



T.38 Fax over IP Design Best Practices

David Hanes
Customer Advanced Engineering

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- Today's featured expert is David Hanes
- Ask him questions now about T.38 Fax Over IP



David Hanes

Technical Leader in Customer
Advanced Engineering, Cisco

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Expert Series



T.38 Fax over IP Design Best Practices

David Hanes
Customer Advanced Engineering

Cisco Support Community—Ask the Expert

- Today's featured expert is David Hanes
- Ask him questions now about T.38 Fax Over IP



David Hanes

Technical Leader in Customer
Advanced Engineering, Cisco



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Poll Question

On a scale of 1 to 5 with 1 being "not important at all" and 5 being "very important or critical", please rate the importance of fax communications within your organization.

5

4

3

2

1

Submit

Poll Response

On a scale of 1 to 5 with 1 being "not important at all" and 5 being "very important or critical", please rate the importance of fax communications within your organization.

5



4



3



2



1



Agenda

- Introduction to FoIP and T.38
- QoS Design Considerations
- Implementation Models
- Best Practices
- Key Takeaways

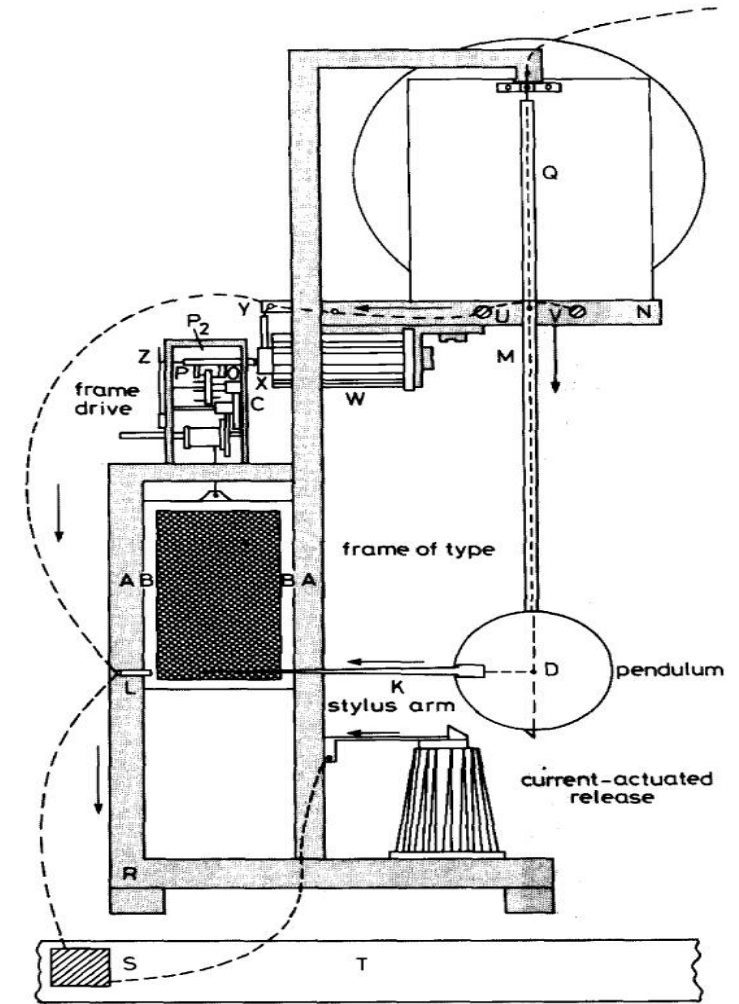




Introduction to FoIP and T.38

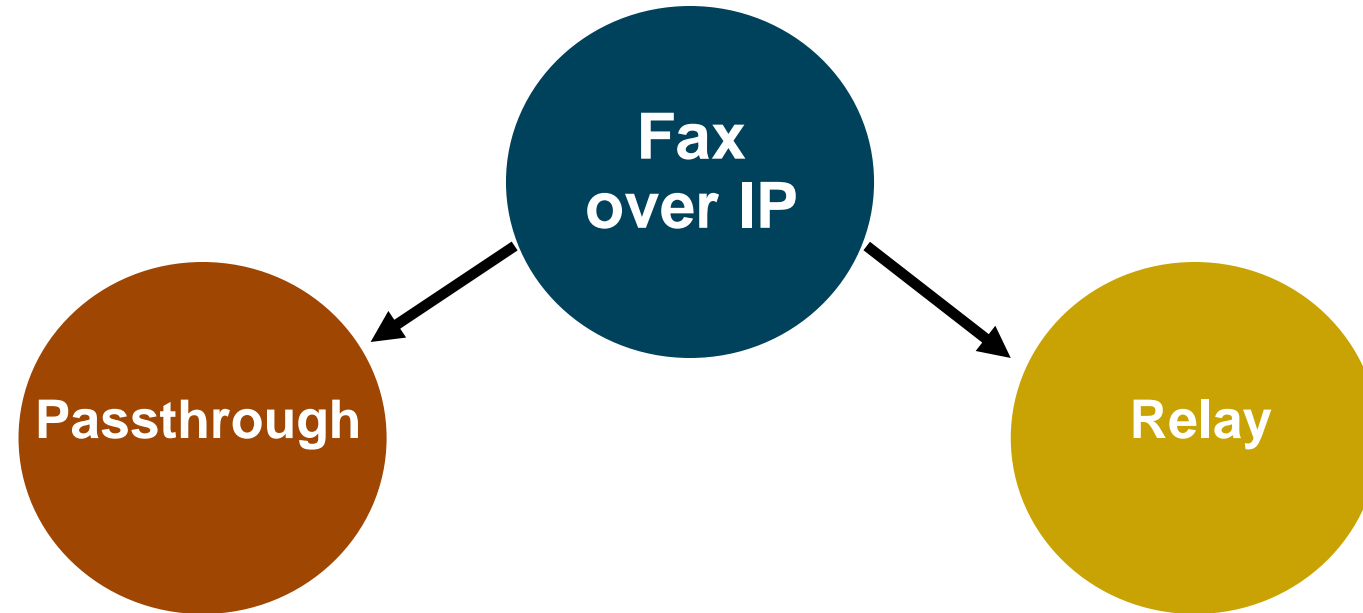
Fax Communications

- Fax invented by Alexander Bain in 1843 (patented 30 years before the telephone)
- Fax is a ubiquitous form of communication today and Fax over IP (FoIP) is often overlooked in IP Telephony
- Group 3 (G3) is today's fax standard (speeds up to 14.4 kbps)
- Super G3 is an optional extension of G3 that allows for speeds up to 33.6 kbps

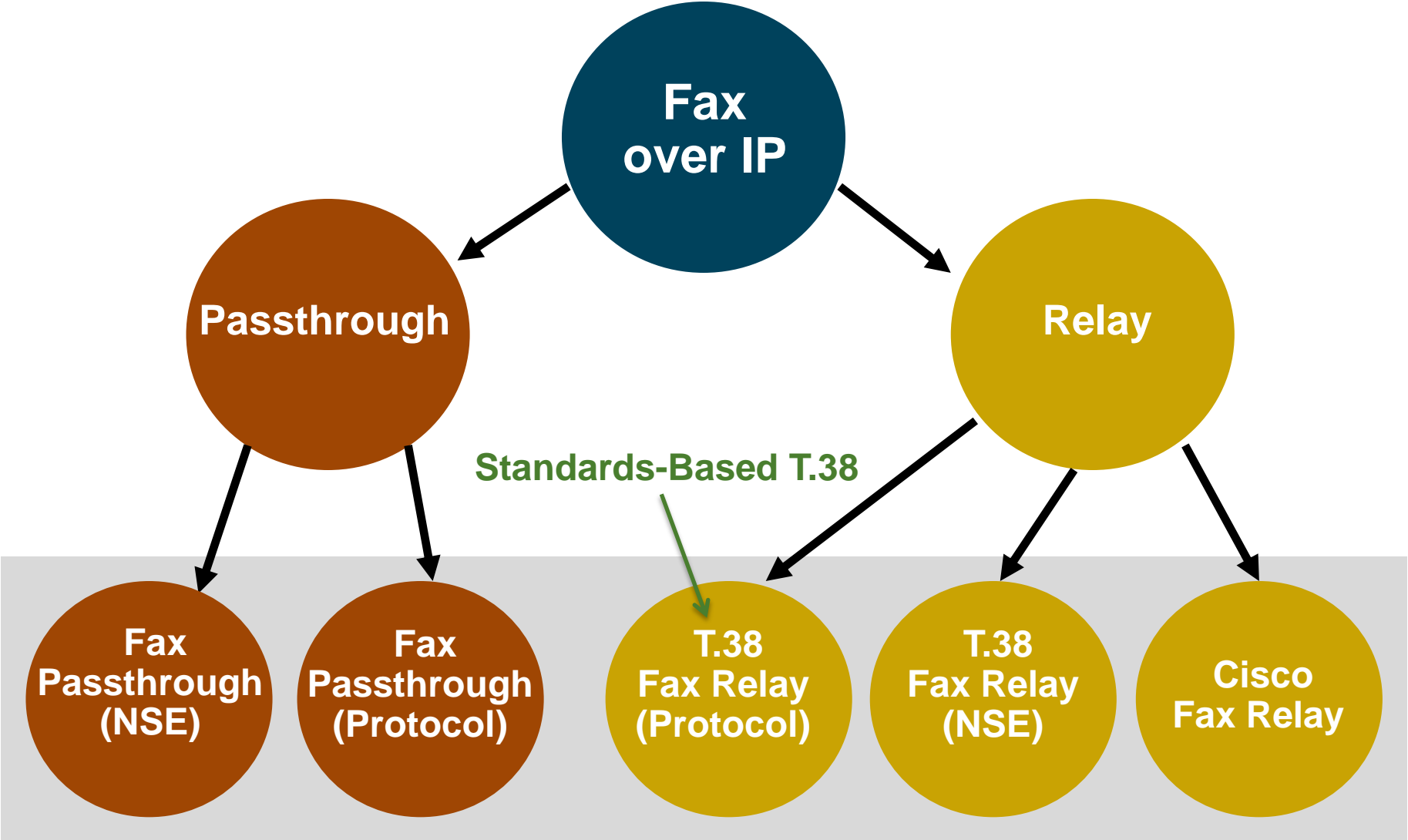


Alexander Bain's Facsimile Apparatus,
British Patent 9745

Real-Time Fax Transport Methods

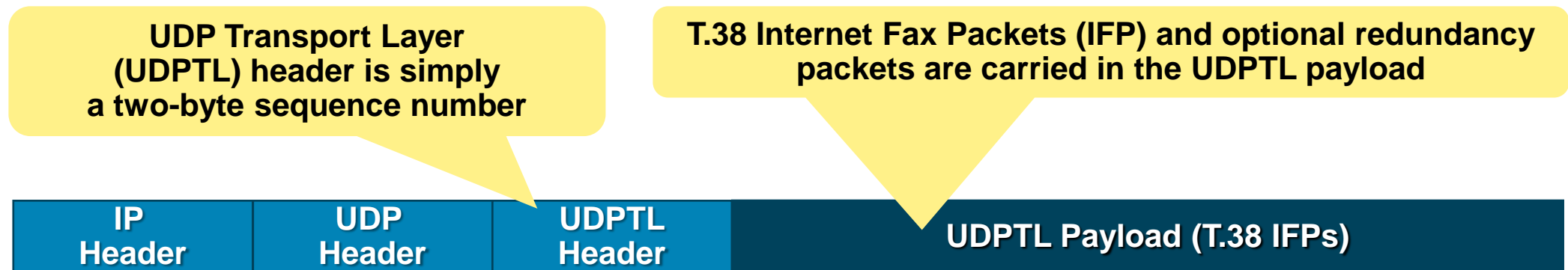


Real-Time Fax Transport Methods



T.38 Fax Relay

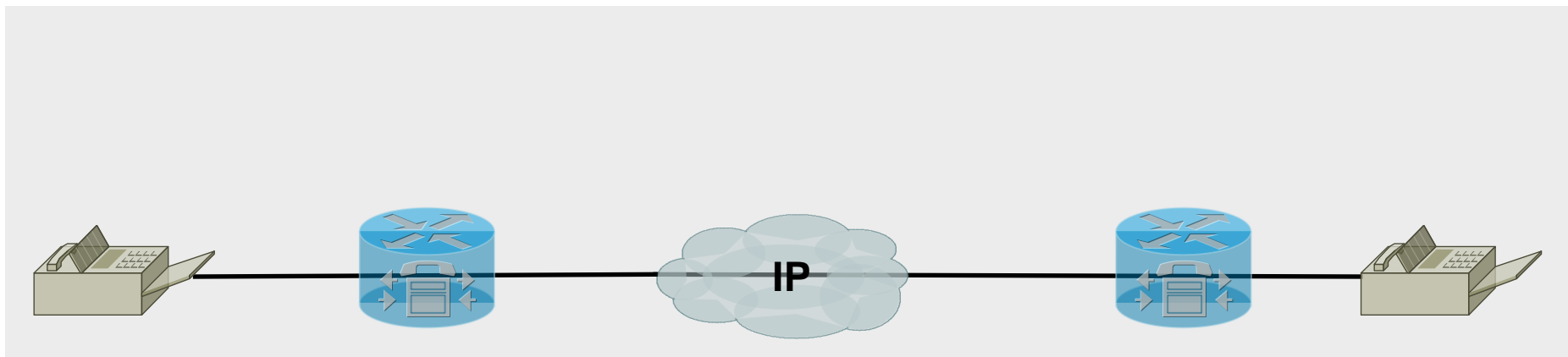
- T.38 is the de facto standard for handling fax transmissions today
- Cisco has always supported the 1998 version (known as version 0) of the ITU-T T.38 specification with UDP/UDPTL encapsulation
- In IOS version 15.1(1)T Cisco started supporting SG3 fax over T.38 (version 3)
- Cisco products can use either NSEs (proprietary) or the call control protocol (standards-based) to switch a call to T.38 mode
- Due to the absence of an RTP header, no support for SRTP and CRTP



UDP Encapsulated T.38

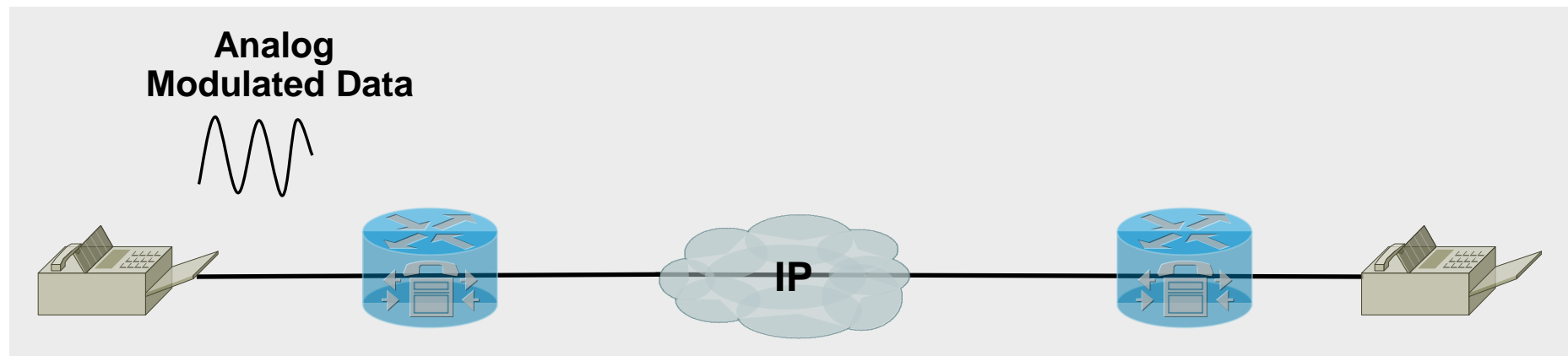
How Does T.38 Fax Relay Work?

- The analog modulated fax data is demodulated by a Digital Signal Processor (DSP) on the gateway and the binary information is extracted
- Binary information is encapsulated in T.38 packets and then transported over the IP network
- A DSP on the destination gateway extracts the binary information carried within the T.38 packets and re-modulates it into a traditional analog fax signal on the telephony side



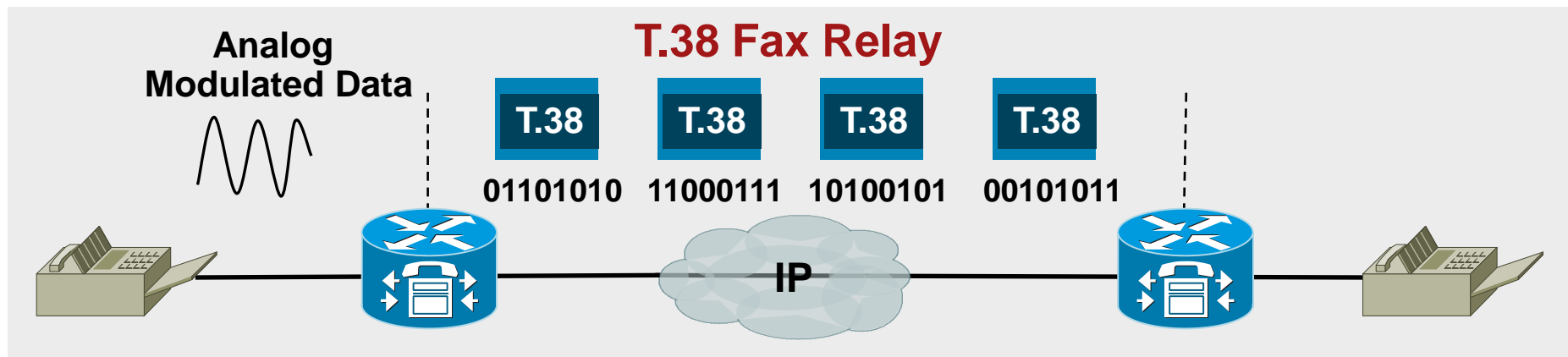
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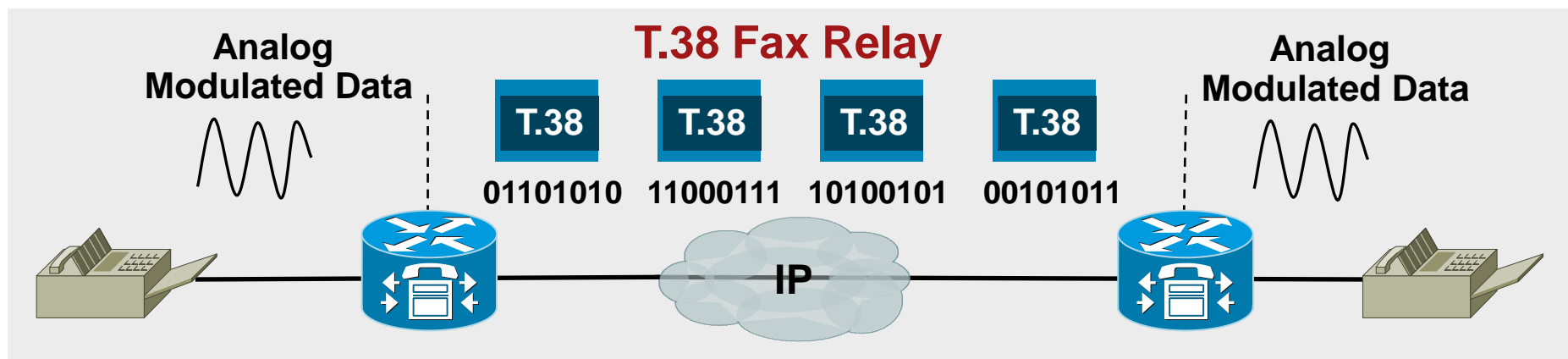
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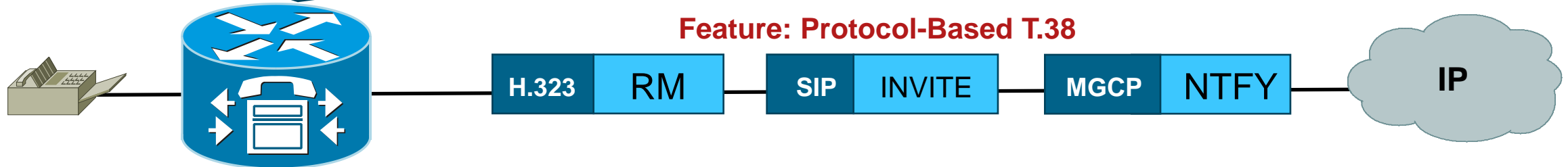
Configuring Standards-Based T.38

SIP/H.323:

dial-peer voice 1 voip

fax protocol t38 version [0|3] ls-redundancy 0 hs-redundancy 0 fallback cisco

Note: Version 0 configures legacy T.38 G3 fax support, whereas version 3 enables the newly supported SG3 over T.38 feature [as of 15.1(1)T]



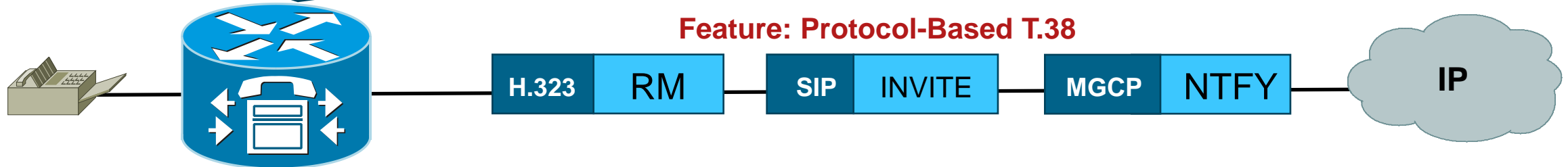
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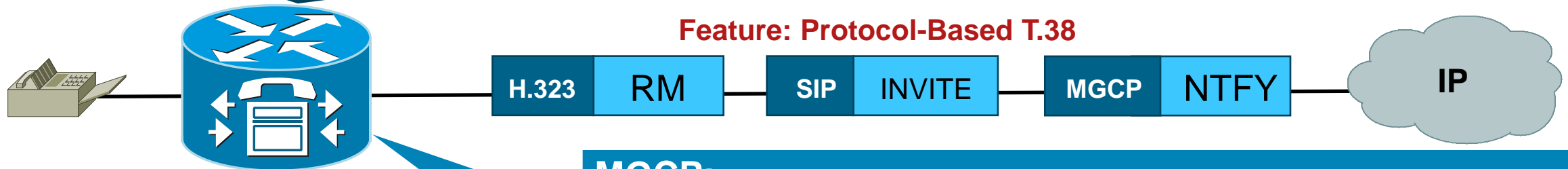
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MGCP:

mgcp package-capability fxr-package
mgcp default-package fxr-package

Note: These two commands are needed to go from the default configuration of NSE-based T.38 to protocol-based T.38. The command **no mgcp fax t38 inhibit** is required for both NSE and protocol-based T.38, but it is the default.

MGCP does not offer any version 3 support.

Poll Question

Please mark the answer that best matches your organization's approach to the use of T.38 for fax communications.

- Have already deployed T.38
- In the process of rolling out T.38
- Considering the use of T.38
- Minimal or no interest in T.38

Submit

Poll Response

Please mark the answer that best matches your organization's approach to the use of T.38 for fax communications.

Have already deployed T.38



In the process of rolling out T.38



Considering the use of T.38



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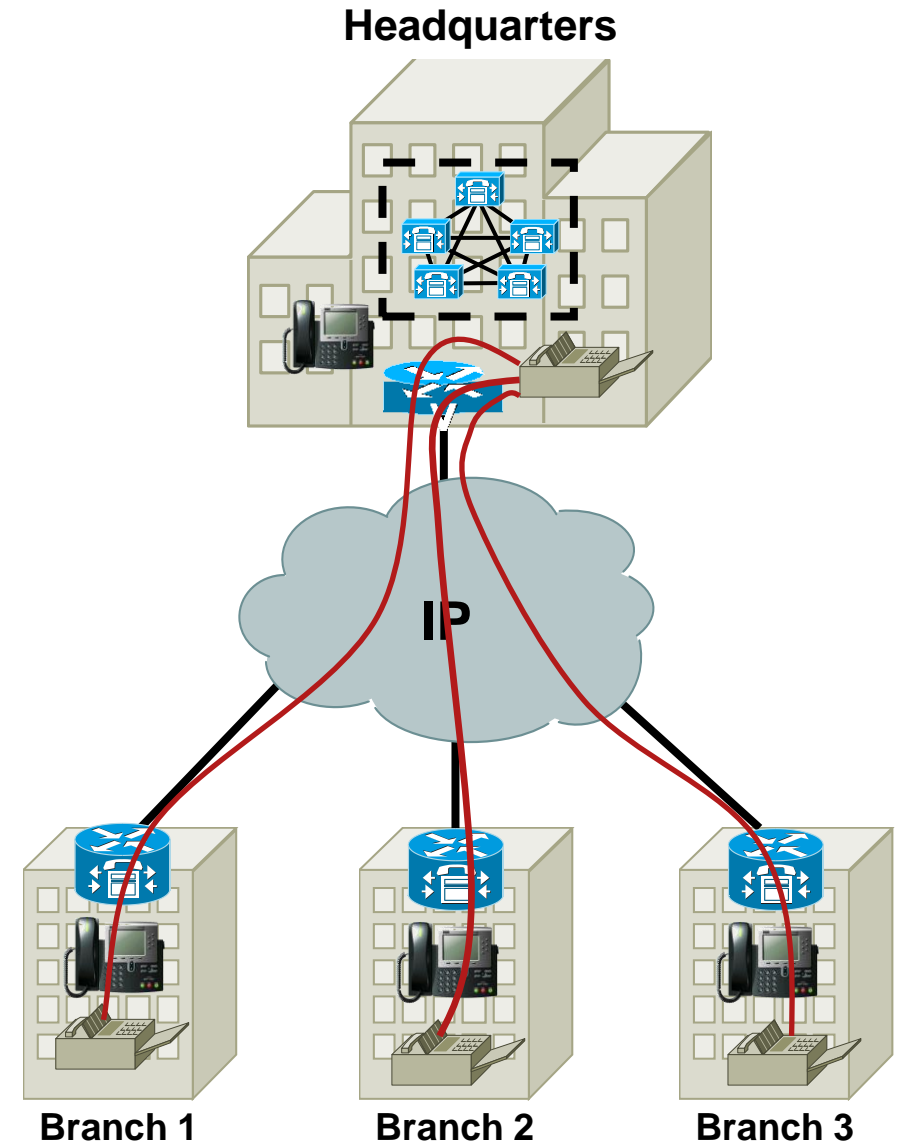




QoS Design Considerations

Are VoIP QoS Policies Sufficient for Fax?

- In many cases, fax devices are located where VoIP is already installed
- You can “piggyback” fax traffic onto the same QoS policy implemented for VoIP
- As a rule of thumb, if good voice quality exists between locations, then fax communications should also work



T.38 and Packet Loss

Originating
Gateway

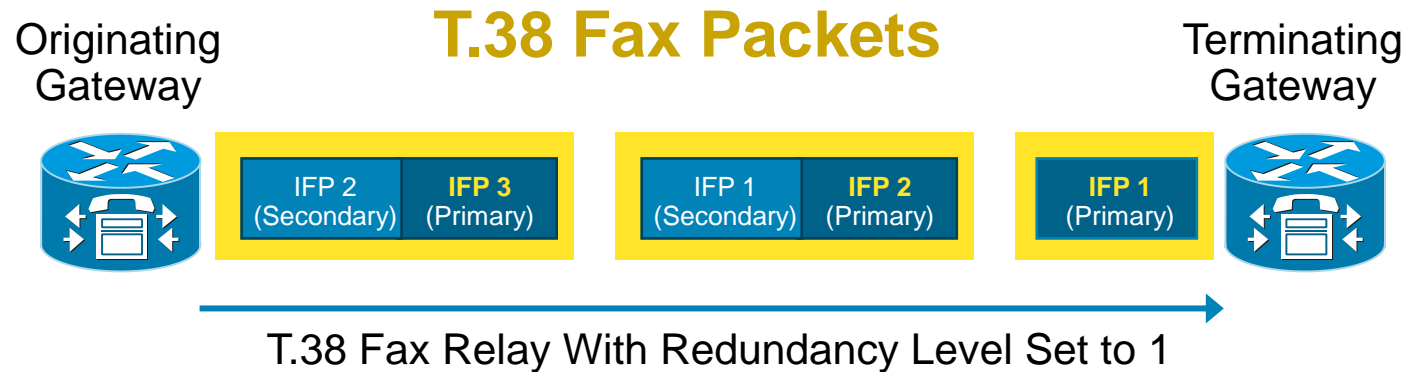


Terminating
Gateway



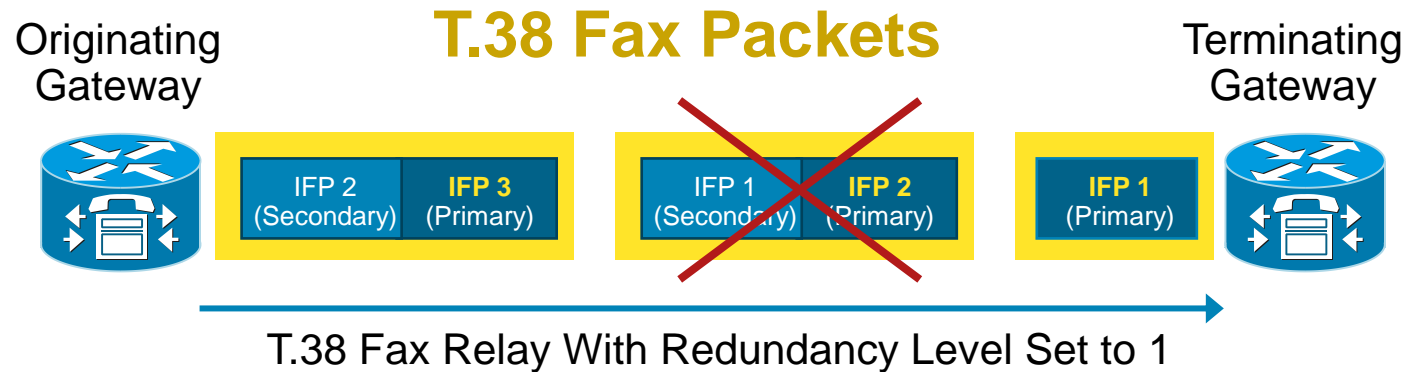
- Fax over IP (FoIP) is generally more affected by packet loss than VoIP
- Ideally no packet loss should occur for a fax call
- If packet loss is present then enable T.38 with redundancy
- Enabling T.38 redundancy requires more bandwidth

T.38 and Packet Loss



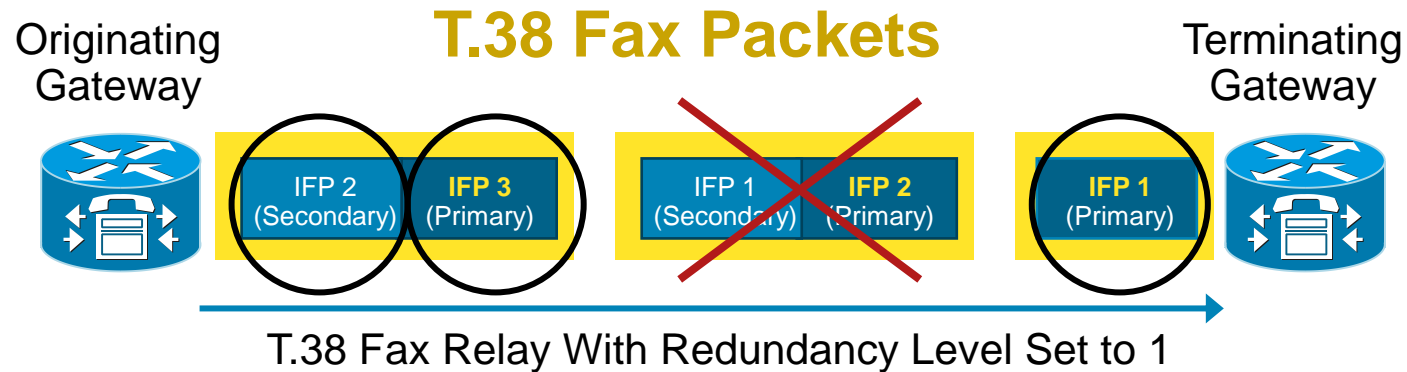
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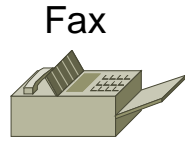


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QoS Design Parameters for T.38 Fax

	Delay	Jitter	Packet Loss
Voice	< 150 ms (one-way, mouth to ear)	< 30 ms (average, one-way)	< 1%
T.38 Fax	< 1000 ms	< 300 ms	None (unless T.38 with redundancy is enabled)

T.38 QoS Marking Configuration on Gateways



T.38 QoS Marking Configuration on Gateways



```
dial-peer voice 100 voip
destination-pattern 100
session target ipv4:10.1.1.1
fax protocol t38 ls-redundancy 0 hs-redundancy
0 fallback cisco
```

- Fax, modem, and text QoS marking via DSCP can be simply added at the dial-peer level for H.323 and SIP or globally for MGCP with the command “mgcp ip qos dscp”

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0 fallback cisco
```

```
cae-dh-3660#show dial-peer voice 100
<snip>
type = voip, session-target = `ipv4:10.1.1.1',
technology prefix:
settle-call = disabled
ip media DSCP = ef, ip signaling DSCP = cs3,
<snip>
```

- Fax, modem, and text QoS marking via DSCP can be simply added at the dial-peer level for H.323 and SIP or globally for MGCP with the command “mgcp ip qos dscp”
- Dial-peer QoS markings can be viewed with the command **show dial-peer voice**
- Default dial-peer QoS markings are **cs3** for signaling and **ef** for media



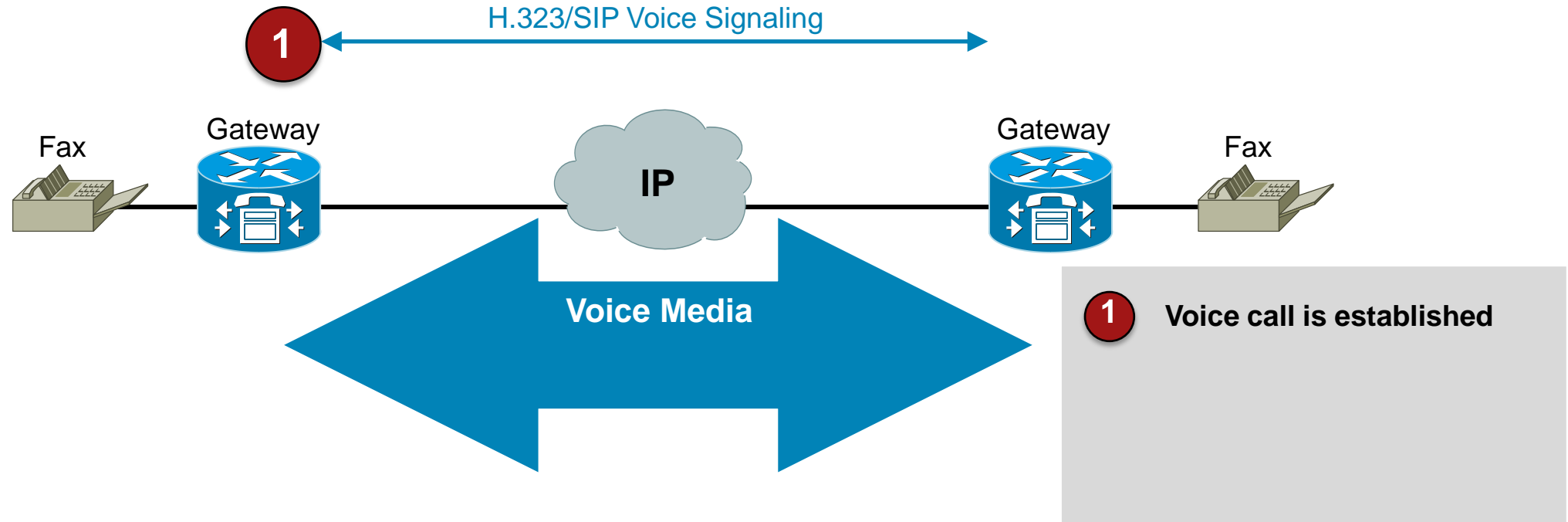
Implementation Models

Gateway to Gateway



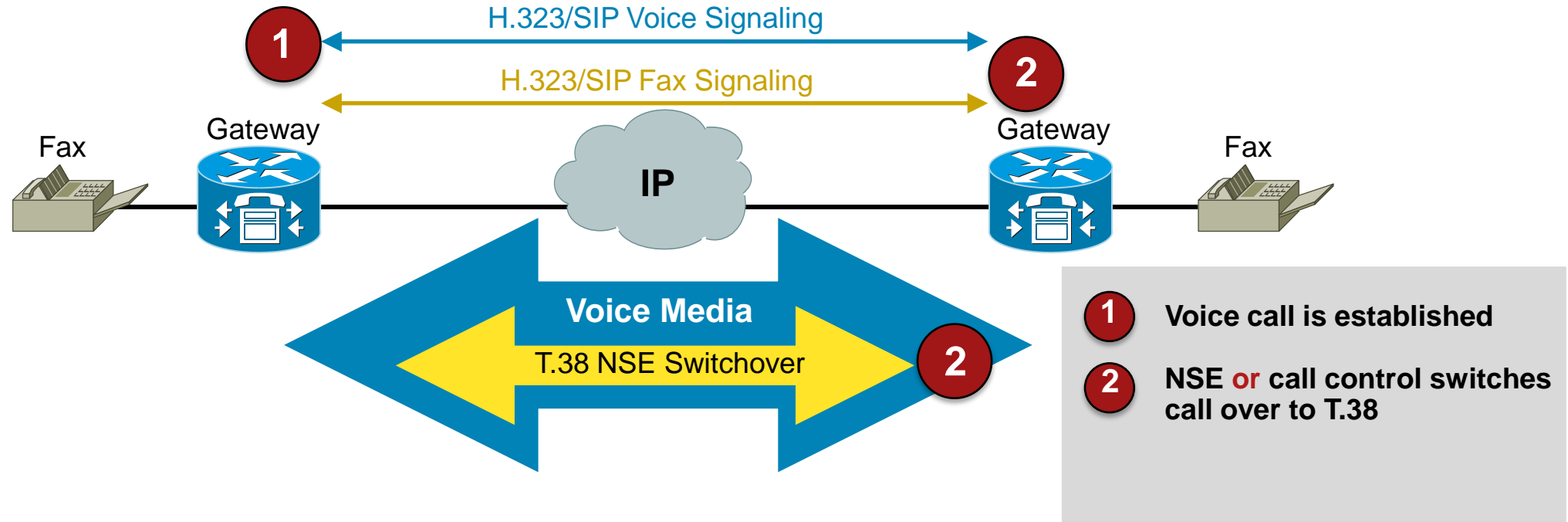
- All FoIP calls start out as VoIP calls
- Signaling and media packets are exchanged between the voice gateways
- T.38 NSE-based switchovers occur within the voice media stream while T.38 protocol-based (standards-based) switchovers happen within the call control protocol

Gateway to Gateway



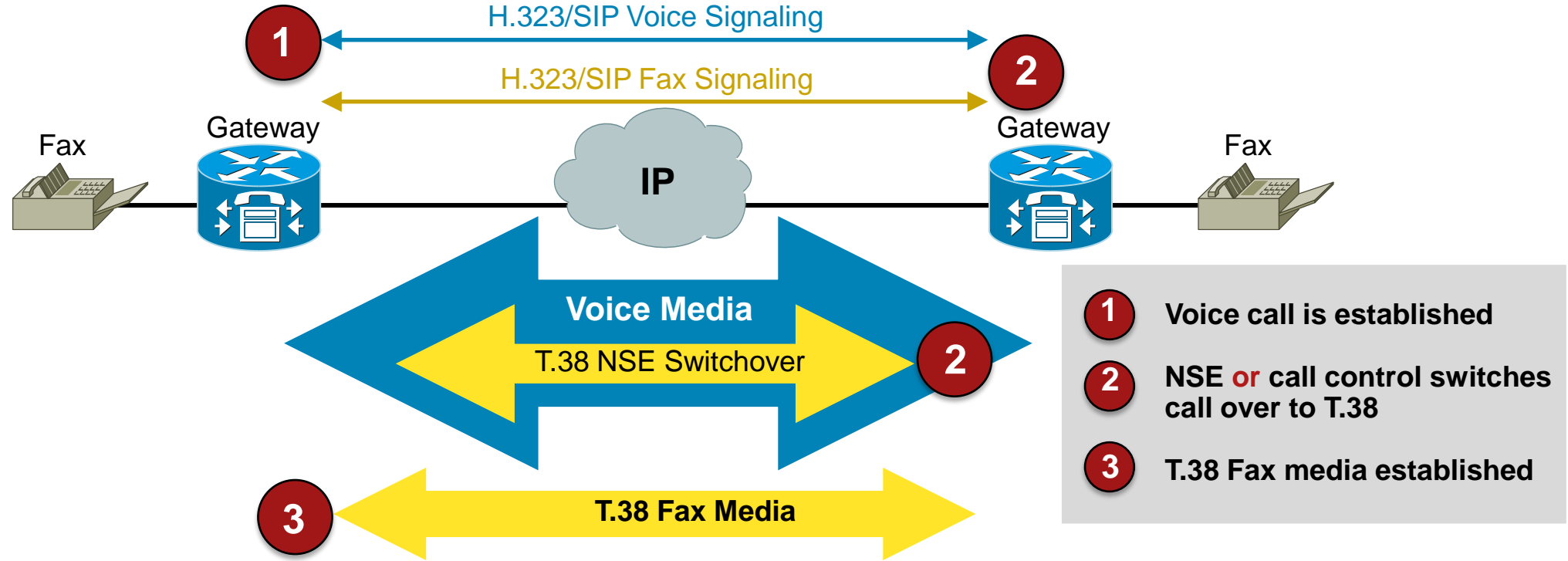
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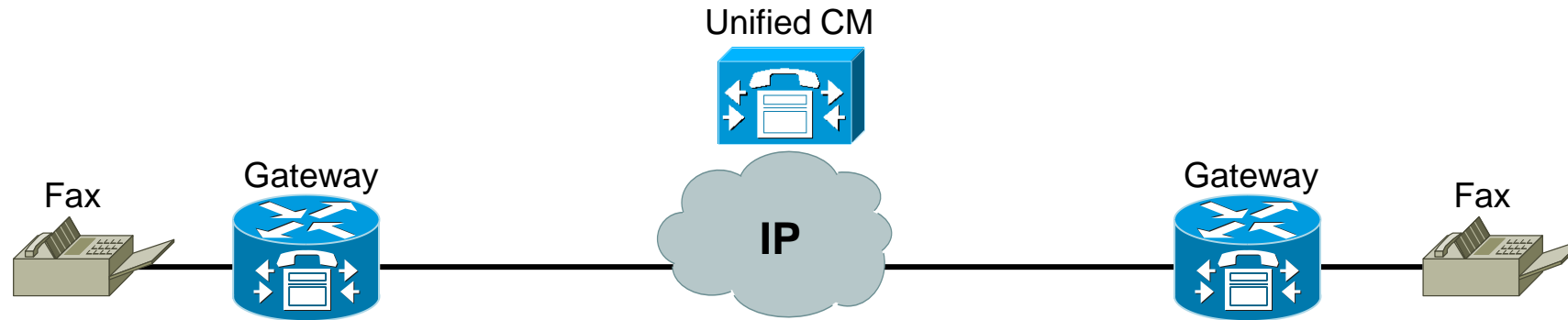
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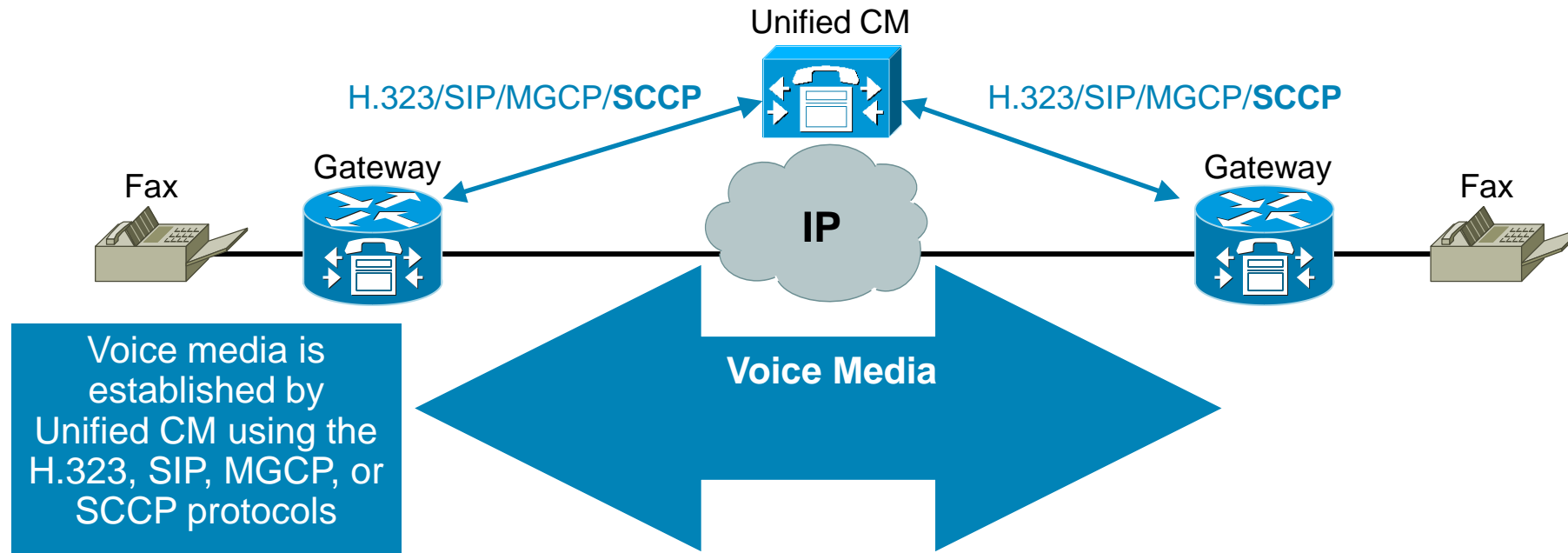
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Cisco Unified Communications Manager, Gateway-Controlled



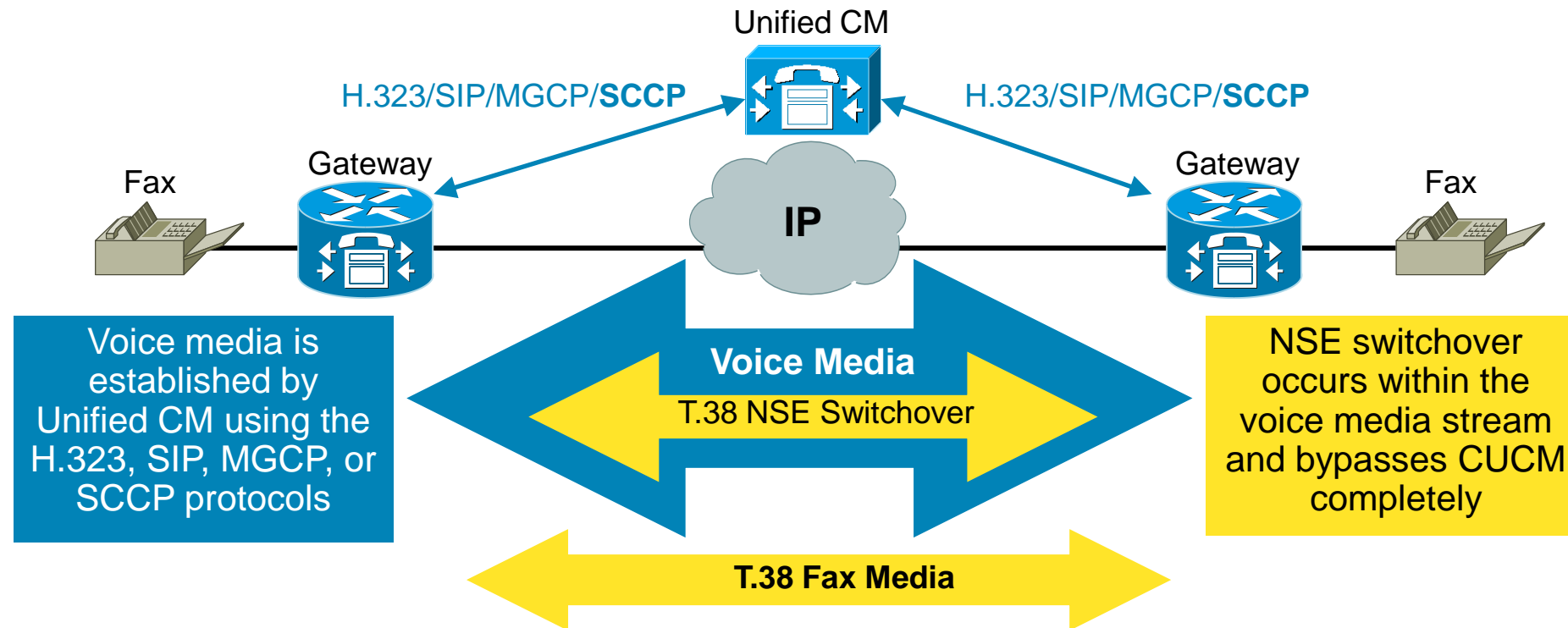
- Cisco Unified Communications Manager (CUCM) controls the setup of the initial voice call between the gateways using standard call control signaling such as H.323, SIP, MGCP, and SCCP
- Skinny (SCCP) gateways **only** support this integration model

Cisco Unified Communications Manager, Gateway-Controlled



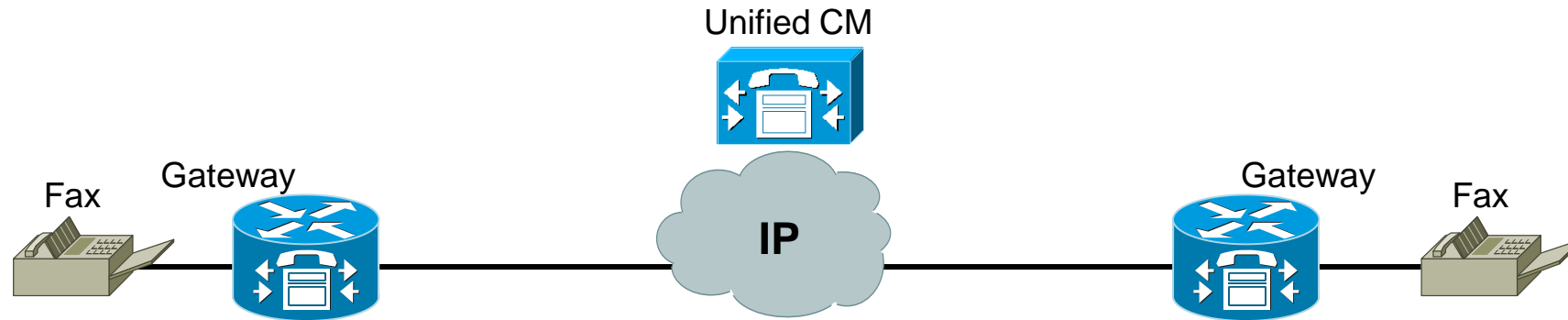
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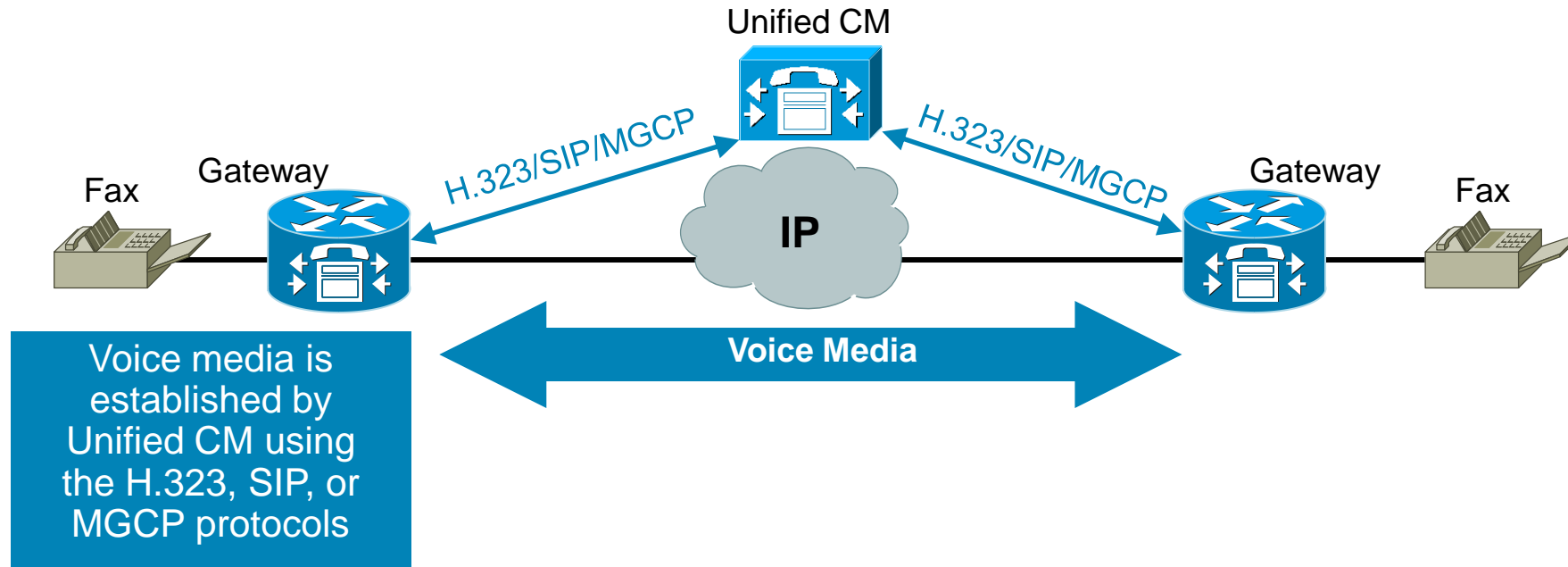
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Cisco Unified Communications Manager, CA-Controlled



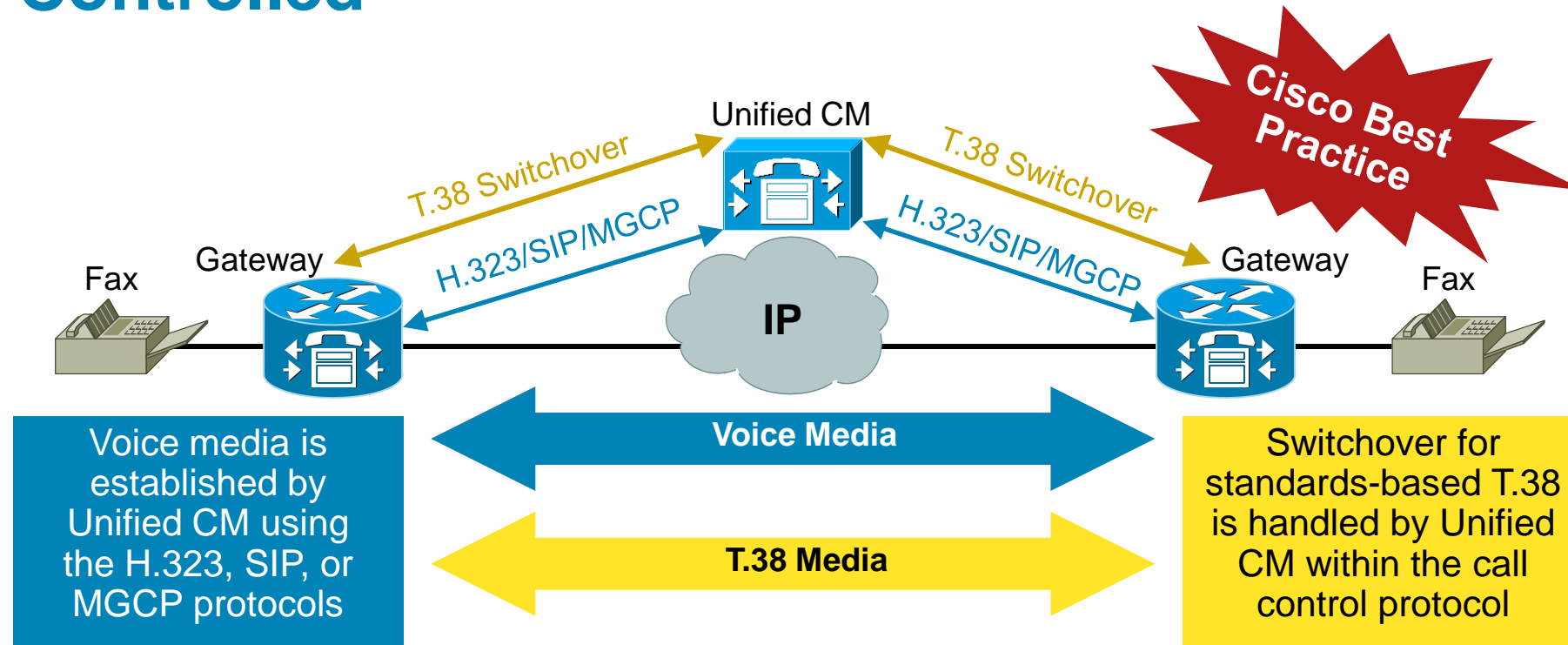
- Cisco Unified Communications Manager controls the setup of the initial voice call between the voice gateways **and** controls the switchover to T.38 fax relay
- Instead of the gateways independently handling the switchover, Cisco Unified Communications Manager coordinates the switchover using the call control protocol

Cisco Unified Communications Manager, CA-Controlled



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Cisco Unified Communications Manager and T.38 Support

Call Control Protocol Support for T.38	Cisco Unified Communications Manager Software Release
H.323	4.1(1), 4.2(3), 5.0(1), and 6.0(1)
H.323 and MGCP	4.2(3) and 6.0(1)
H.323 and SIP	5.0(1) and 6.0(1)
H.323, SIP, and MGCP	6.0(1) and later

- Only release 6.0(1) and later offers support for T.38 within the call control protocols of H.323, SIP, and MGCP
- The SCCP protocol only handles T.38 using an NSE-based switchover



Best Practices

FoIP Bandwidth Utilization

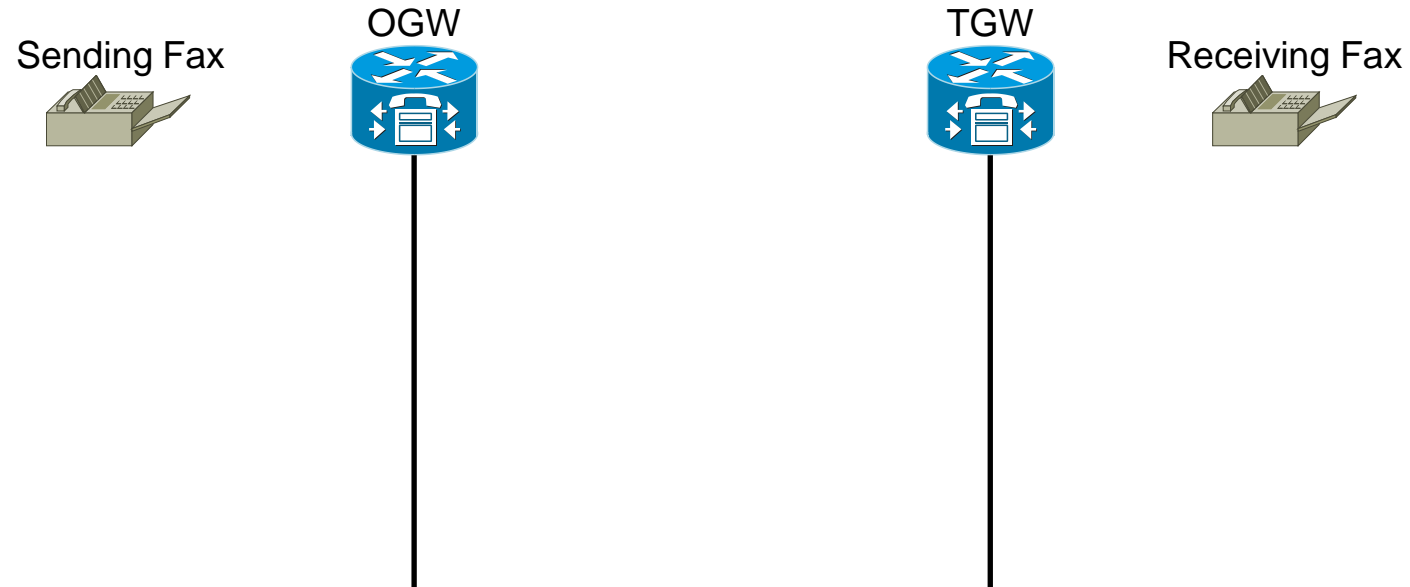
- T.38 offers the best bandwidth savings compared to other FoIP transports
- For CAC (Call Admission Control) planning, T.38 without redundancy is roughly equivalent to G.729
- Be cautious when enabling T.38 redundancy to ensure that CAC thresholds are not exceeded

¹Values are approximate with Ethernet or Frame Relay headers

²Values are peak and only occur unidirectionally during the sending of a page at 14.4 Kbps

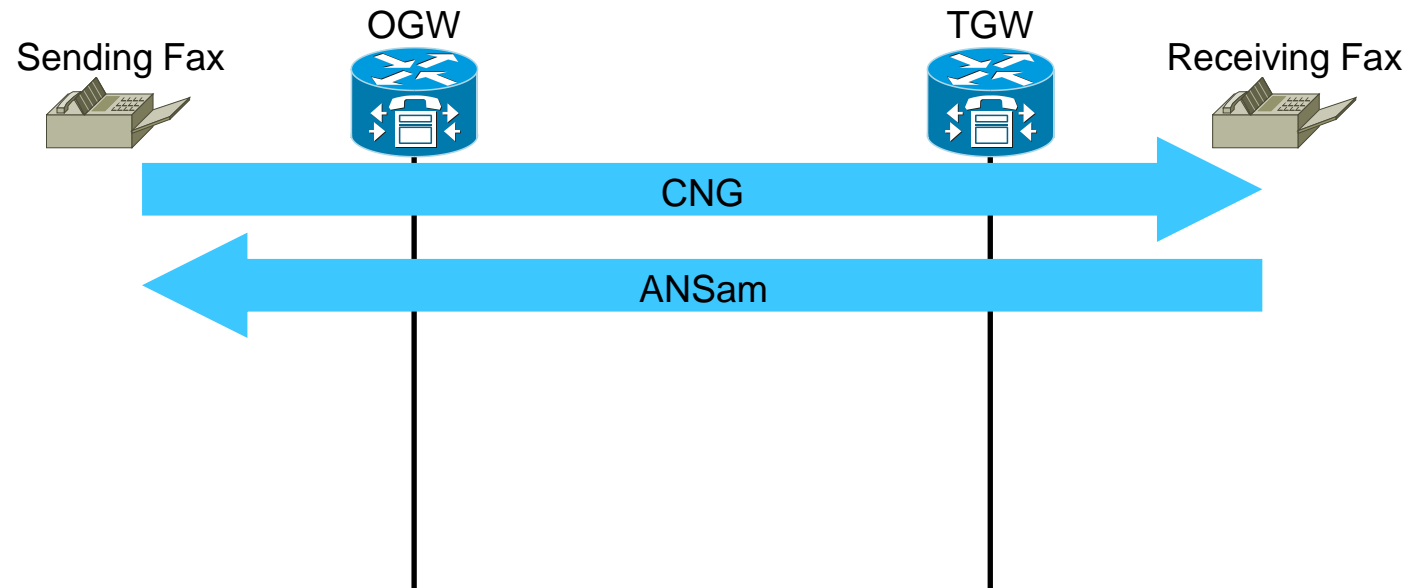
Codec	Bandwidth ¹
G.711 (64 Kbps)	83 Kbps
G.729 (8 Kbps)	27 Kbps
G.723 (6.3 Kbps)	19 Kbps
Fax passthrough/ passthrough (G.711)	83 Kbps
Fax passthrough (G.711) with redundancy	170 Kbps
T.38 (no redundancy)	25 Kbps ²
T.38 (redundancy level 1)	41 Kbps ²
T.38 (redundancy level 2)	57 Kbps ²
Cisco fax relay	48 Kbps ²

Handling SG3 Fax Calls with T.38



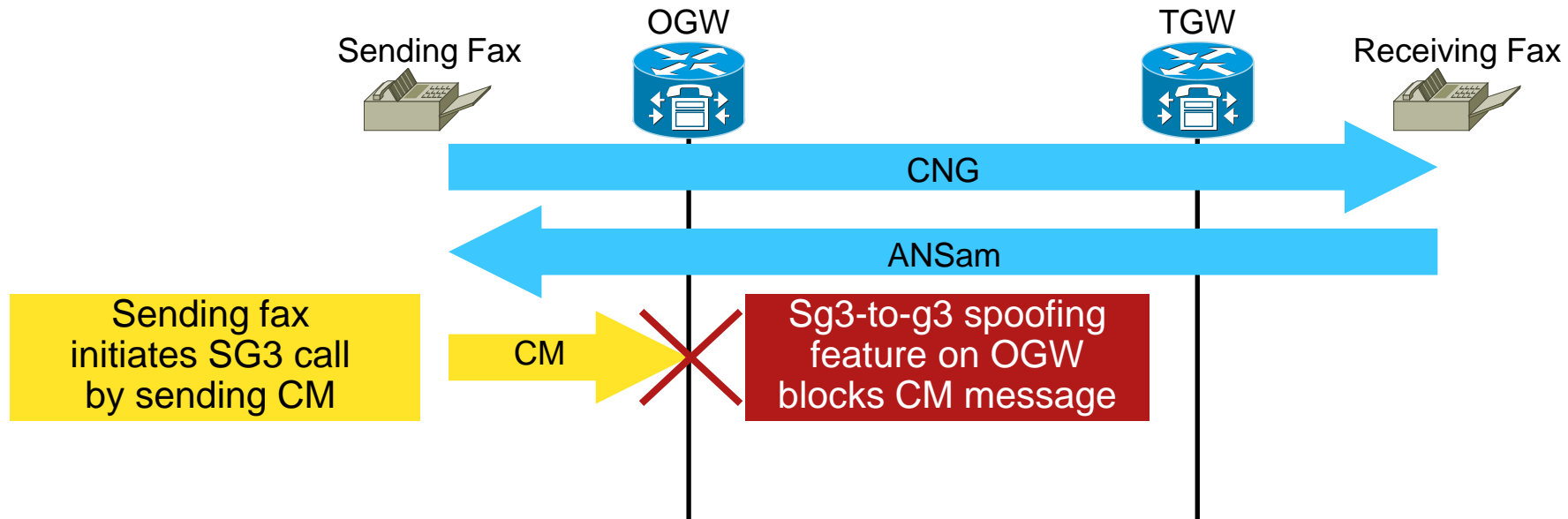
- Starting in IOS 15.1(1)T SG3 over T.38 is supported for H.323 and SIP only
- When SG3 over T.38 support is not available or disabled the **sg3-to-g3 spoofing feature** is automatically enabled
- The sg3-to-g3 spoofing feature forces SG3 fax calls to G3 calls that are compatible with version 0 T.38

Handling SG3 Fax Calls with T.38



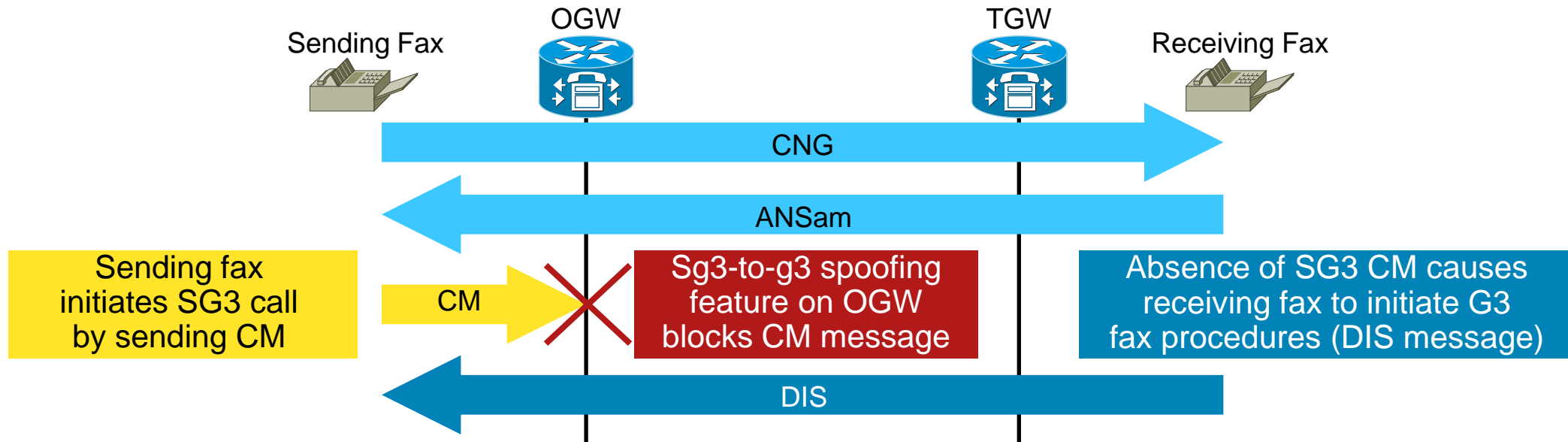
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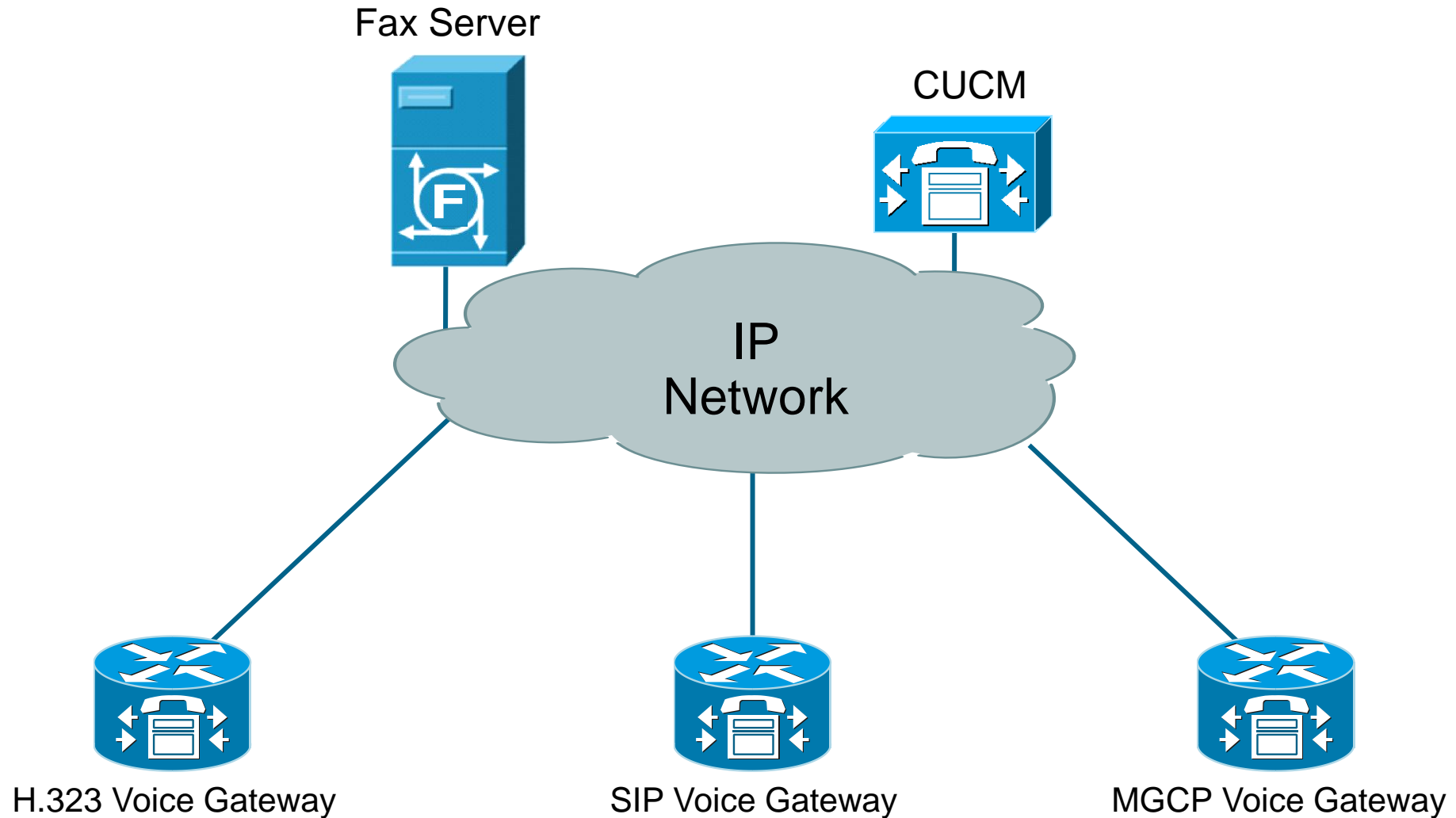
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SIP Trunks and FoIP

- The three common fax transport methods available with SIP trunking are T.38, G.711 voice, and fax passthrough
- T.38 is the best choice but it is still not offered by some providers and interoperability problems are still being resolved in some cases

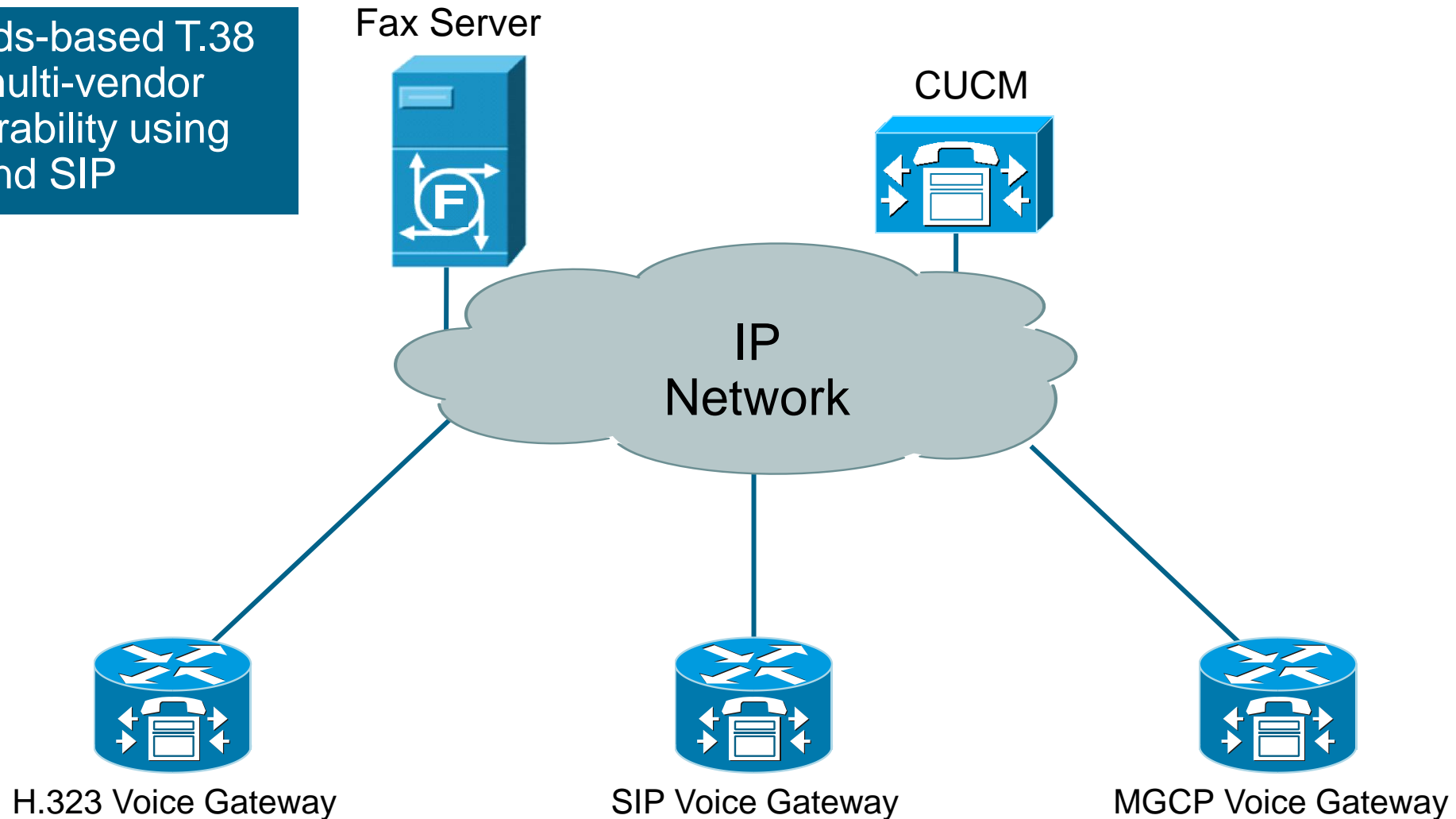
Fax Method	T.38 Fax Relay	G.711 Voice	Passthrough
Pros	<ul style="list-style-type: none"> ▪ Highest fax success rates can be achieved ▪ Cleanest solution from signaling and media point of view ▪ Use less bandwidth than G.711 	<ul style="list-style-type: none"> ▪ Most widely deployed ▪ Simplest solution 	<ul style="list-style-type: none"> ▪ Provides bandwidth savings as G.729 voice call only upspeeds to G.711 if call is fax
Cons	<ul style="list-style-type: none"> ▪ Interoperability between different vendors ▪ Not offered by many Service Providers 	<ul style="list-style-type: none"> ▪ Consumes a large amount of bandwidth for all calls ▪ Sensitive to impairments, no redundancy 	<ul style="list-style-type: none"> ▪ Interoperability between different vendors ▪ Not supported by Cisco Unified Communications Manager ▪ Sensitive to impairments, no redundancy

Third Party Interoperability—Fax Server



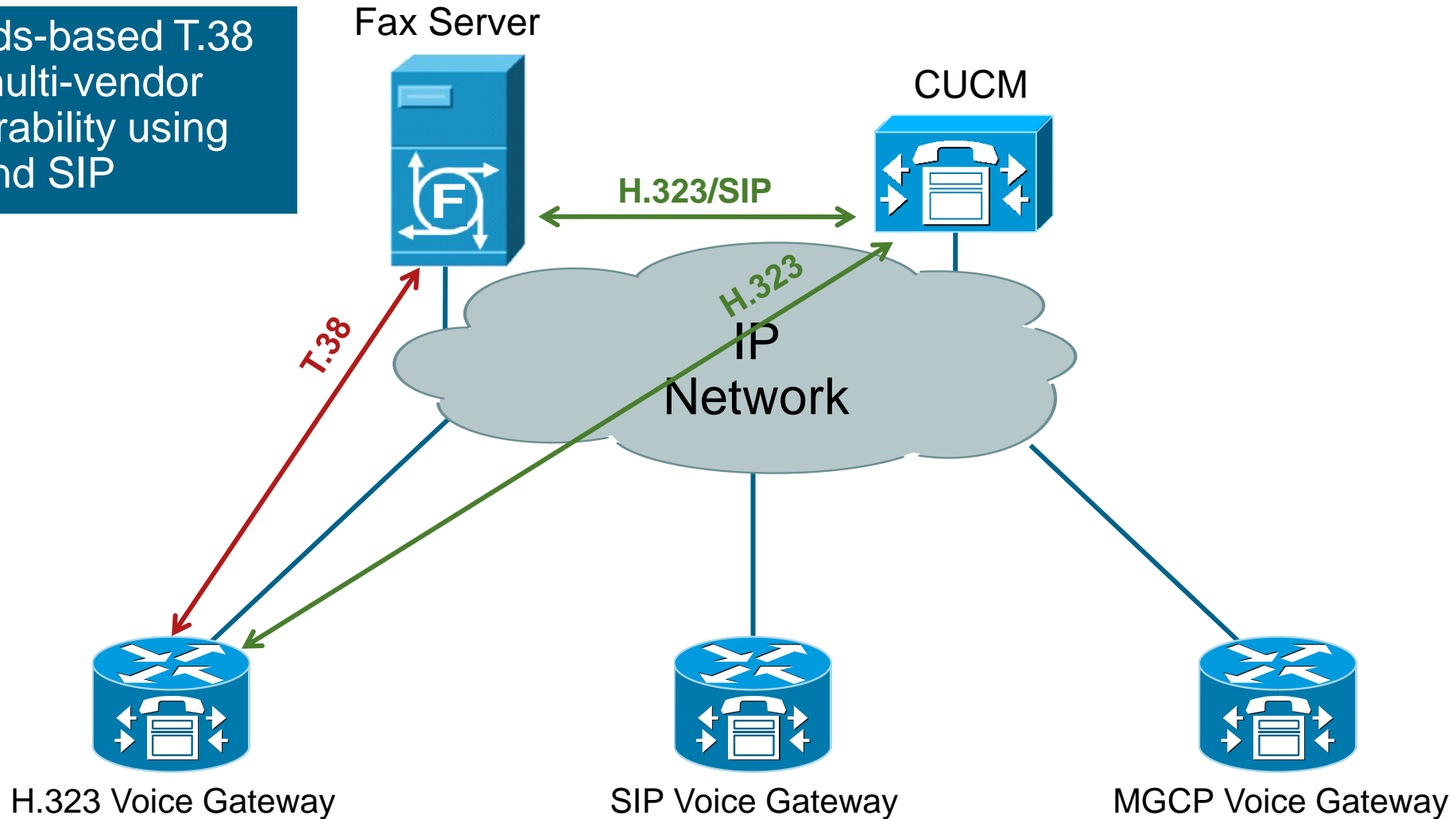
Third Party Interoperability—Fax Server

Standards-based T.38 allows multi-vendor interoperability using H.323 and SIP



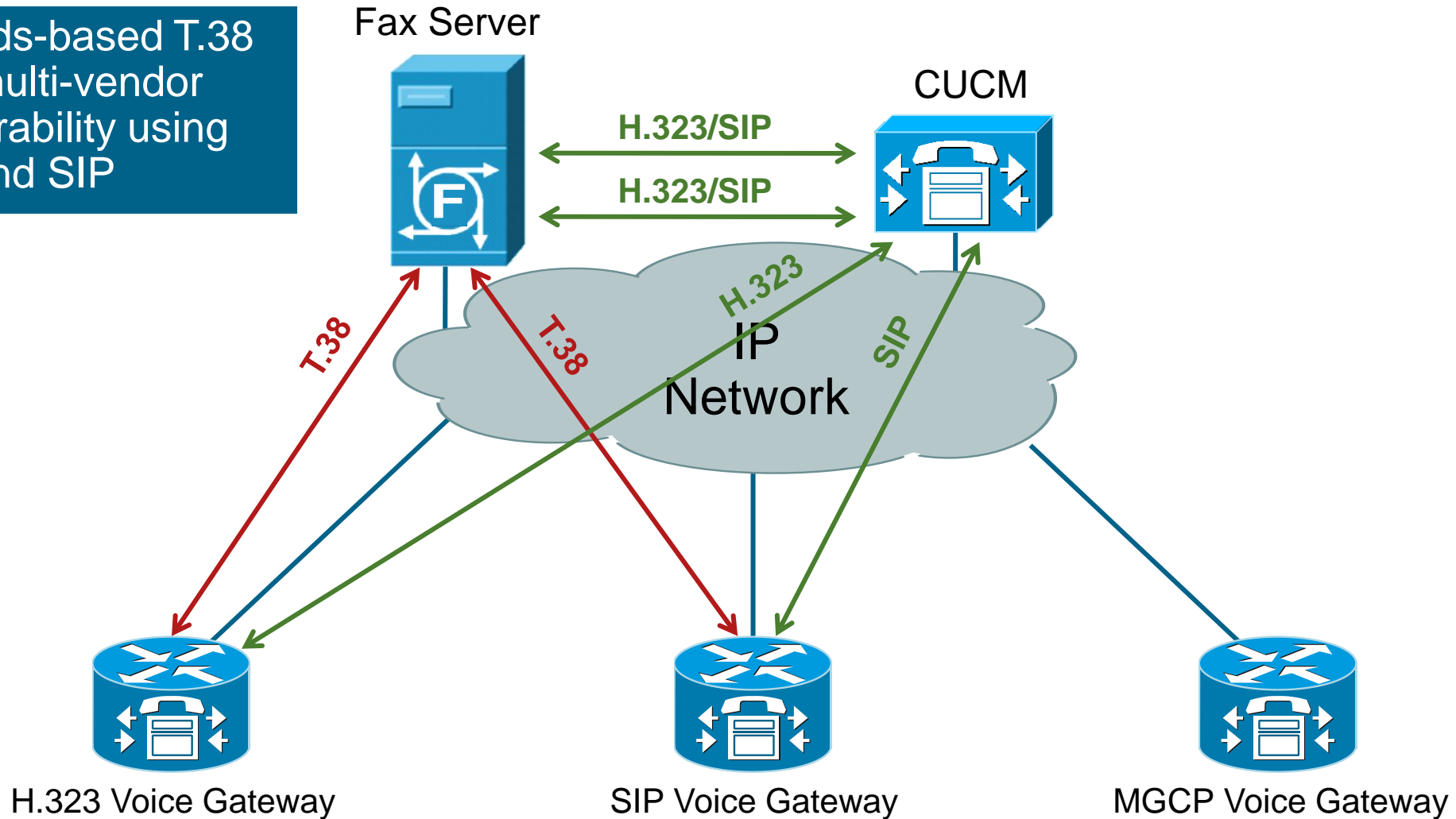
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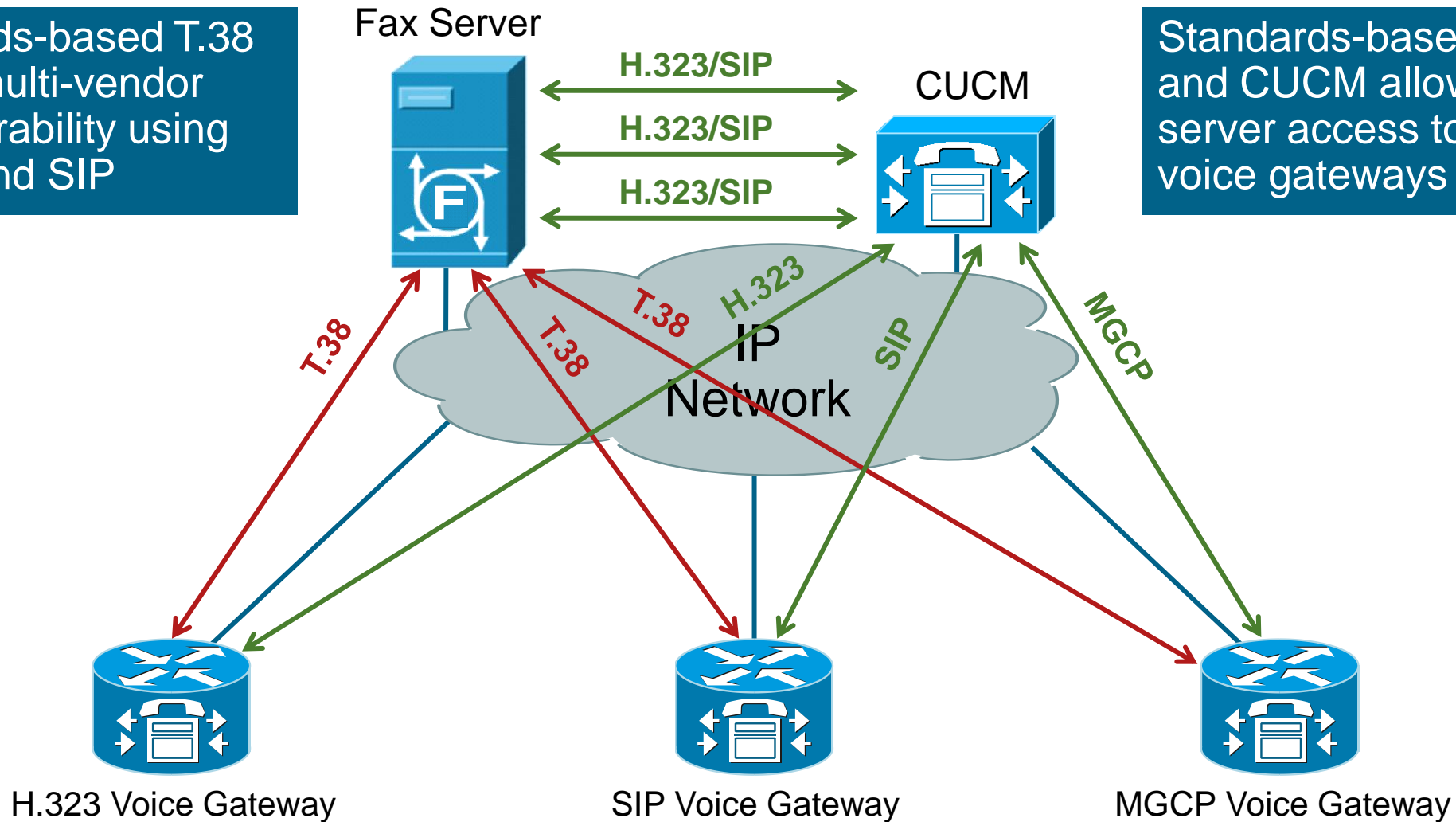
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Third Party Interoperability—Fax Server

Standards-based T.38 allows multi-vendor interoperability using H.323 and SIP

Standards-based T.38 and CUCM allows fax server access to MGCP voice gateways



Poll Question

Please mark the answer that best describes your organization's use of a fax server?

- Use an IP-based, T.38 fax server
- Use a fax server but it is directly connected to the PSTN
- Planning on deploying a fax server in the future
- No plans to deploy a fax server

Submit

Poll Response

Please mark the answer that best describes your organization's use of a fax server?

Use an IP-based, T.38 fax server



Use a fax server but it is directly connected to the PSTN



Planning on deploying a fax server in the future



No plans to deploy a fax server





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4. T.38 supports SG3 in IOS version 15.1(1)T and later for SIP and H.323 only. No T.38 SG3 support for MGCP and SCCP voice gateways.

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7. Cisco products running standards-based T.38 with SIP and H.323 interoperate with third party devices such as fax servers and gateways.
8. T.38 uses a UDPTL header instead of RTP so secure RTP (SRTP) and compressed RTP (CRTP) are not available.



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