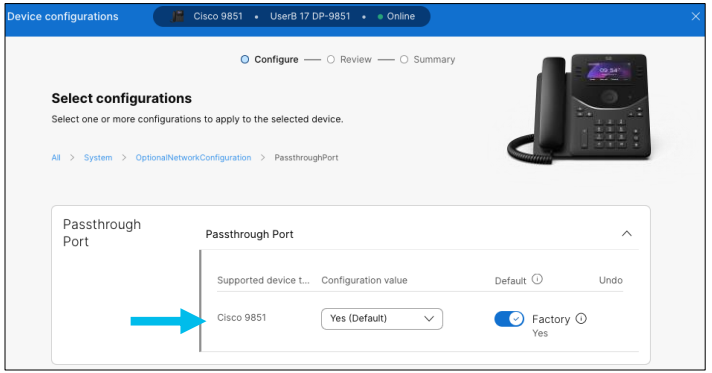


Always Apply Changes

For new 9800 Cisco Desk Phones

- Devices > Select Device > All configurations



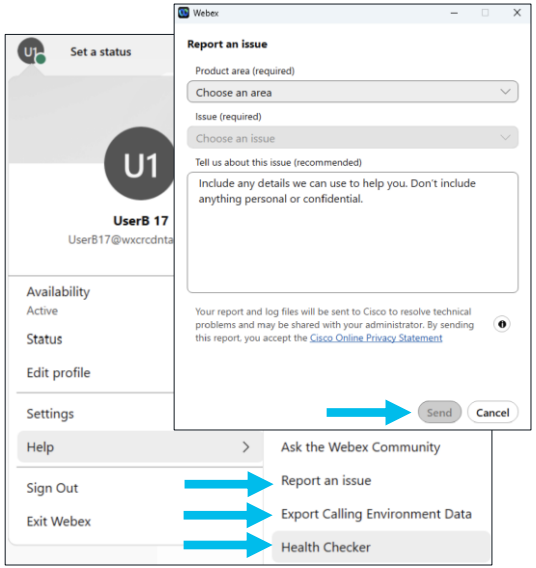


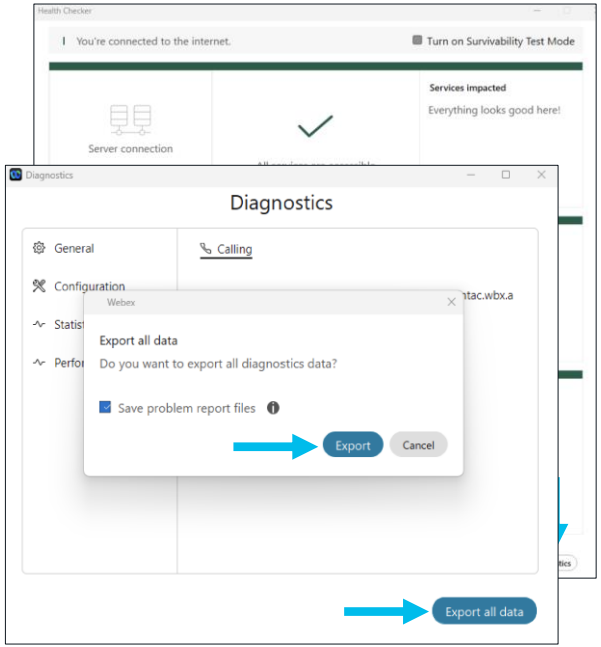
Location of log files for Webex Application
1. Windows: %USERPROFILE%\AppData\Local\CiscoSpark
2. MacOS: ~/Library/Logs/SparkMacDesktop

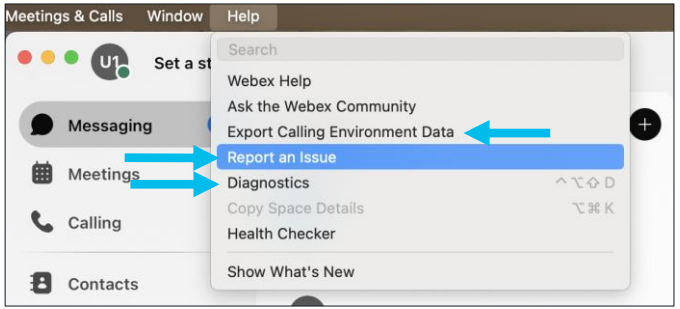
Collecting Logs from Webex App

Method 1 – Generate and Collect *Obfuscated* logs from **Webex App**

- Navigate to **Help** > **Report an Issue** & **Calling Environment**
- **Help** > **Health Checker** > **Diagnostics** > **Export all data (Includes Calling Environment)**



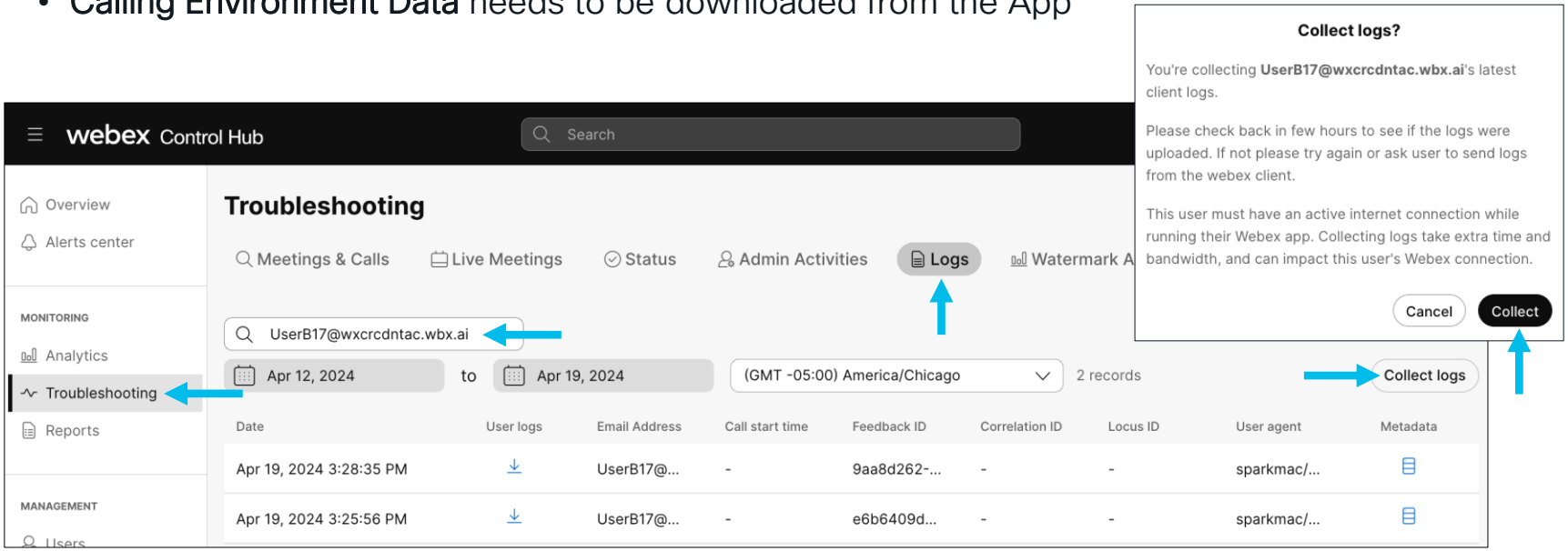




Collecting Logs from Webex App

Method 2 – Generate and Collect *Obfuscated* logs from **Control Hub**

- Navigate to **Troubleshooting** > **Logs** > search for **User Email** > **Collect logs**
- **Calling Environment Data** needs to be downloaded from the App



Calling Environment Data

From current_log.txt

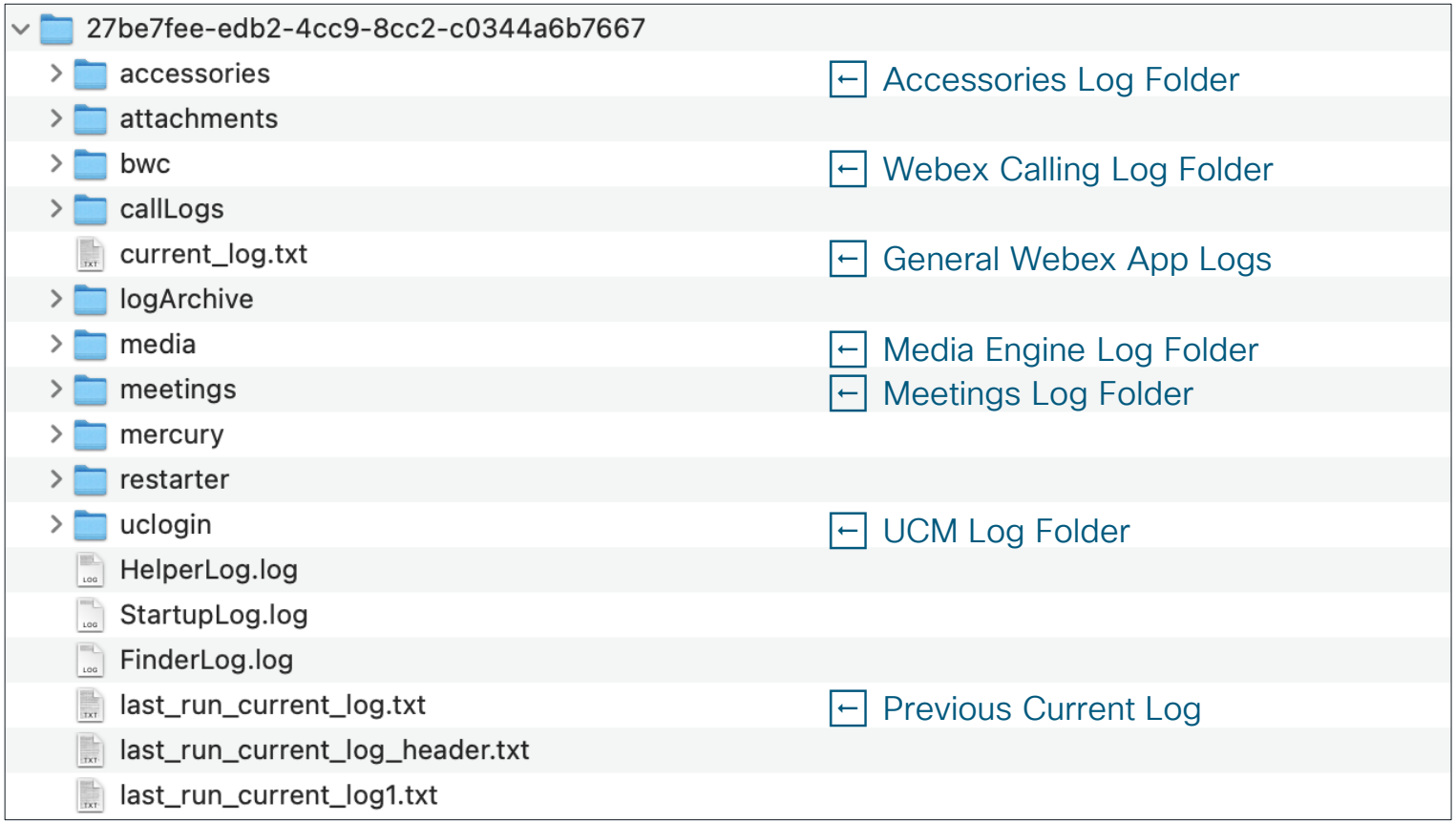
```
REGISTER sip:98027369.us10.bcld.webex.com SIP/2.0
Via: SIP/2.0/TLS {!9f15ed7865f56151!}:55486;branch=z9hG4bKf7bcd2fb8a625947;alias;rport
Max-Forwards: 70
To: sip:{!78a08c89abe884c3!}@{!3f29207b5c1fdb70!}
From:
sip:{!78a08c89abe884c3!}@{!3f29207b5c1fdb70!};tag=0399a3bdc7fb55d1ebdd4d59984bec77
CSeq: 340389365 REGISTER
```

```
"78a08c89abe884c3":"asaweeusz8_G80CS6Z7XSBL",
```

Calling-environment-data.dat

```
"3f29207b5c1fdb70": "98027369.us10.bcld.webex.com",
"3fad57e49b2ca43a"        : "<sip:asaweeusz8_G80CS6Z7XSBL@192.168.50.248:8933;transport=tls>;q=1.0",
"78a08c89abe884c3"        : "asaweeusz8_G80CS6Z7XSBL",
"834484e4a0608d8a"        : "UserB 17",
"9f15ed7865f56151"        : "192.168.50.248",
"a281b427a997a4eb"        : "asaweeusz8_G80CS6Z7XSBL@98027369.us10.bcld.webex.com",
```

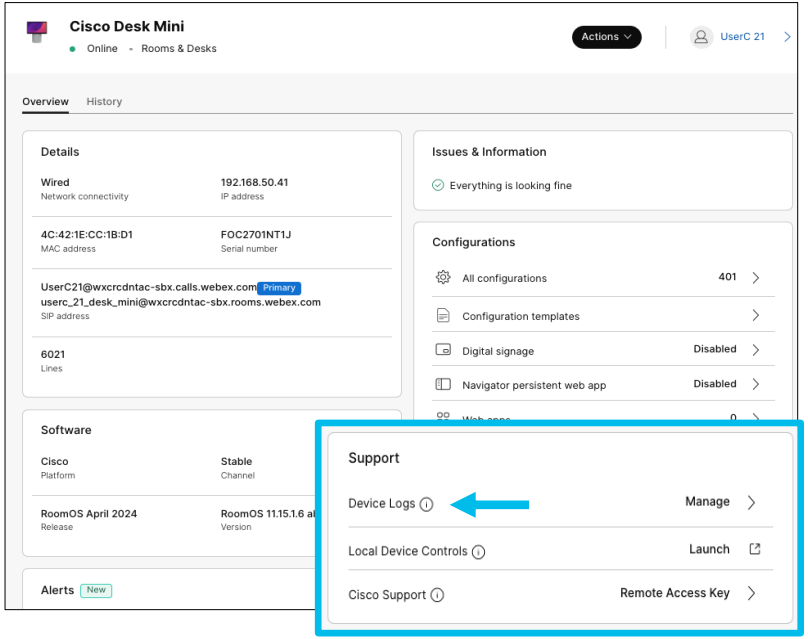
Collecting Logs from Webex App

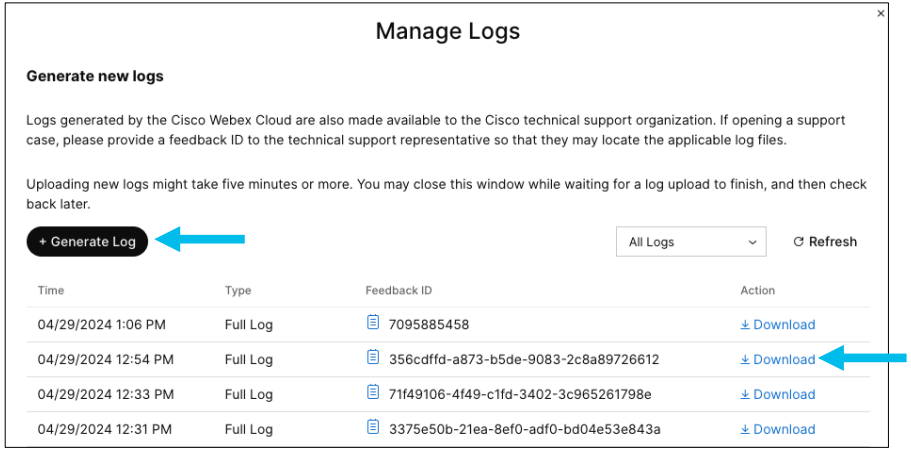


Collecting Logs from Room Devices

Method 1 – Generate *Obfuscated* Logs from **Control Hub**

- Devices > Select Device > Device Logs
- From **Manage Logs** you can **Generate** and **Download** the logs

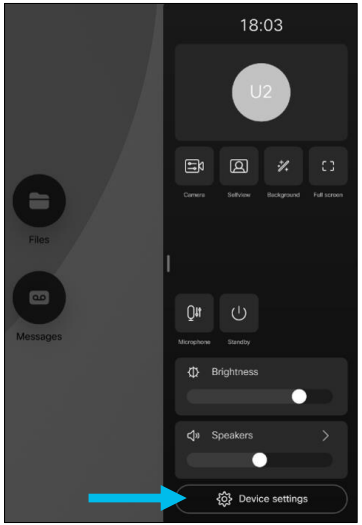


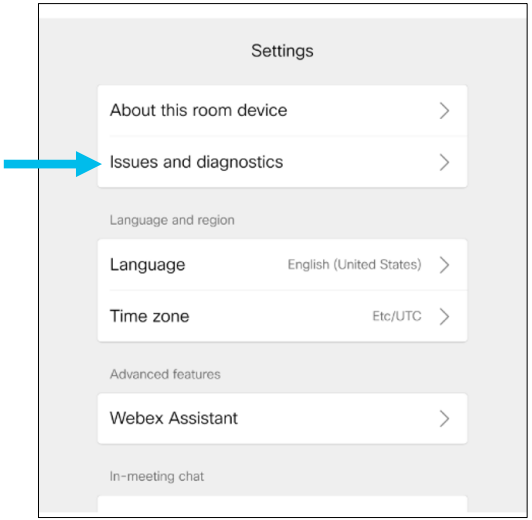


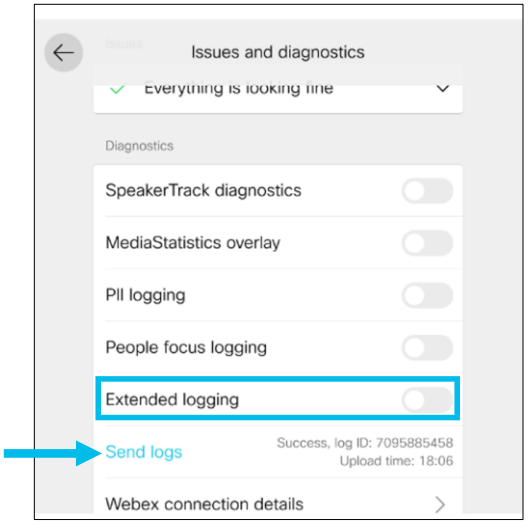
Collecting Logs from Room Devices

Method 2 – Generate *Obfuscated* Logs from **Device Menu**

- Swipe right to left > Device Settings > Issues and diagnostics > send logs
- Optional: Extended Logging (Verbose Logs)







Collecting Logs from Room Devices

Method 3 – Generate and Collect Device Logs from **Device web menu**

- Device > Local Device Controls > Proceed
- Issues and Diagnostics > System Logs > System logs / Extended Logging