

## Agenda

- Analog/Digital Signaling
- ISDN/SS7 Signaling
- QSIG
- H.323
- SIP
- Media Gateway Controller

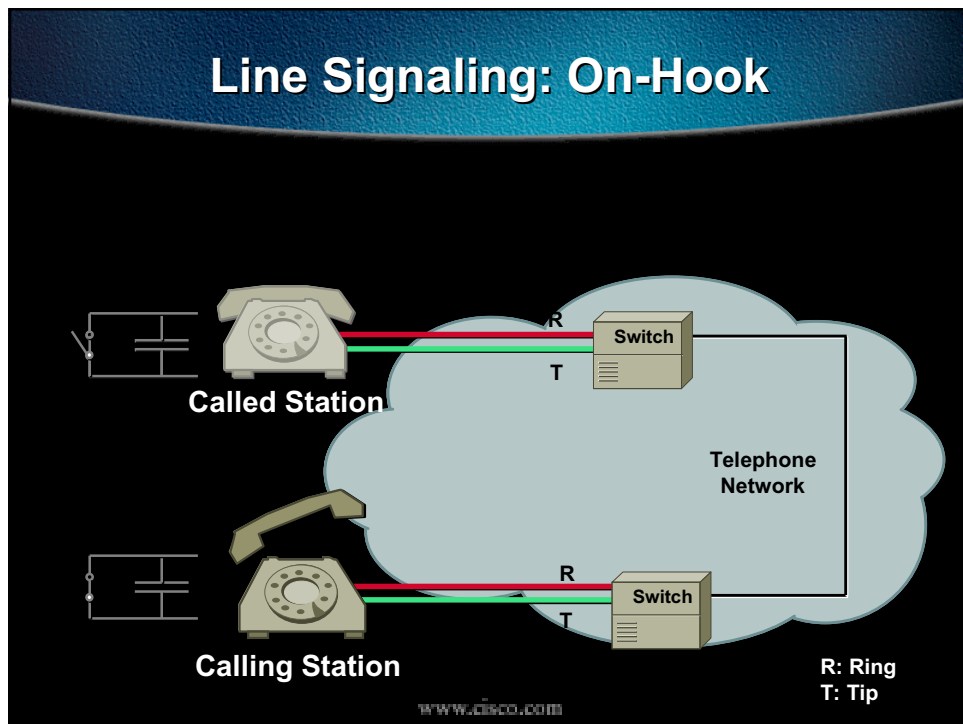
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## In the Beginning—Well Almost!



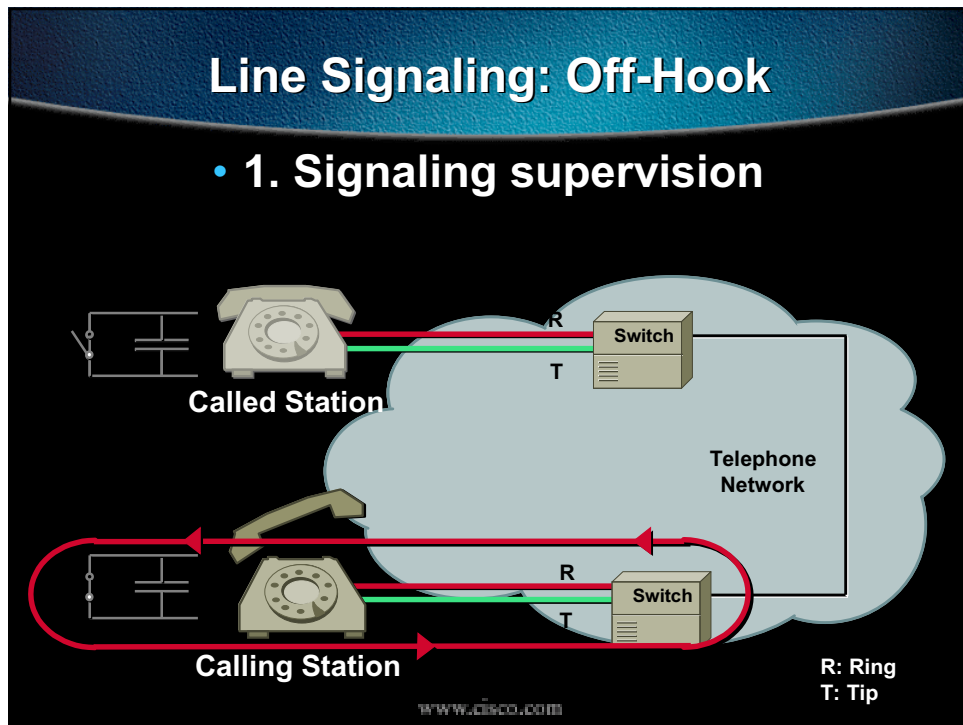
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## Line Signaling: On-Hook



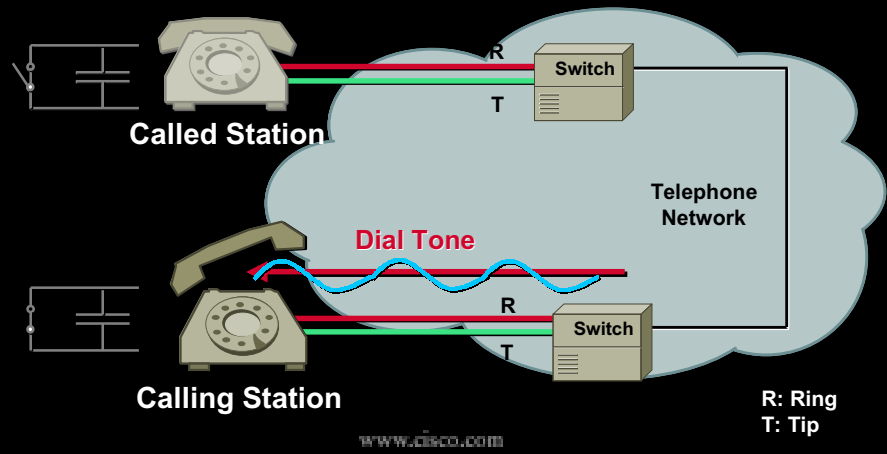
## Line Signaling: Off-Hook

- 1. Signaling supervision



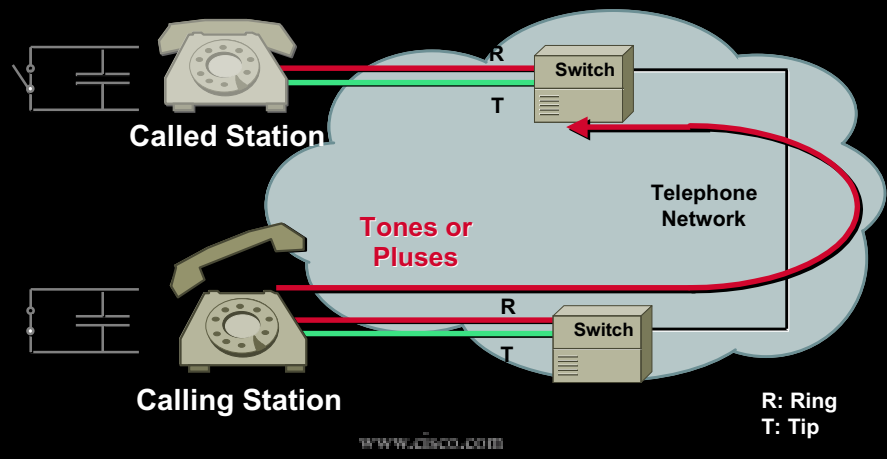
## Line Signaling: Dial-Tone

- 2. Call information (network to user)



## Line Signaling: Addressing

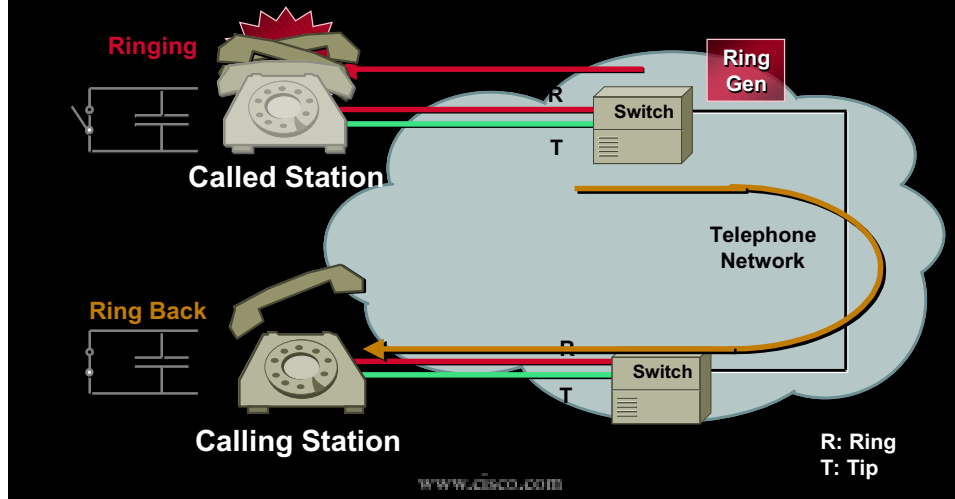
- 3. Dialing the destination





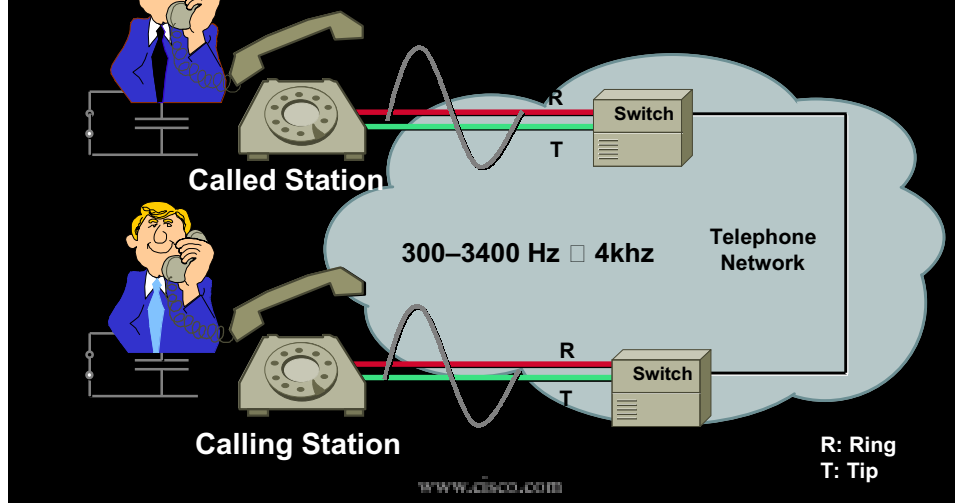
## Line Signaling: Ringing

- 4. Call information (network to user)

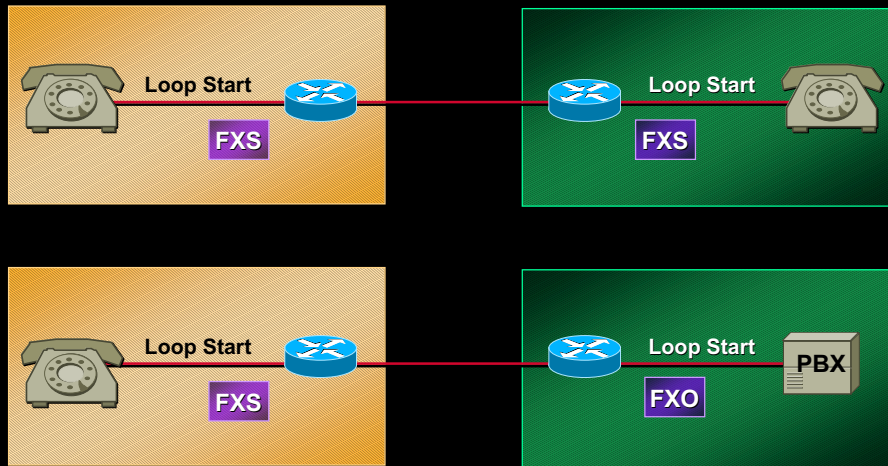


## Line Signaling: Off-Hook

- 5. Call Completion

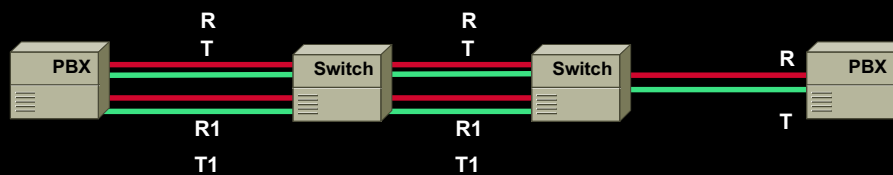


## Applications of Line Signaling



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## Trunk Signaling

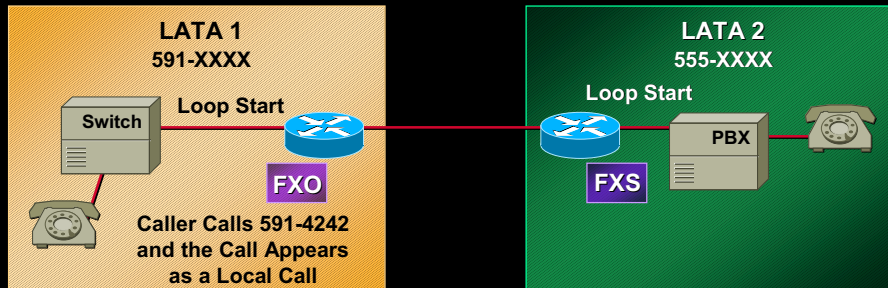


- Loop start
- Ground start
- E&M

R: Ring  
T: Tip  
R1: Ring 1  
T1: Tip 1

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## Application—Foreign Exchange (Loop Start)



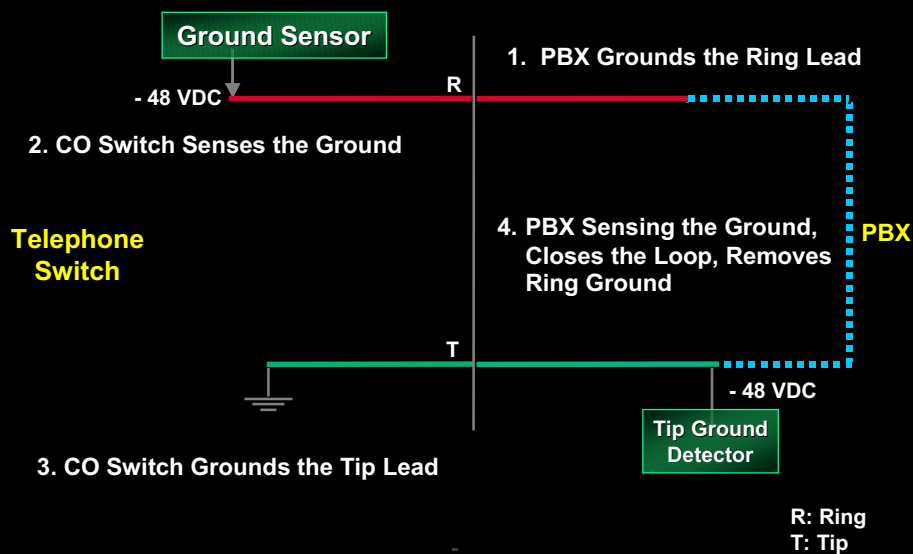
- **Limitations:**

Simultaneous trunk seizure (glare)

Lack of far-end disconnect notification

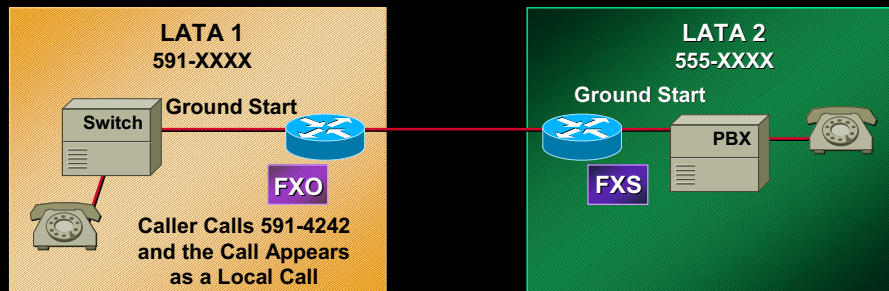
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## Ground Start Supervisory Signaling—From PBX



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## Application—Foreign Exchange (Ground Start)



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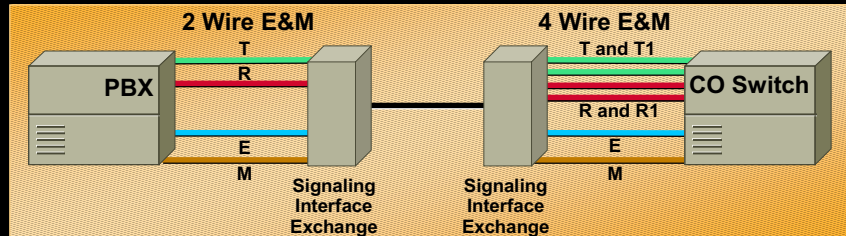
## Ground Start Benefits and Limitations

- **Benefits**
  - Reduces glare by quickly recognizing incoming seizure (tip ground)
  - Provides remote disconnect supervision
- **Limitations**
  - Mixed voice and signaling
  - Tip and ring cannot be reversed
  - CO switch and PBX must have same potential ground

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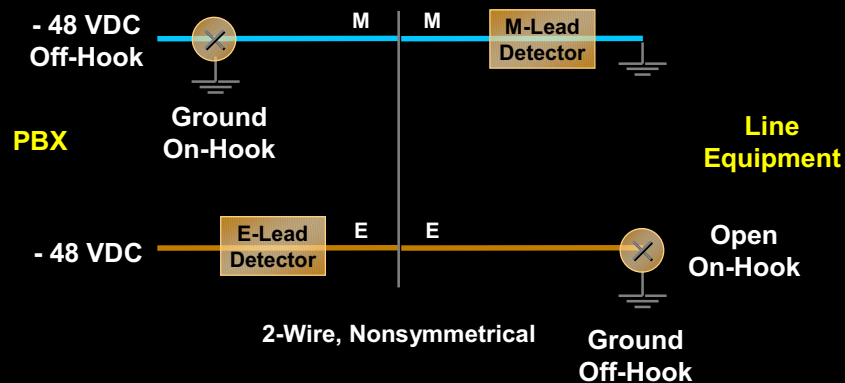
## Ear and Mouth (E&M) Separate Signaling Path



- 2 wire and 4 wire refer to the voice wires
- The switch listens on the ear (E-lead)
- The switch signals on the mouth (M-lead)

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## E&M Type 1



- Common ground must exist between PBX and line equipment

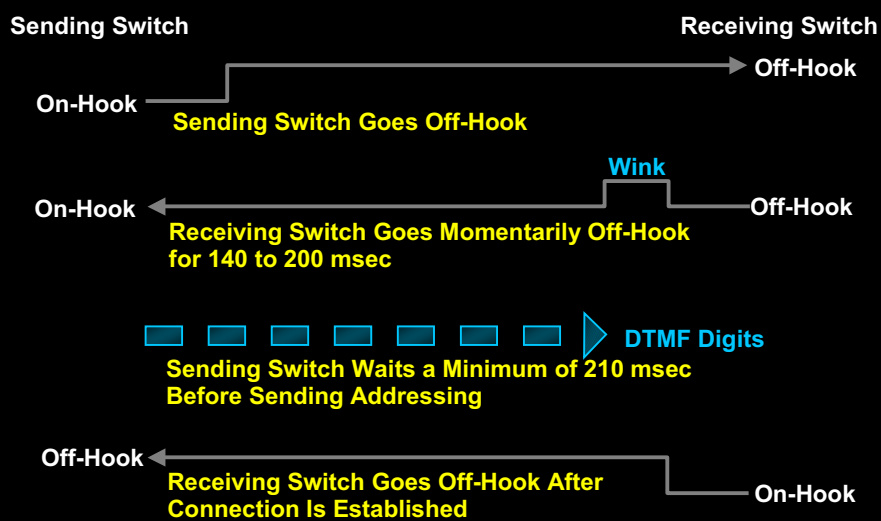
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## E&M Signaling States

E&M Type	Condition	M-Lead/SB	E-Lead/SG
Type I	On-Hook	Ground	Open
	Off-Hook	Battery	Ground
Type II	On-Hook	Open	Open
	Off-Hook	Battery	Ground
Type III	On-Hook	Ground	Open
	Off-Hook	Loop Current	Ground
Type IV	On-Hook	Open	Open
	Off-Hook	Ground	Ground
Type V	On-Hook	Open	Open
	Off-Hook	Ground	Ground

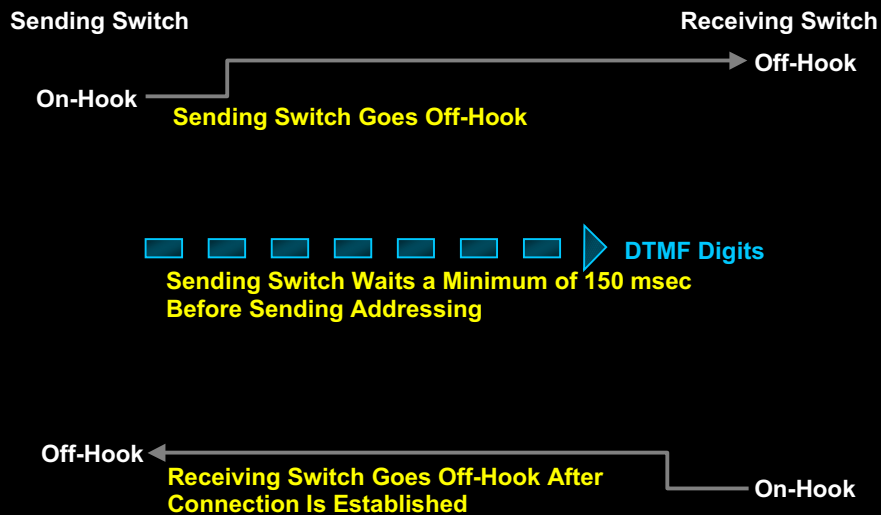
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## I'm Ready to Receive the Number Now—Wink Start



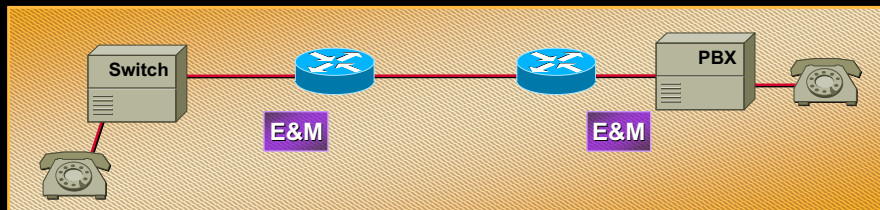
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## I'm Always Ready to Receive— Immediate Start



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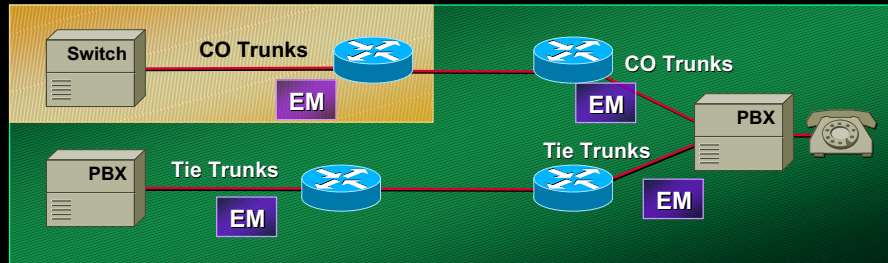
## E&M Signaling and Wink Start or Immediate Start



- The only caveat—make sure your signaling type matches up with your PBX

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## Primary Trunk Signaling Method



- PBX to local exchange office (telephone company)
- CO trunks
- Direct inward dial (DID) trunks
- Direct outward dial (DOD) trunks
- PBX to PBX connections
- Tie trunks

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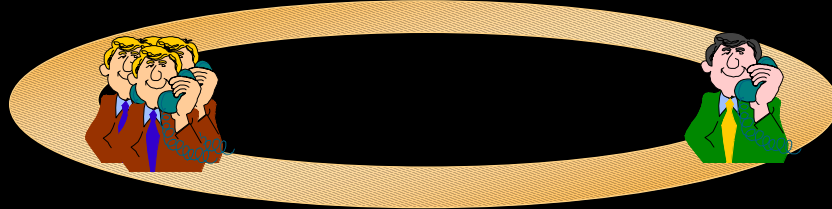
## Voice Evolution: The Formative Years



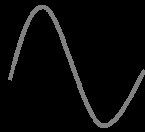
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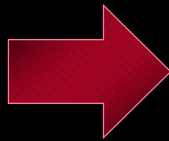
## Digital Signaling— Better and Cheaper



Distorted Analog  
Communications



300–3400 Hz □ 4 KHz



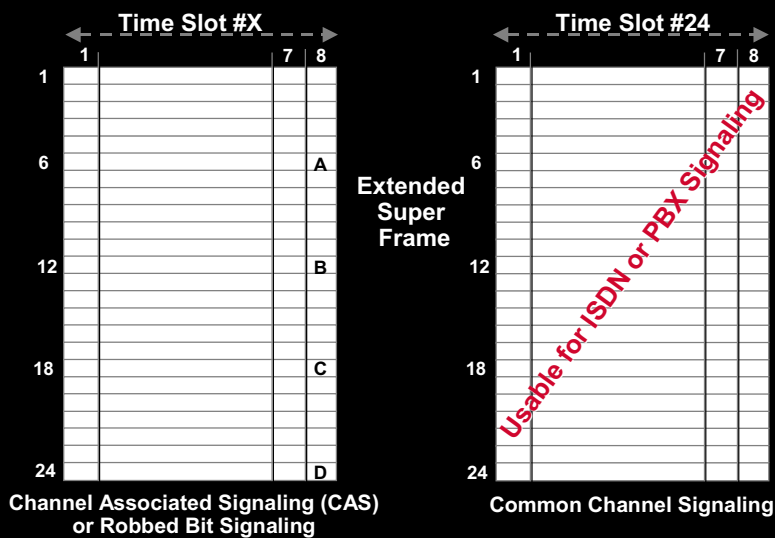
Clear Digital  
Communications



$2 \times 4 \text{ KHz} = 8 \text{ KHz}$   
 $8 \text{ KHz} \times 8 \text{ Bits} = 64 \text{ kbps}$

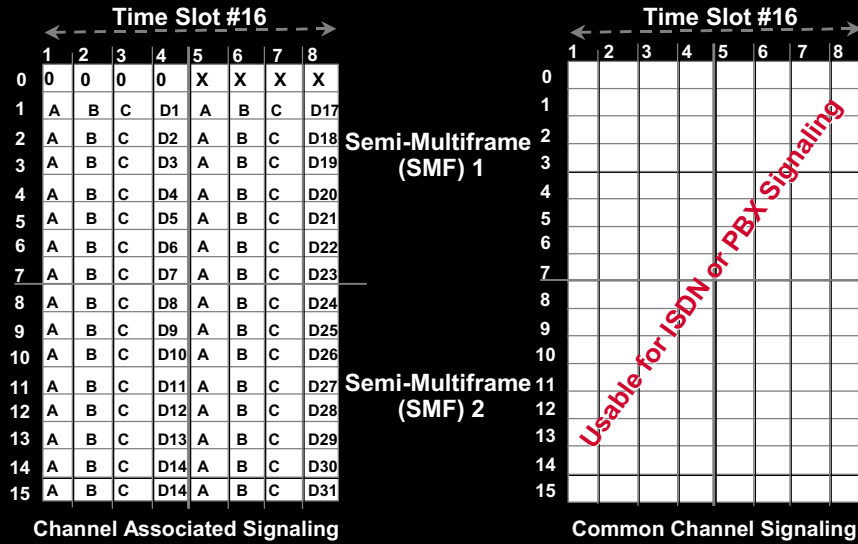
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## T1 Signaling Format

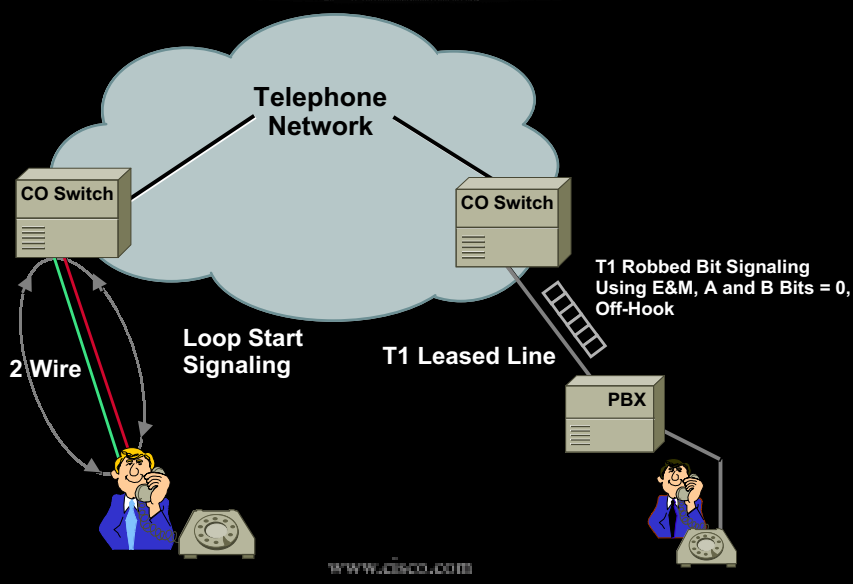


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## E1 CAS Signal Format



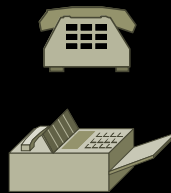
## Sample Call



## Voice Evolution: Dawn of the Digital Age



Touch Tone Phones  
Faxes  
Wow! This Is Better Than Fire



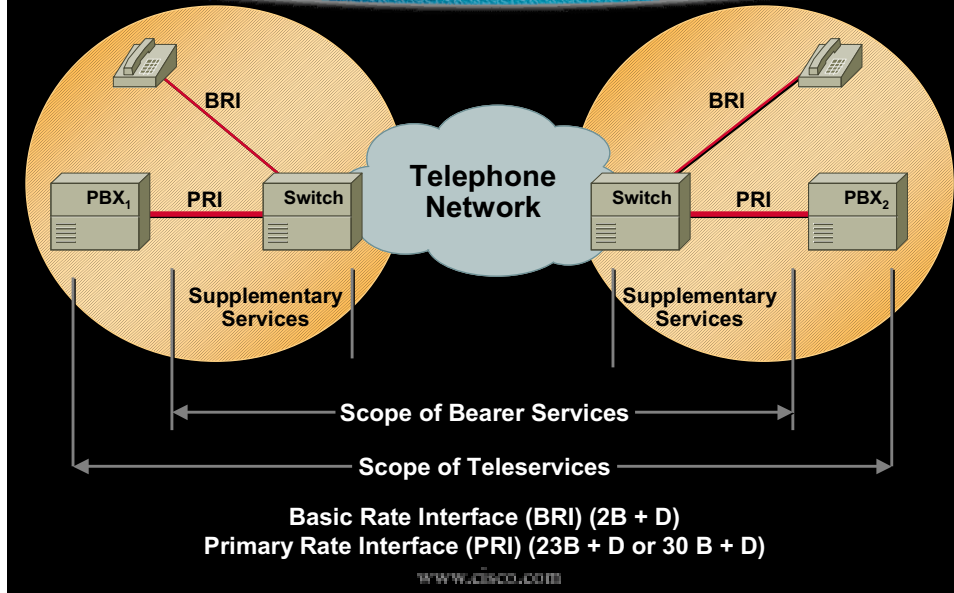
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## The Advanced Intelligent Network

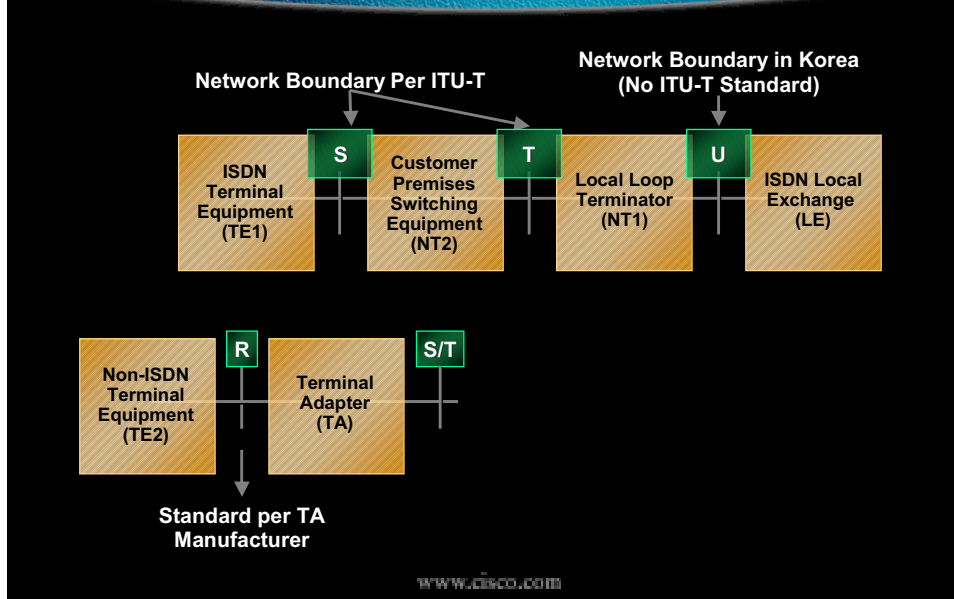
- More efficient
- Support real-time operations of telephone network's capabilities
- Supports transport transparency
- Customer can create new applications and is provided greater control

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## Public N-ISDN Intelligent Access to the Network

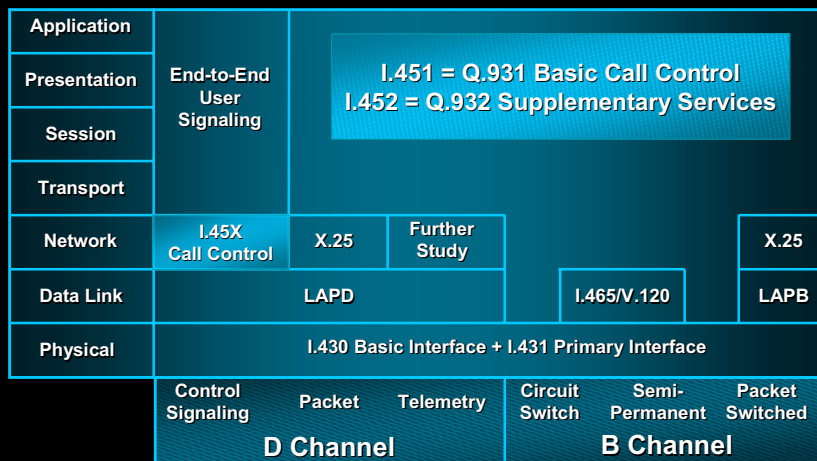


## Functional Devices and Reference Points





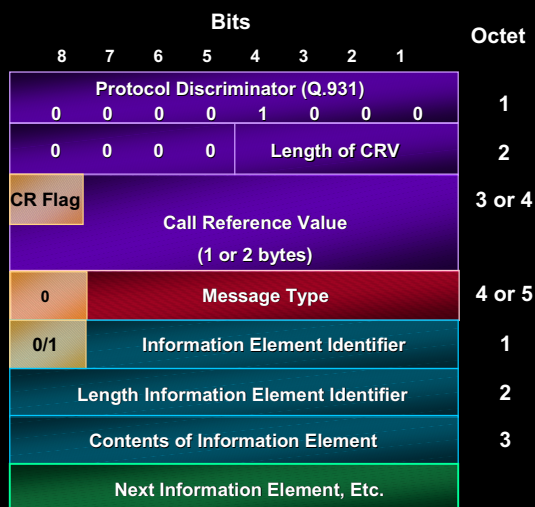
## ISDN Protocol Stack



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## Q.931/932 Message Format

- **Call reference**—establishes a unique value between user and the network
- **Message type**—can be grouped into call establishment, call info phase, call clearing and misc.
- **Information elements**—are self contained entities that further define the message



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## Supplementary Services

- **Types:**

Number identification, call offering, call completion, multiparty, community of interest, charging, additional information transfer

- **Control and invocation, three generic protocols:**

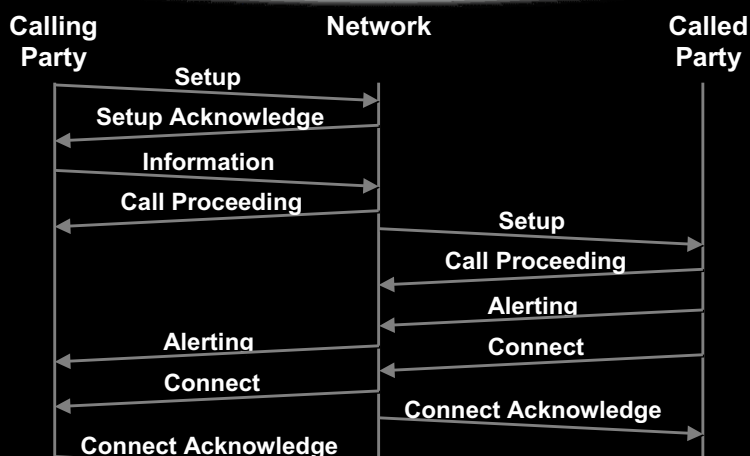
**Keypad**—uses the keypad and display information elements

**Feature key**—uses the feature activation and feature indication information elements

**Functional protocol**—facility message and facility information element or specific messages like HOLD

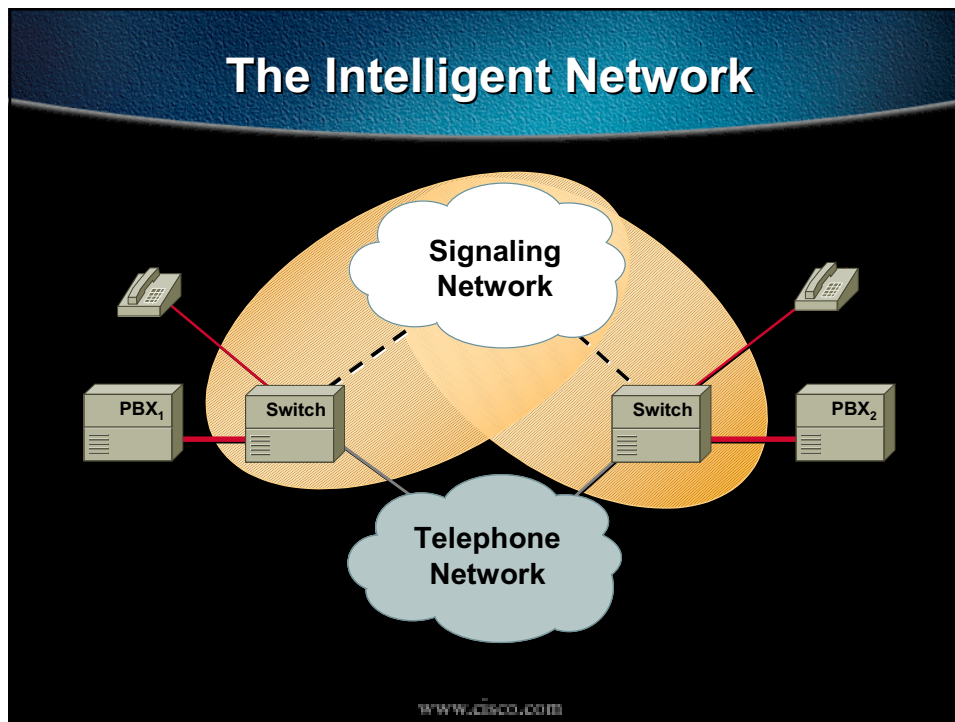
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## Q.931/Q.932 Call Completion

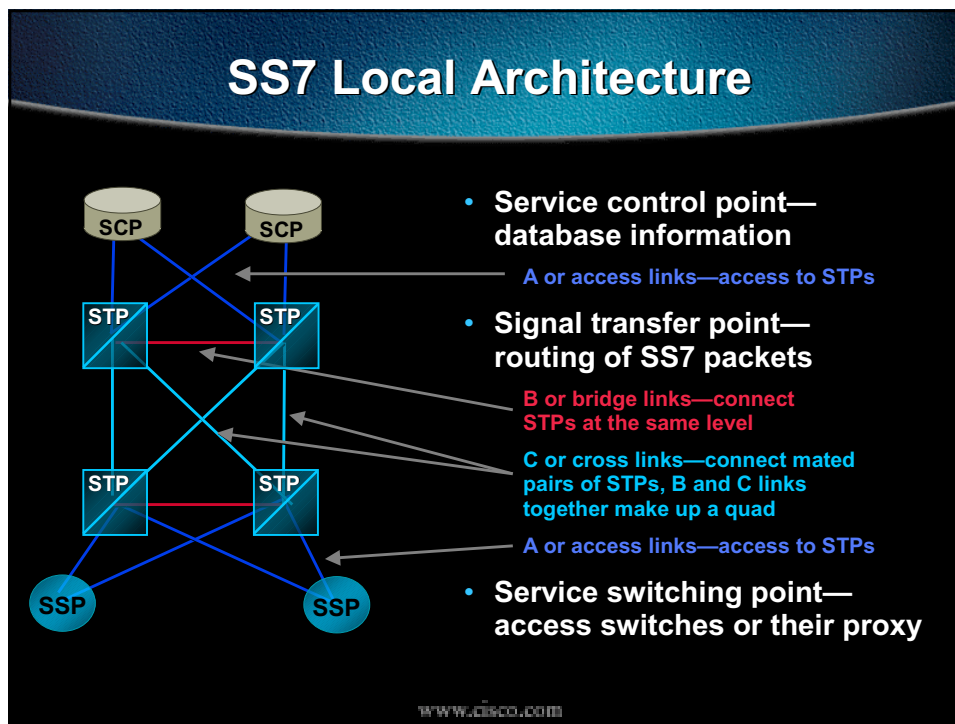


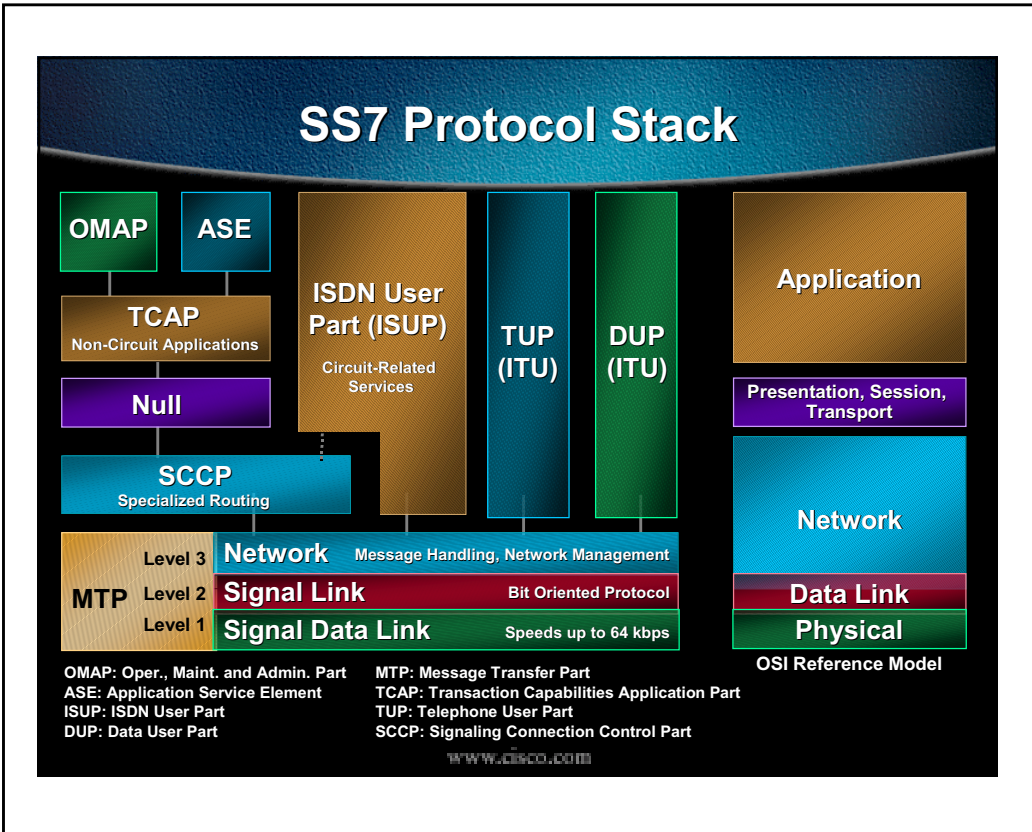
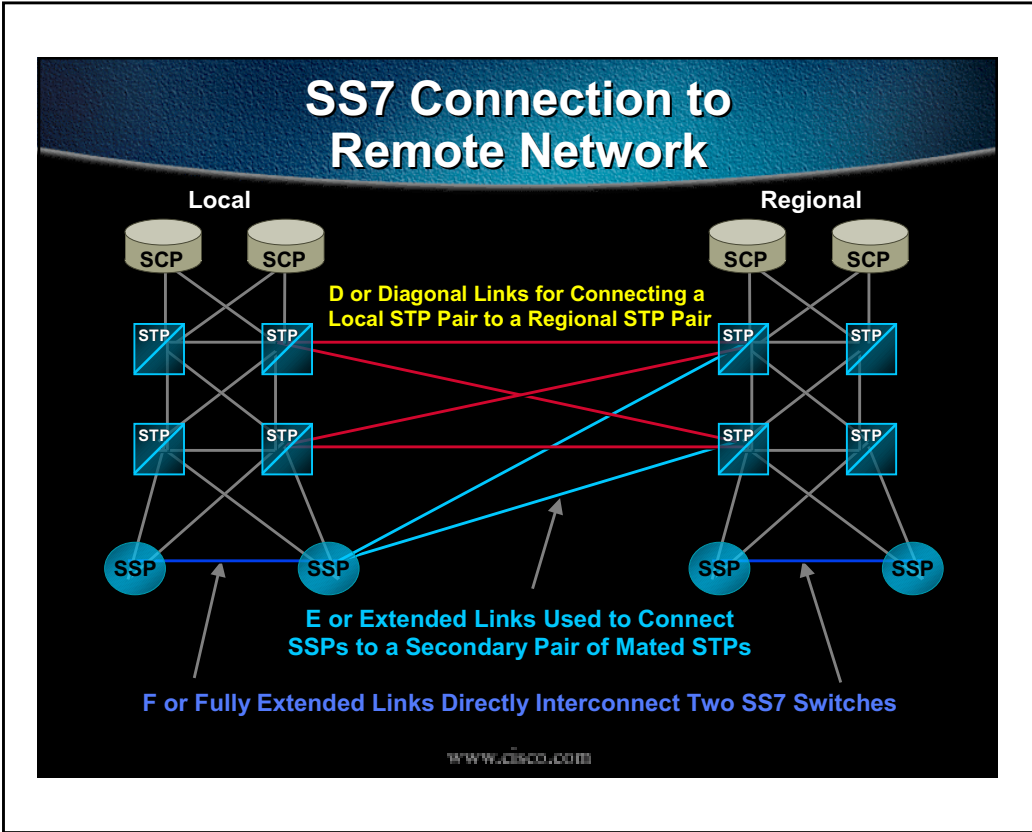
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## The Intelligent Network



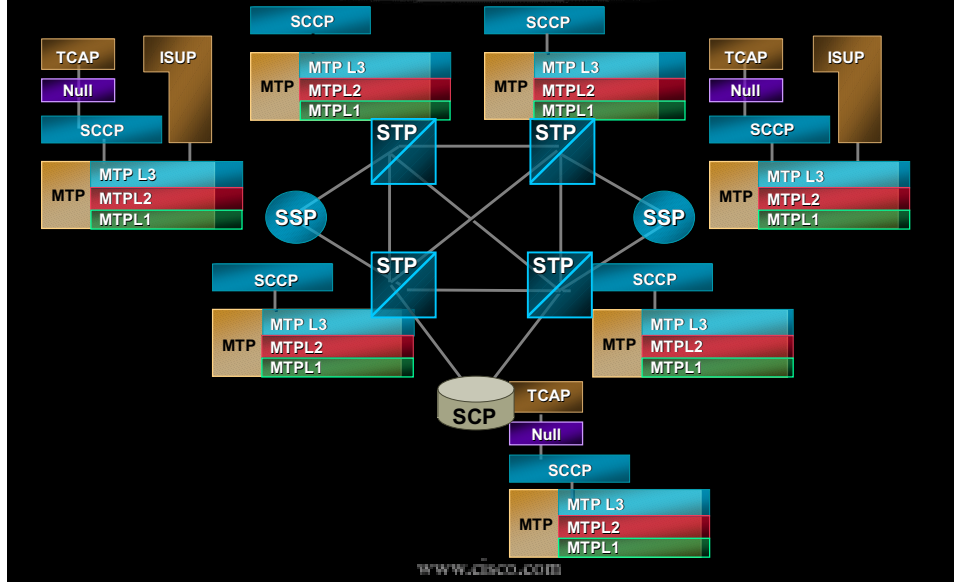
## SS7 Local Architecture



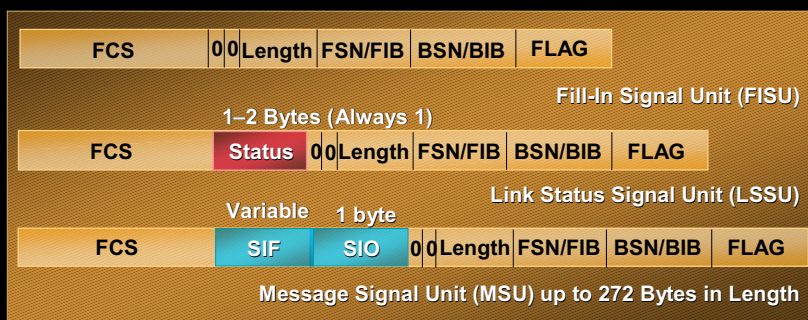




## Protocol Usage— Network Elements

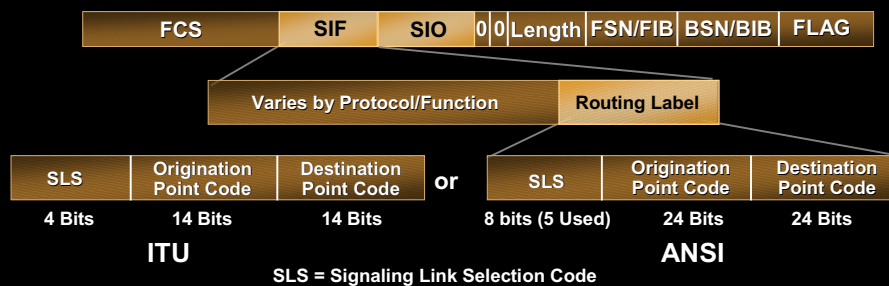


## MTP Messages (Level 2 and 3)



**BSN/BIBB**—Backward Sequence Number/Backward Indicator Bit  
**FSN/FIB**—Forward Sequence Number/Forward Indicator Bit  
**Length**—0=FISU, 1 or 2 = LSSU, 3 or Greater = MSU  
**SIO**—Service Information Octet, Type of Protocol and Standard  
**SIF**—Service Information Field, Transfer Control Information  
**FCS**—Frame Check Sequence

## Message Signal Units (MSUs)



- **Message discrimination**—looks at the point code in the routing label to determine if the message is local
- **Message distribution (message is local)**—uses the SIO to determine the user (application) part
- **Message routing (message is not local)**—attaches a new routing label and determines the proper link for next signal point

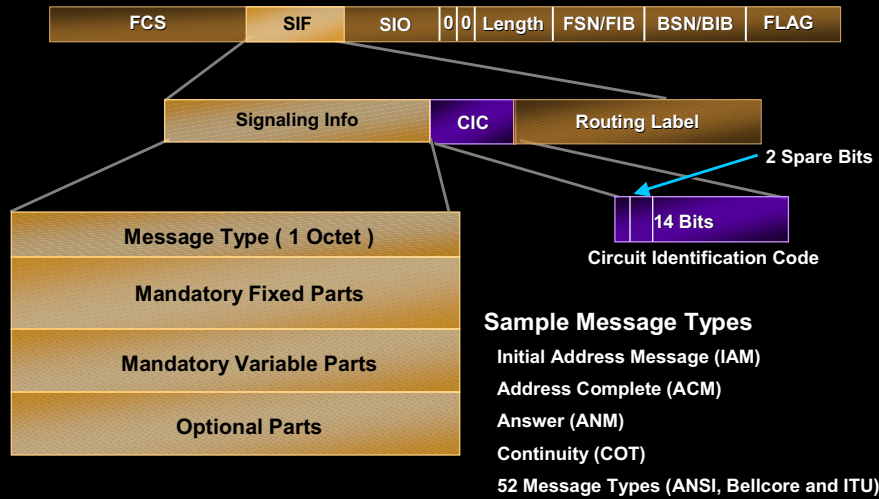
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## ISDN User Part (ISUP)

- **ISUP is used to set up and tear down all circuits used in the PSTN, Telephone User Part (TUP) is used internationally as well**
- **Support for non-voice calls and supplementary services with end-to-end significance**

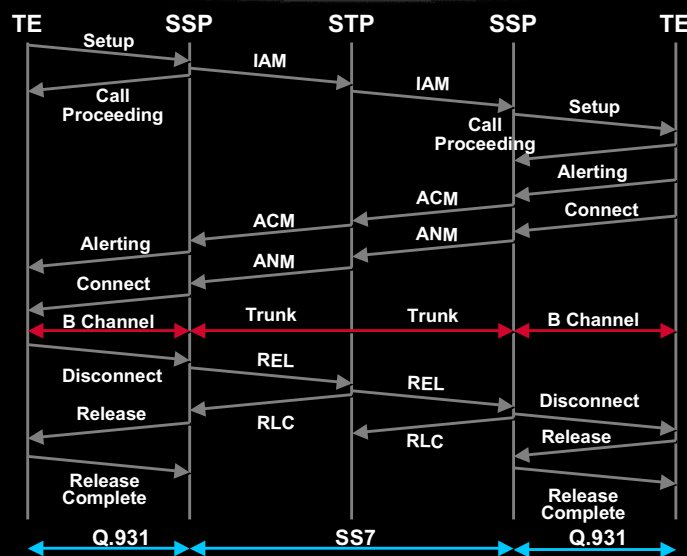
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# ISDN User Part (ISUP)



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# ISUP Call Flow



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## Signaling Connection Control Part (SCCP)

- Larger more complete address space supplements MTP addressing by adding called party and calling party numbers (subsystem numbers—SSNs)
- Protocol used for accessing databases and other network entities (i.e., TCAP)
- Global title translation

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## Signaling Connection Control Part (SCCP) Message Format



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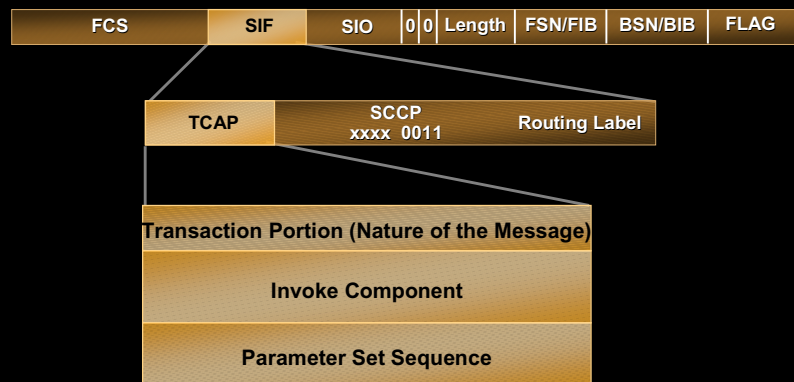


## Transaction Capabilities Application Part (TCAP)

- General purpose remote operation function for SS7
- Originally designed to support database queries, such as calling cards and 800 numbers

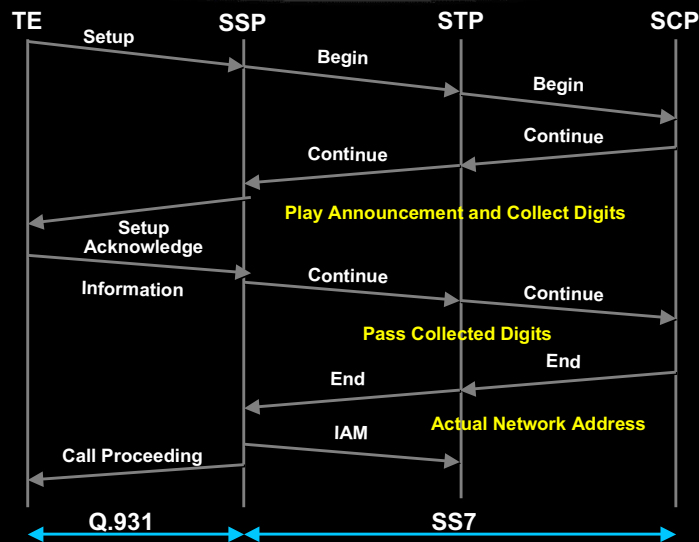
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## TCAP Message Format



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## TCAP Call Flow



## IN Limitations

- **Sporadic deployment**
- **Poor consistency**
  - Lack of interoperability between vendors and between service providers
- **Master slave relationship**
- **Intelligence resides in the network**

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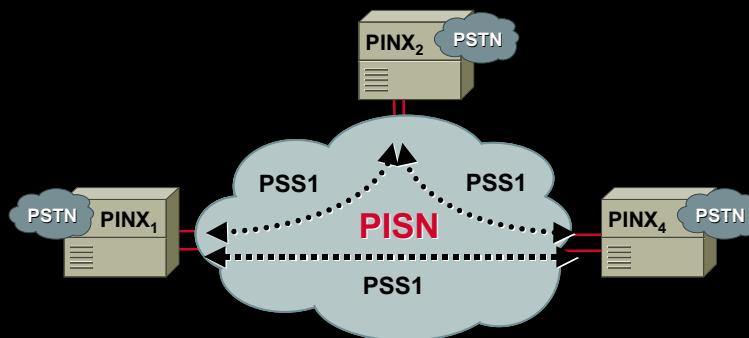
## Voice Evolution: AIN Services



These 900 Numbers, What  
Will They Think of Next?

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## Private N-ISDN (QSIG)



- **Purpose:** To extend facilities normally only available between extensions on a single PBX to all extensions on PBX's that are connected together in a Private Network

PINX: Private Integrated Services Network Exchange

PISN: Private Integrated Services Network

PSS1: Private Signaling System 1 (QSIG)

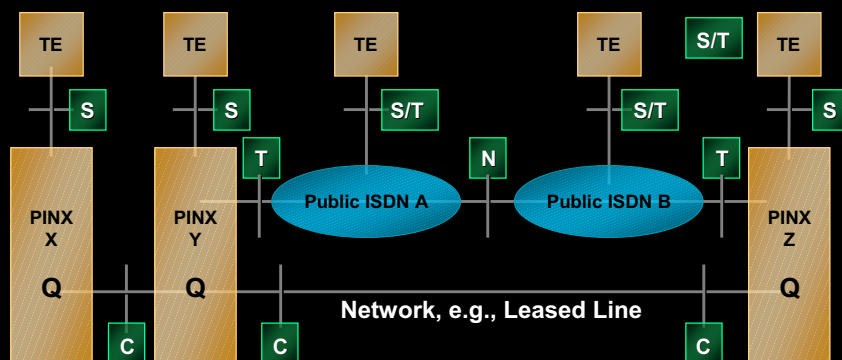
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## QSIG Benefits

- Multivendor ISDN PBX-based network
- Networking of remote ISDN PBX's
- Interconnecting voice/fax and DP servers
- Network wide applications
- Support mobility

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## QSIG Reference Points



- **PINX—Private Integrated Services Network Exchange**

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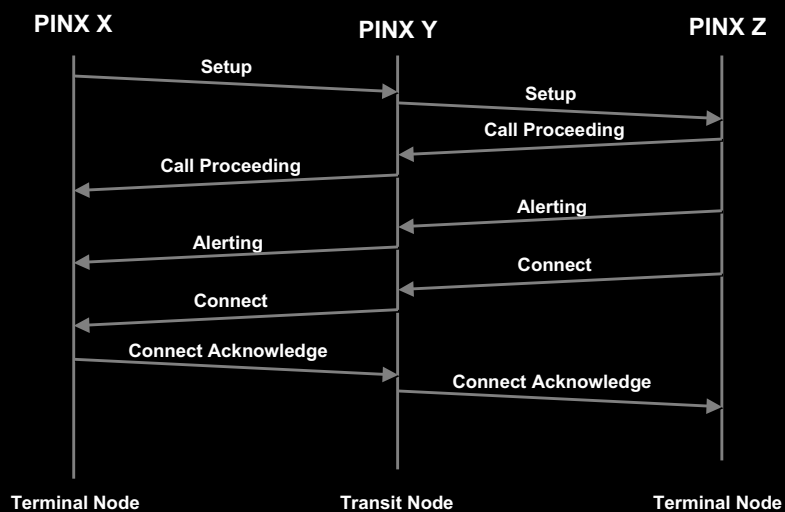


## QSIG Protocol

Layer 4-7	ROSE: Remote Operation Service Elements ACSE: Association Control Service Elements Network Specific		End-to-End Protocol Network Transparent
Network	ECMA 148, 157, 163, 164, 173-178, 185, 186, 191-194, 202, 203, 211-214, 220, 221, 224, 225, 241, 242, 250, 251, 263, 264		Supplementary Services and ANFs
	ISO 11582, ETS300 239 ECMA156, 161, 165		QSIG Generic Functional Procedures
	ISO 11574, ETS300 171/172/173, ECMA 106, 142, 143		QSIG Basic Call
Link Layer	LAPD, ETS300 402		Interface Dependent Protocols
Physical	Basic Rate I.430	Primary Rate I.431	
Media	Copper	Copper	

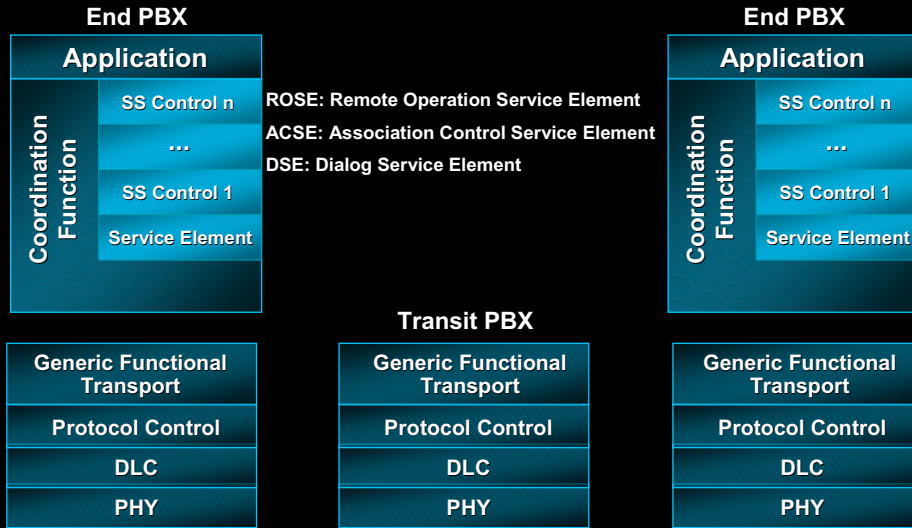
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## Basic Call Completion

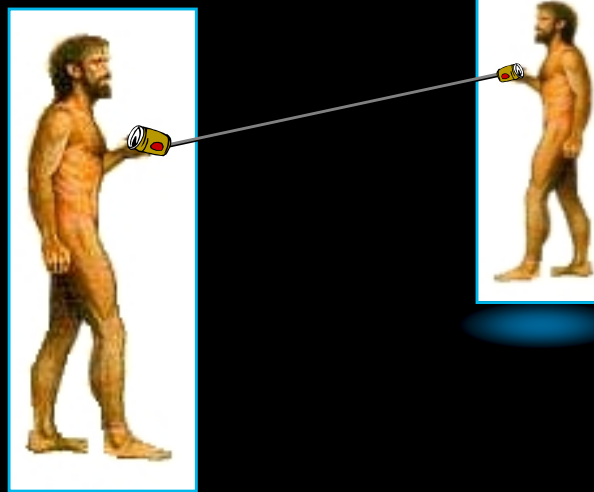


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# QSIG Generic Functional Procedures



# Voice Evolution: A Better Private Network



## Why Packet-Based Telephony?

- Data networks are growing at a faster rate than voice networks
- One network is cheaper and easier to manage than two
- Leverage the flexibility inherent in data networks for voice

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## H.323

- International (ITU) standard for: **Packet-based multimedia communications systems**
- Version 1 established in 1996, Version 2 in 1998 and Version 3 in the works
- Refer to various annexes for more details
- Leverages previous developments within ITU (i.e., Q.931)

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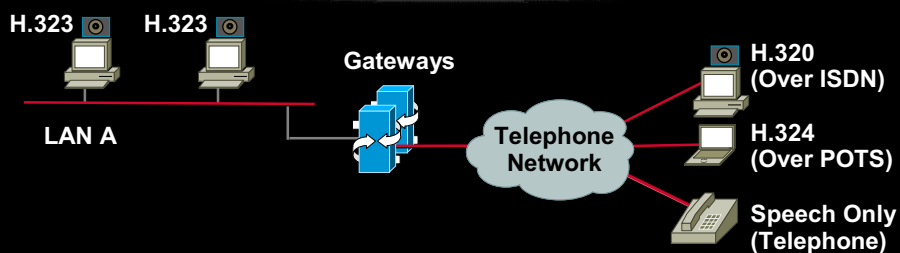
## H.323 Terminal



- **Multimedia communications services over packet-based networks**
- **Real-time audio, video and/or data communication**
- **Point-to-point, multipoint, or broadcast**

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## H.323 Gateways

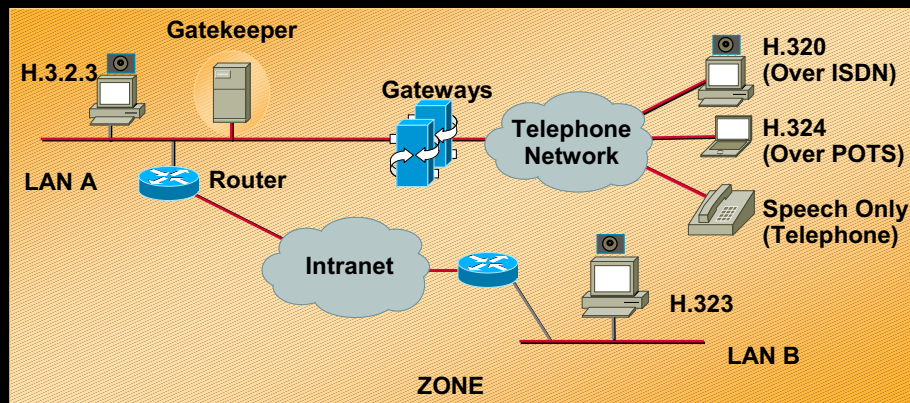


- **Appropriate translation between transmission formats**
- **Translation between communication procedures**
- **Call setup and clearing on both sides**

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## H.323 Gatekeeper



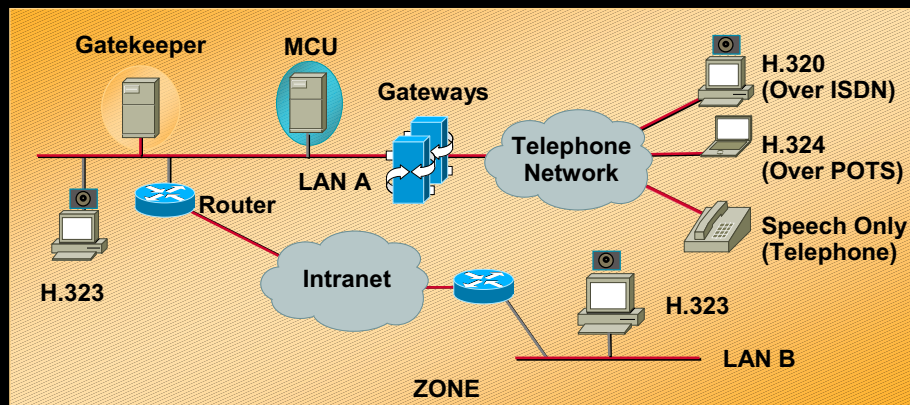
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## H.323 Gatekeeper

- **Optional**
- **Required features**
  - Address translation (alias to transport within zone)
  - Admissions control (maybe null)
  - Bandwidth control during the call (maybe null)
- **Optional features**
  - Call control signaling/routing (under GK control)
  - Call authorization
  - Call management (call status, tracking, PBX-like services, etc.)

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## H.323 Multipoint Control Unit (MCU)



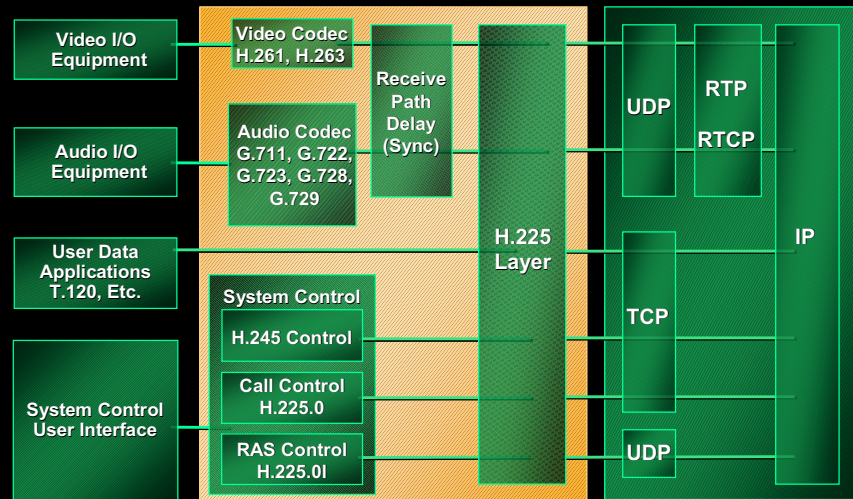
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## H.323 Terminal—Multipoint Control Unit (MCU)

- An endpoint which provides support for multipoint conferences
- A MCU consists of a multipoint controller (MC) and one or more multipoint processors (MP)
- Endpoints establish a point-to-point connection with the MC
- Actual video or audio distribution maybe centralized or distributed

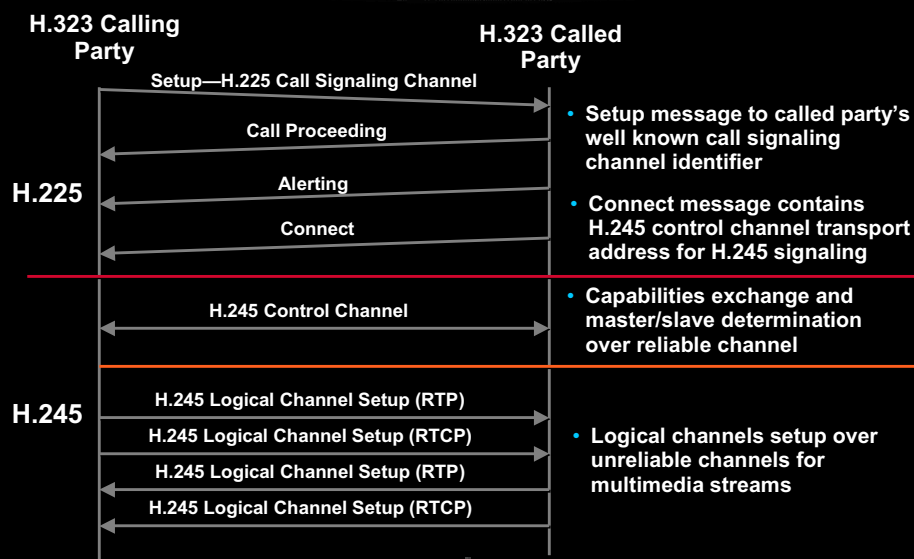
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## Scope of H.323 Recommendation



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## Call Signaling Procedures— No Gatekeeper



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## H.450 Supplementary Services

- **H.450-1 Generic Functional Protocol**
- **H.450-2 Call Transfer Supplementary Services**
- **H.450-3 Call Diversion Supplementary Services**

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## H.323 Limitations

- **Relatively slow—due to the extensive amount of message exchange**
- **Designed with peer-to-peer multimedia communications in mind**
- **Protocol format has some limitations**

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## Voice Evolution: End of the Intelligent Network?

I Guess I Better Reboot My Phone

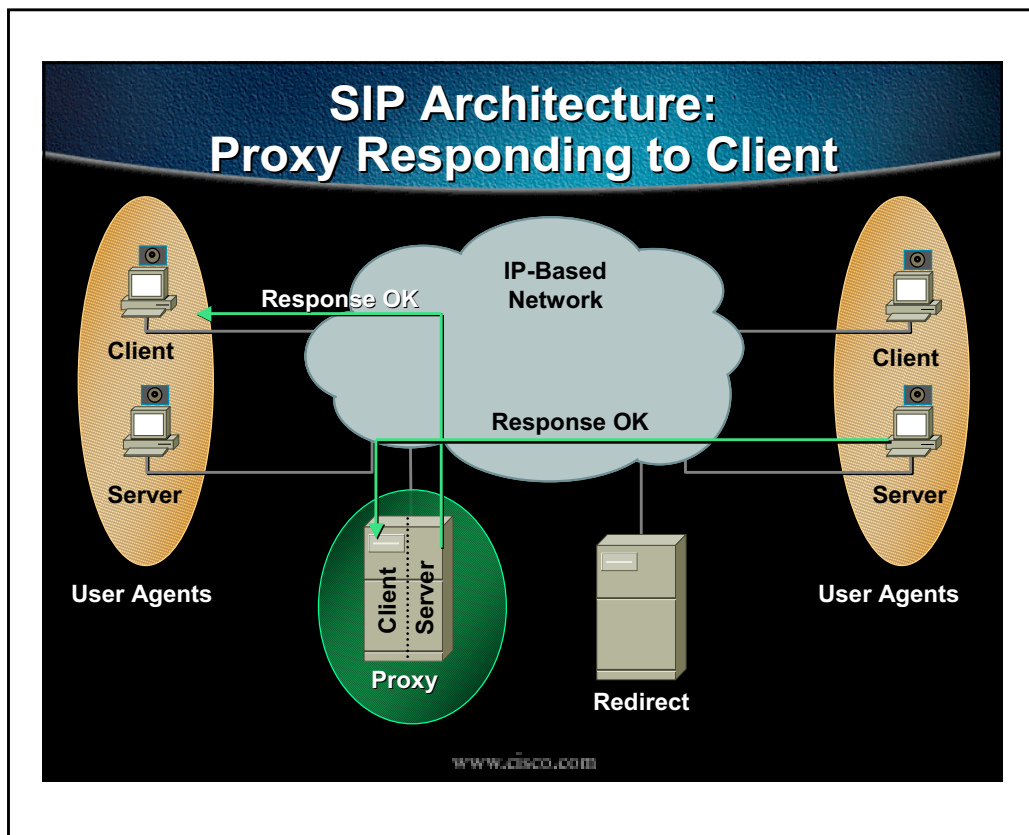
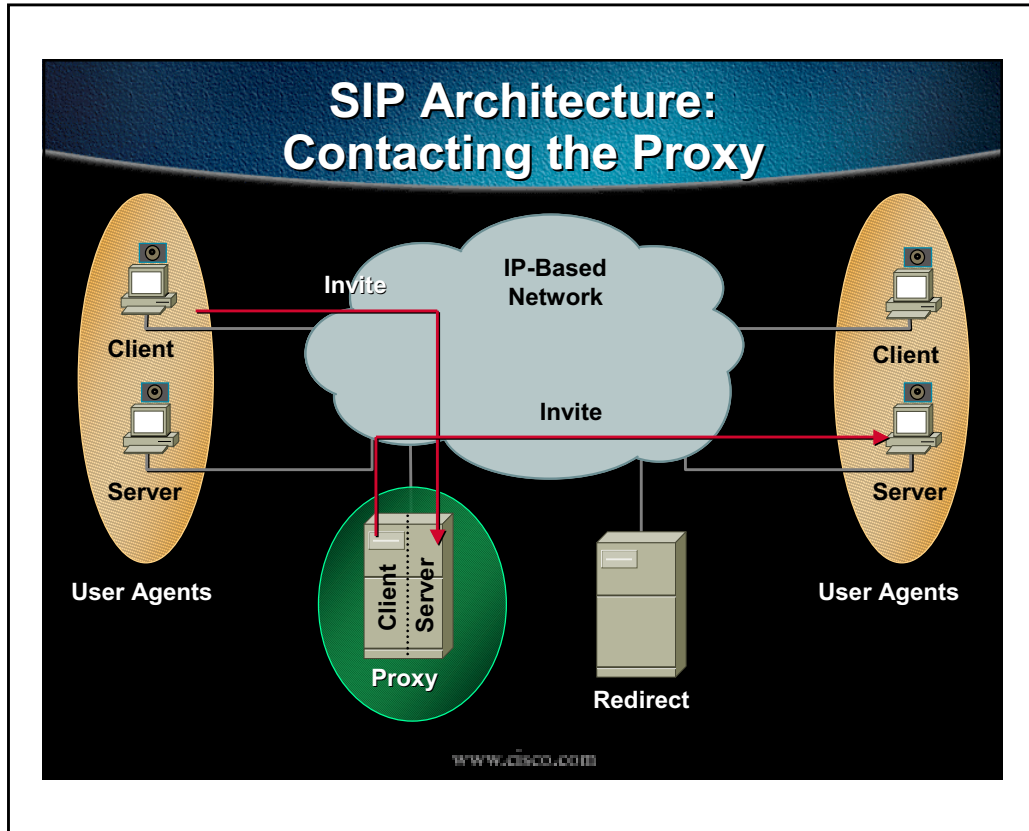


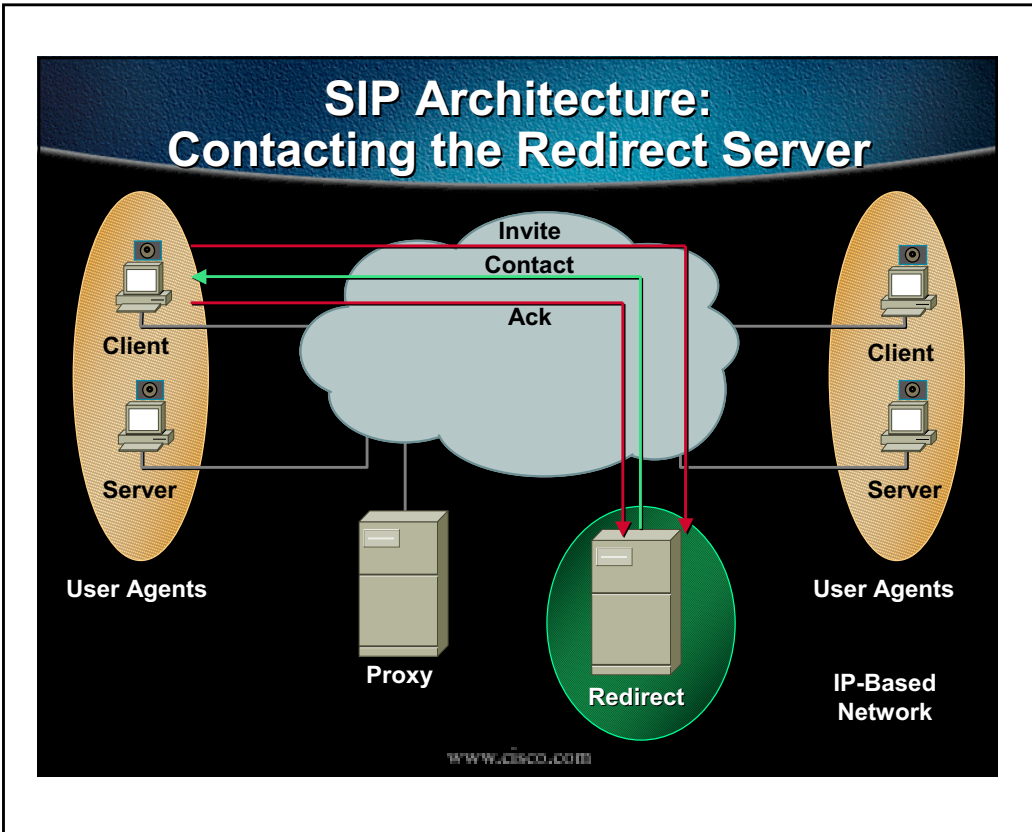
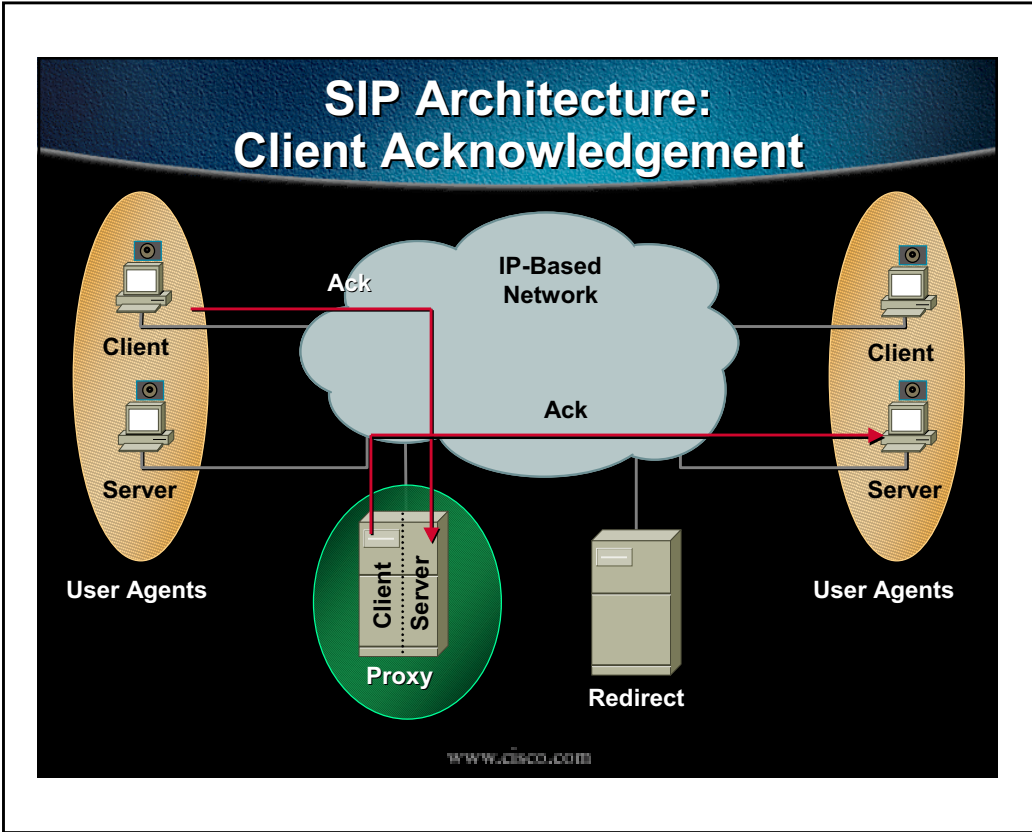
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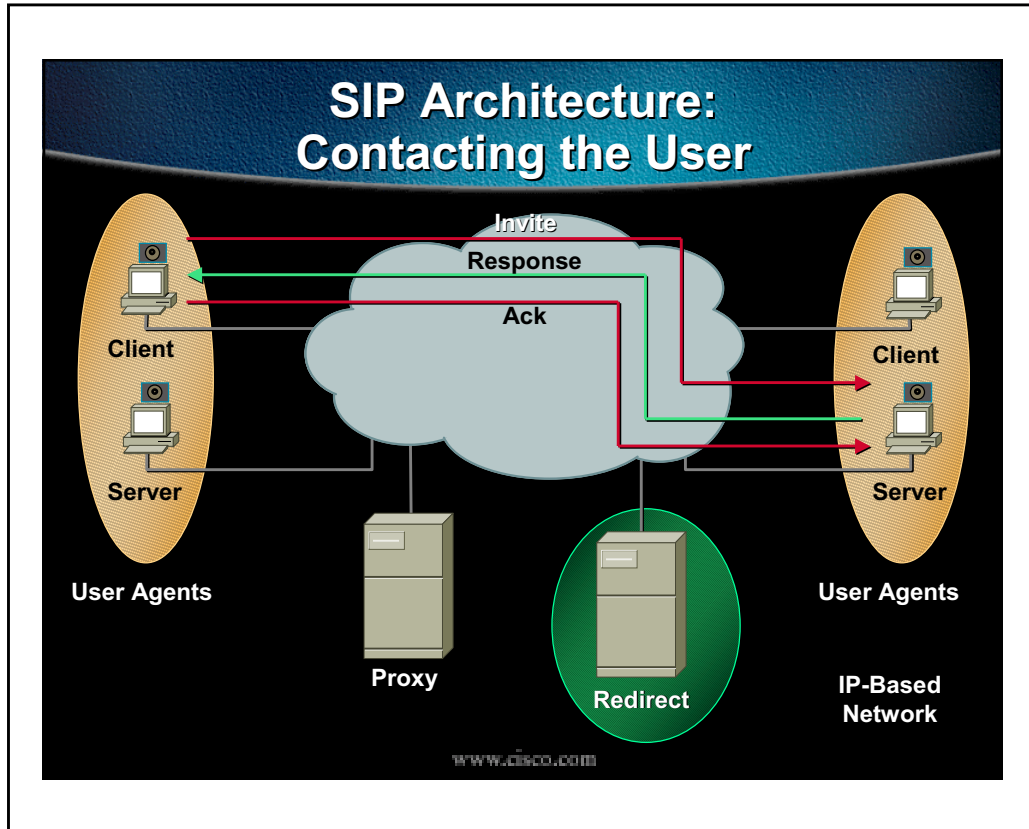
## Session Initiation Protocol (SIP)

- Internet telephony not telephony over Internet
- Currently underdevelopment within the IETF (multiparty multimedia session control working group)

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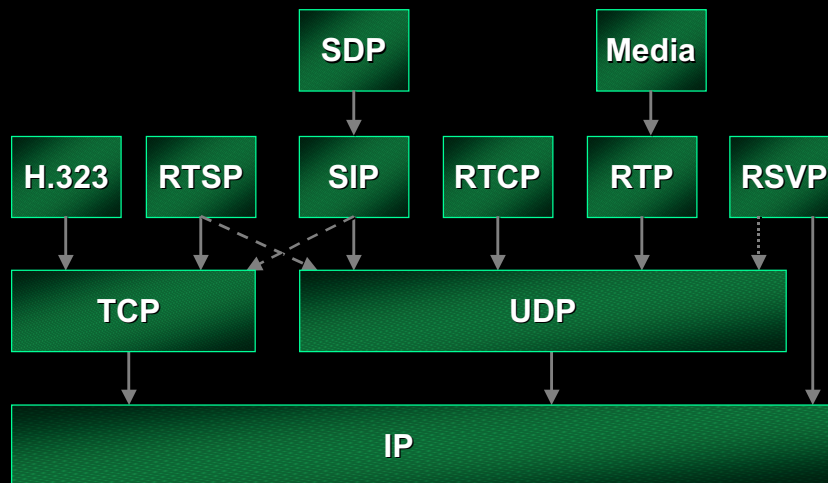




- ### SIP Protocol
- **SIP addressing takes the form of a mail to URL (i.e., user@host, examples sip:squan@cisco.com)**
  - **Session Description Protocol (SDP) is used to form the message, analogous to Q.931 messages and information elements**
  - **Modeled around HTTP, but with UDP**
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## Internet Telephony Protocols



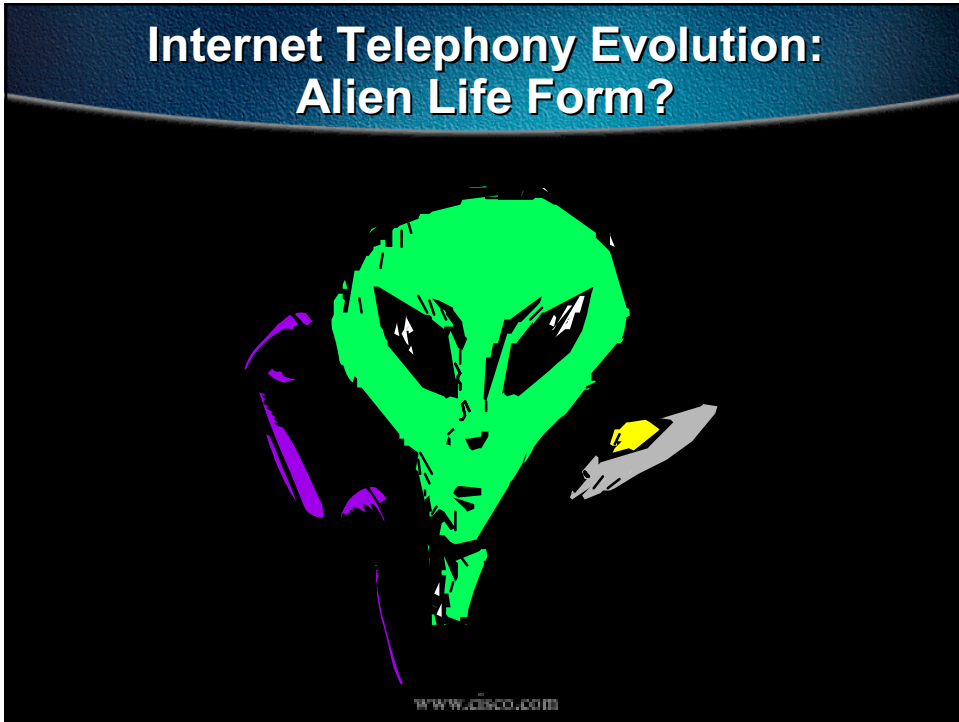
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## SIP vs. H.323

- **SIP uses text for encoding of messages; H.323 uses ASN.1**
- **SIP uses a single request to send all necessary information**
- **UDP based; recent changes by H.323 will allow utilization of UDP as well**
- **H.323 has widespread usage**

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## Internet Telephony Evolution: Alien Life Form?

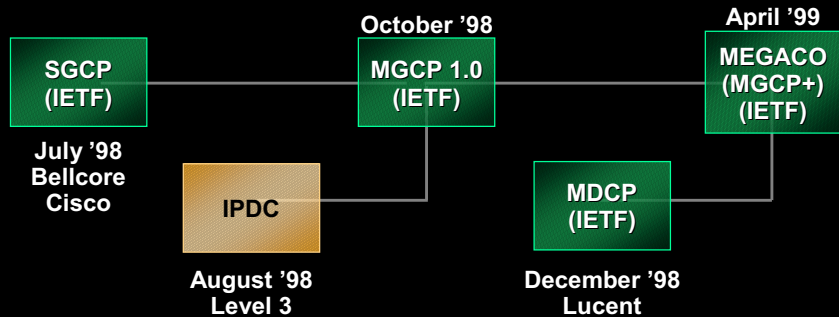


## Gateway Control Protocols

- **Allows remote control of various devices**
- **Create, modify, and delete connections, generates and detect events (tones), tracks resource states**
- **Fits in well with multimedia call signaling (i.e., H.323 and SIP)**
- **Strong support for existing telephone networks**

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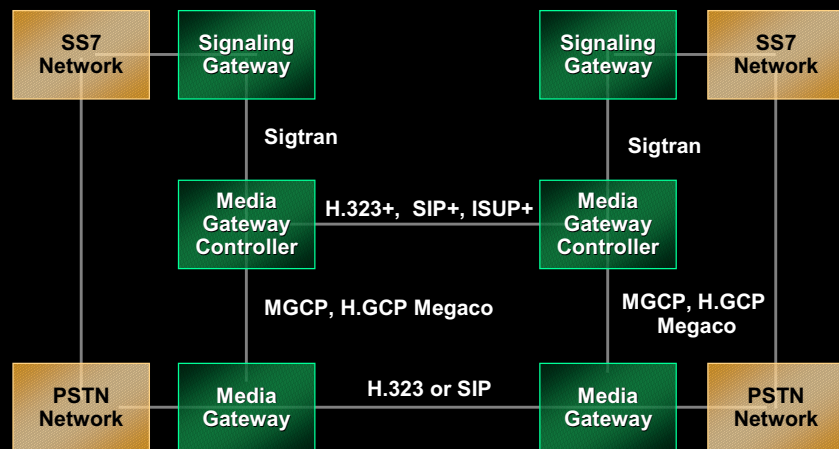
# Gateway Control Migration



- SGCP—Simple Gateway Control Protocol
- IPDC—IP Device Control
- MGCP—Media Gateway Control Protocol
- MDCP—Media Device Control Protocol
- MEGACO—Media Gateway Controller

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# GCP Protocol Relationship



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## MGCP

- Retains SGCP simplicity
- Uses established standards (SDP)
- Additional SDP functions for other network types  
IP, ATM
- Uses IPDC features
  - Wildcard
  - Event grouping
  - Control extensions
  - Endpoint audit
  - Connection audit
  - Restart

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## MGCP Call Agent

Signaling Between Gateway  
and Call Agent

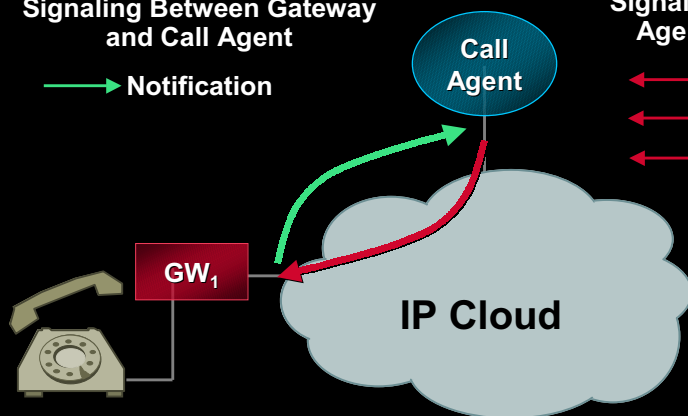
→ Notification

Signaling Between Call  
Agent and Gateway

← Notification

← Modification

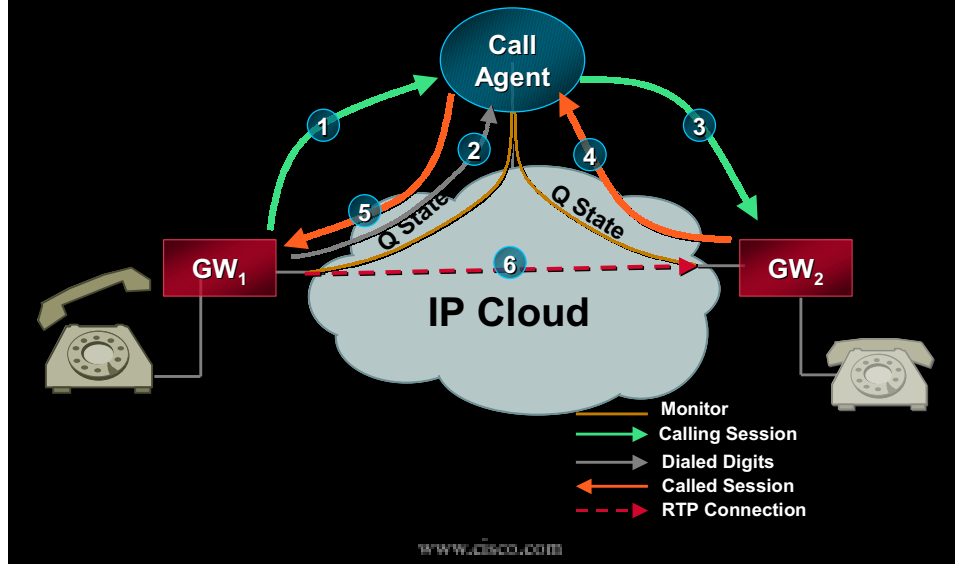
← Creation



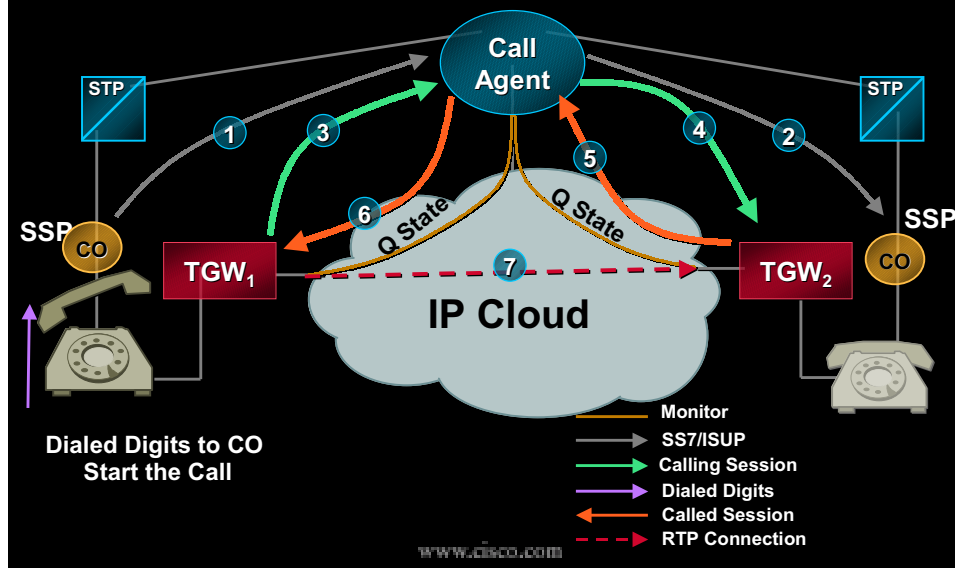
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## Analog Call Using MGCP



## MGCP and SS7 Interoperability



## Summary

- **Call signaling has taken an evolutionary path**
- **The underlying core is to provide basic call control**
- **The next step is understanding how new services are added (supplementary services)**

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