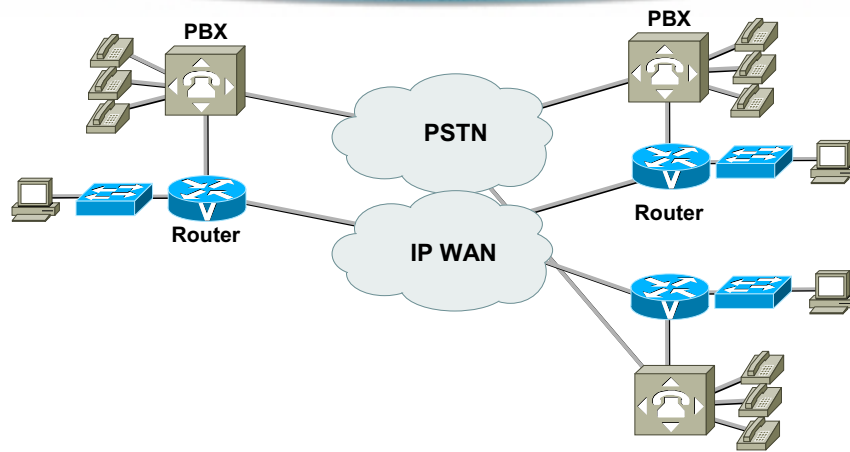


## Why Voice over IP



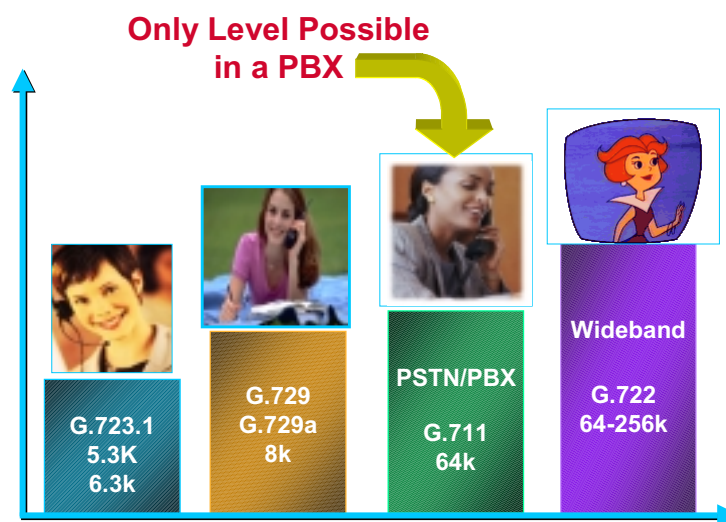
**Primary Benefit - Cost**

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## Voice Technologies Compression



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## Voice Quality Guidelines

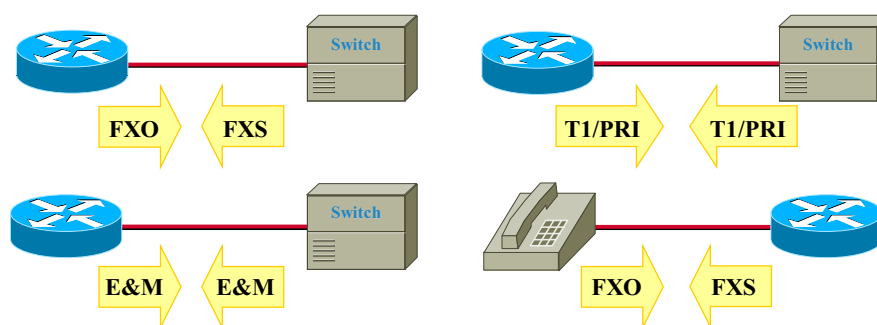
Compression Method	MOS Score	Delay (Msec)	Bit Rate (Kbps)
PCM (G.711)	4.1	0.75	64
ADPCM (G.726)	3.85	1	32–24–16
LD-CELP (G.728)	3.61	3–5	16
CS-ACELP (G.729)	3.92	10	8
CS-ACELP (G.729a)	3.9	10	8
MPMLQ or ACELP (G.723.1)	3.8	30	6.3–5.3

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## Router Voice Interfaces



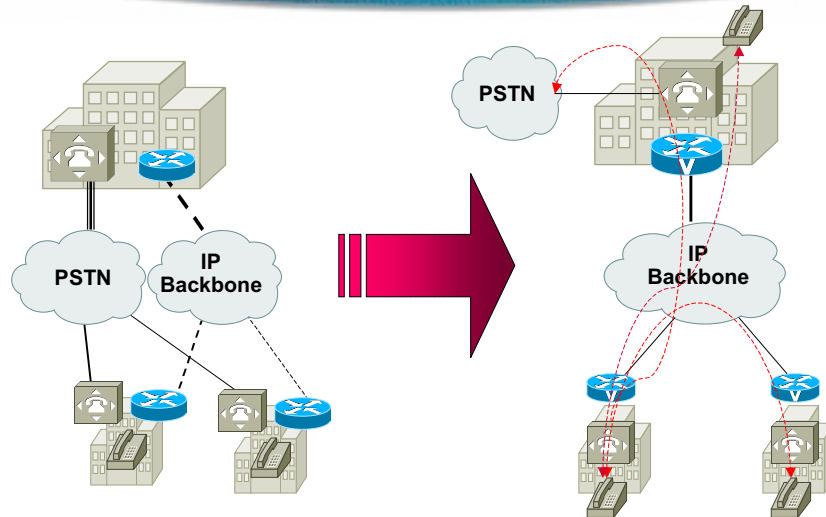
- FXO—Foreign Exchange Office
- FXS—Foreign Exchange Station
- E&M—Ear and Mouth
- PRI—Primary Rate Interface

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## VoIP 이용 PSTN 회선 비용 절감

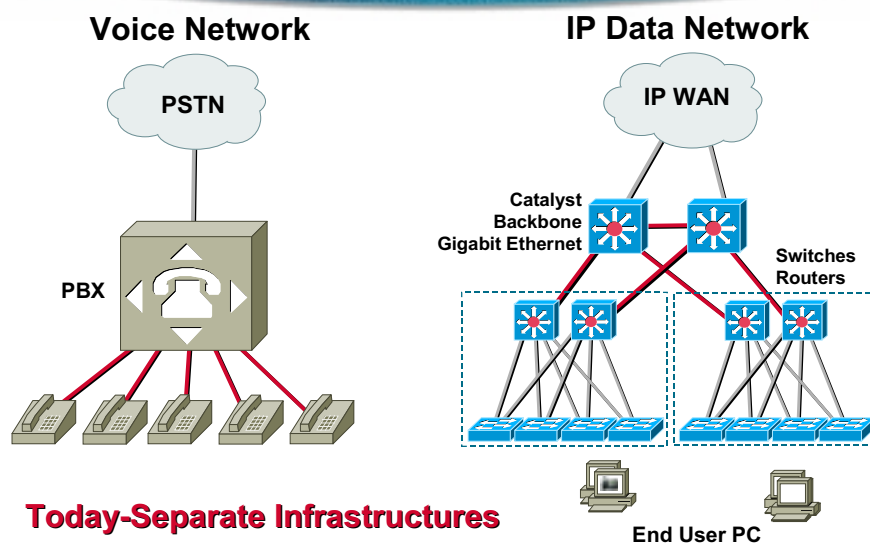


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## Converged Network Infrastructure Choices



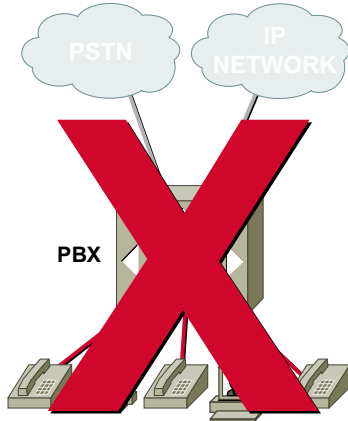
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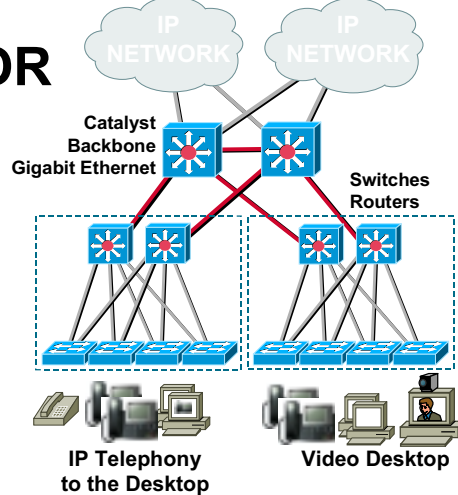
## Choices...

### Converged Network (Data over Voice)



OR

### Converged Network (Voice/Video Is Data)



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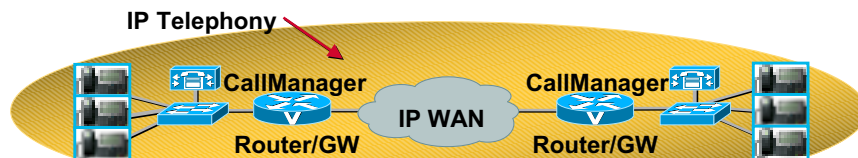
## Enterprise Voice Evolution to IP Telephony



Legacy PSTN Internetworking



Toll Bypass



End-to-End IP Telephony with Application Enablement

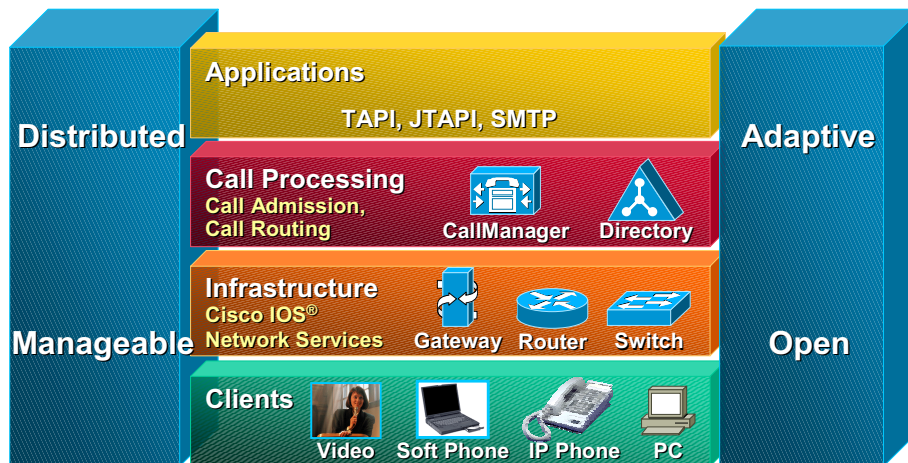
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# Cisco AVVID System Architecture



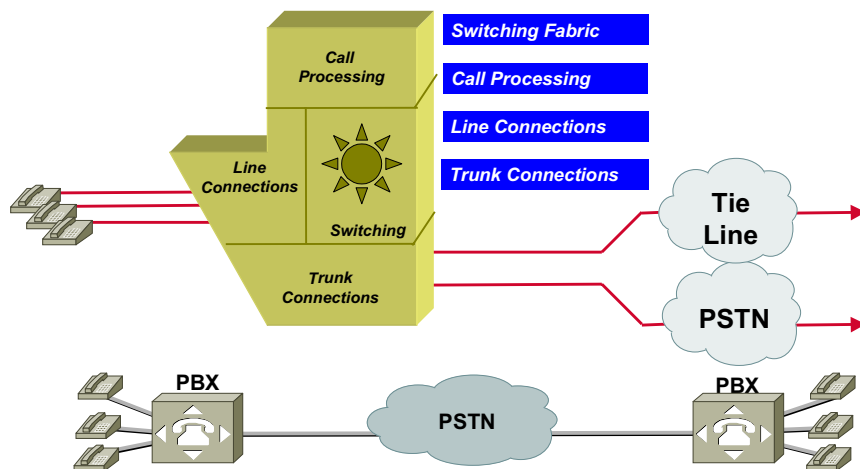
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# Legacy voice/data Internetworking

## PBX Functionality Breaks Down into Four Categories



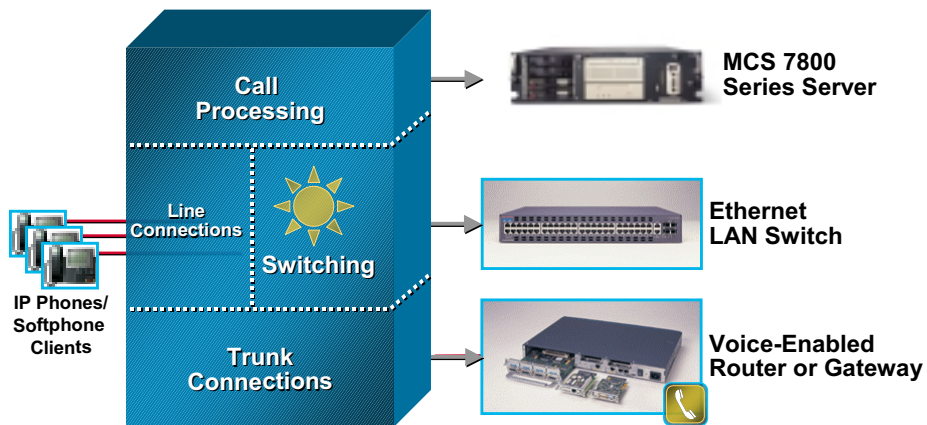
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# New World Voice Architecture

## IP Telephony Replaces PBX Architecture

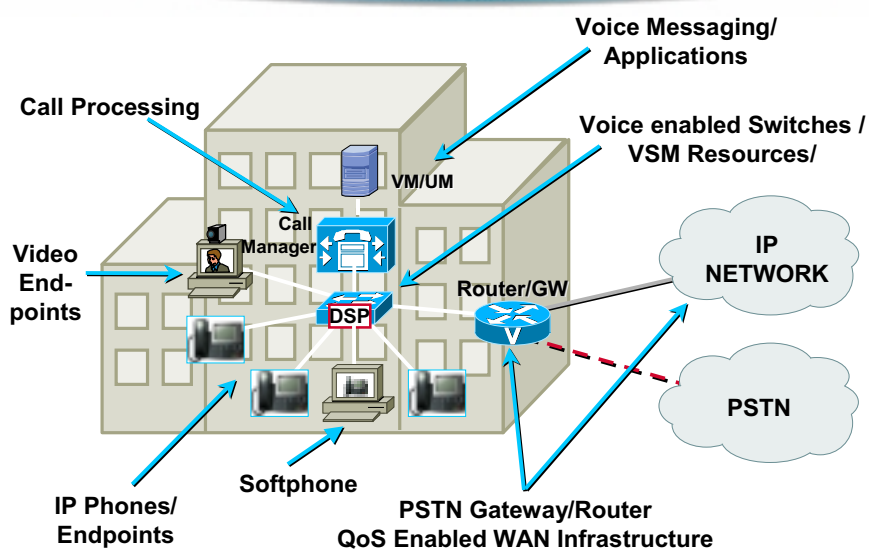


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# IP Telephony Components



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# CallManager Primary Functions (Call Processing)

Connectivity, Signaling and Device Control (IP Phones, Network Gateways, Etc.)  
Operation, Administration, Maintenance and Provisioning (OAM&P)

## Functions (PBX and More...)

- ✓ Call setup/teardown, supervision
- ✓ IP phone auto registration
- ✓ Dial plan Implementation, routing
- ✓ Call detail logging
- ✓ Support for applications (Voice mail, IVR, Call Center...)

## Protocols:

- ✓ Cisco skinny station (client/server)
- ✓ H.323 (peer-to-peer)
- ✓ PBX protocols (CAS, CCS...)
- ✓ PRI signaling
- ✓ MGCP
- ✓ Future standard protocols

## Support for:

- ✓ Media Termination Protocol (MTP – add in SW for supplementary services)
- ✓ Conference bridge SW
- ✓ Other applications (unified messaging, TAPI, JTAPI)
- ✓ Message waiting indicator

## Communicates with:

- ✓ IP phones
- ✓ Soft phones
- ✓ Other CallManagers
- ✓ Integrated PBXs
- ✓ Gateways
- ✓ Unified messaging
- ✓ Other applications



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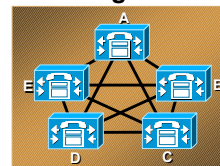
15

# CallManager Cluster

## CallManager Cluster Sizing

- 8 CallManagers maximum in a cluster
- Cluster(s) cannot extend across WAN
- 2500 users maximum per CallManager
- Maximum of 10,000 users in a cluster
- Provision for CallManager failure in a cluster

CallManager Cluster



## CallManager Cluster IP Phone Provisioning

**"Planning Assumes for Failure of One CallManager at a Time"**

<u>CMs in Cluster</u>	<u>Max users per cluster</u>
1	2500
2	2500
3	5000
4	7500
5	10,000

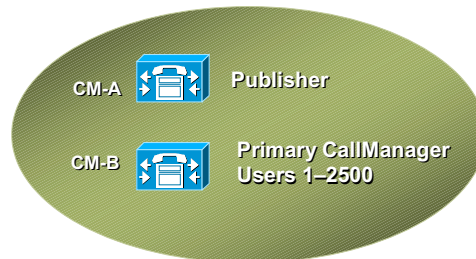
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## Cluster Recommendations Up to 2500 Users



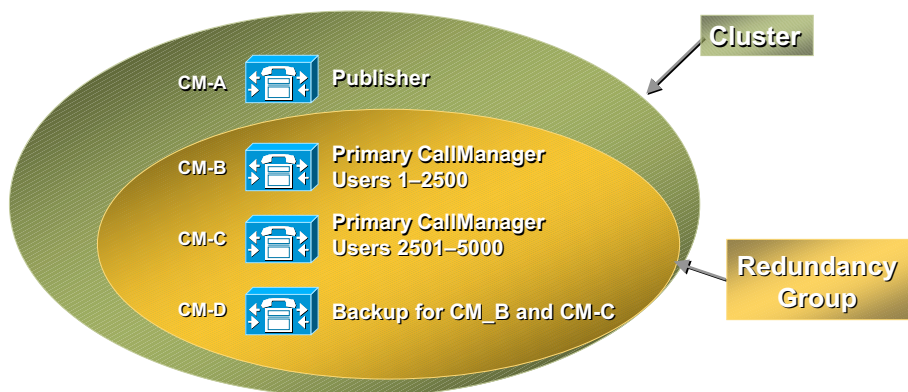
- **A cluster of two CallManagers**  
**Single active CallManager**  
**Dedicated publisher also acts as a standby**

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## Cluster Recommendations Up to 5000 Users

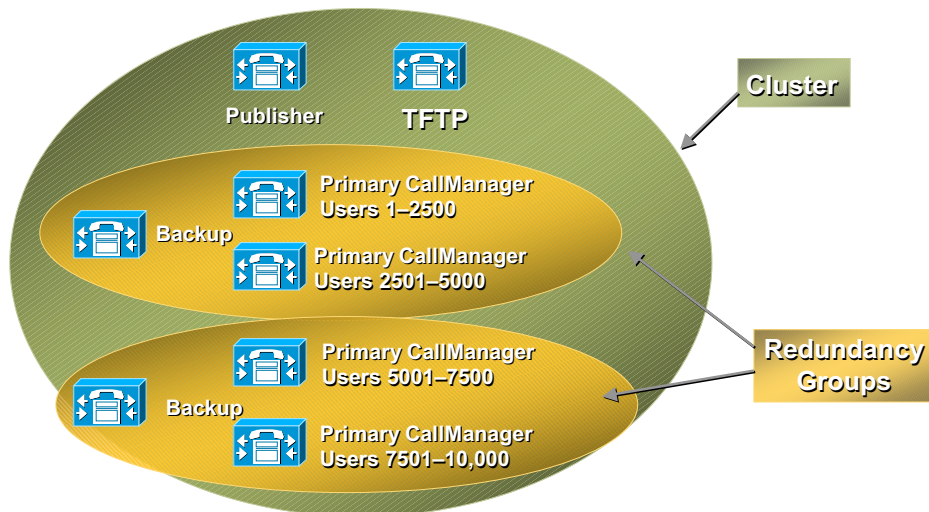


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## Cluster Recommendations Up to 10,000 Users



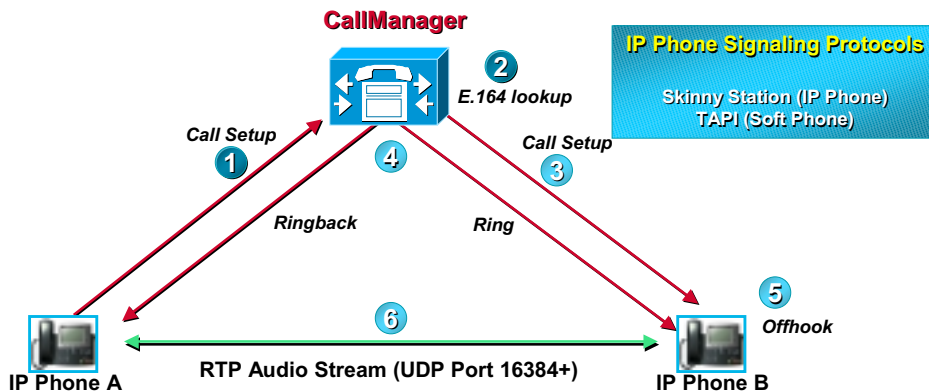
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## Making a Call IP Telephone to IP Telephone

- 1 Off-Hook and Digit Stimulus
- 2 E.164 lookup for phone B
- 3 Call setup request to phone B
- 4 Ring
- 5 Off-Hook
- 6 RTP Stream Established



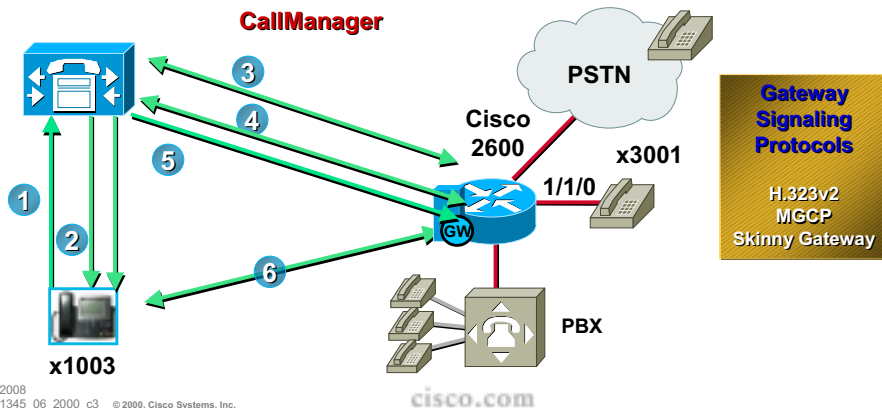
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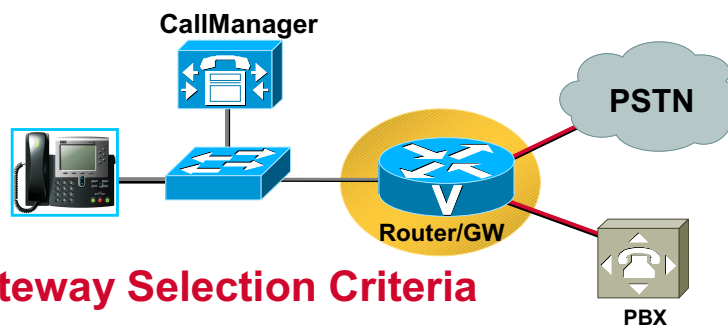
# Making a Call IP Phone to H.323 Gateway

- 1 Off-Hook and Digit Stimulus
- 2 Play Tone Commands
- 3 H.323 Setup
- 4 H.323 Connect
- 5 Setup Media Stream Command
- 6 Audio Stream Established



# Selecting the Proper Gateway

Gateways Provide PSTN Access and PBX Interconnectivity



## Gateway Selection Criteria

- Voice Port density requirements
- Support for required PSTN signaling types
- Support for required WAN interfaces and QoS

# Cisco Voice Gateways

Integrated Digital and Analog Gateways for Catalyst 6000 Family Switches



8 Port T1/E1



24 Port FXS (Telco)



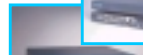
Cisco 7200



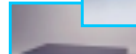
Cisco AS5800



Cisco AS5300



Cisco MC3810



Cisco 3600



VG-200 Standalone Analog and Digital Gateway (Modular, IOS-Based)

Standalone Digital Gateways DT-24+, DE-30+



Standalone Analog Gateways AS and AT



Cisco 1750

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# PSTN/PBX Signaling Support

**T1/E1-CAS, PRI**

Cisco 1750/2600/3600

**DT-24/30+ (Standalone)**

Cisco AS5300

**Catalyst 6000 (Integrated)**

Cisco 7200/7500

**Analog FXO or FXS**

Cisco 1750, 2600, 3600

**AT/AS, VG200 (Standalone)**

**Catalyst 6000 (FXS Only)**

**E1 R2**

Cisco AS5300 Only

**BRI or Analog E&M**

Cisco 1750, 2600, 2600

**VG200 (Standalone)**

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## Most Common Gateway Choices

### Branch Office

Cisco 1750

Cisco 2600

Cisco 3620/3640

### HQ/Large Facility

Cisco 3640/3660

Cisco 7200/7500

Catalyst 6000  
Integrated Gateway

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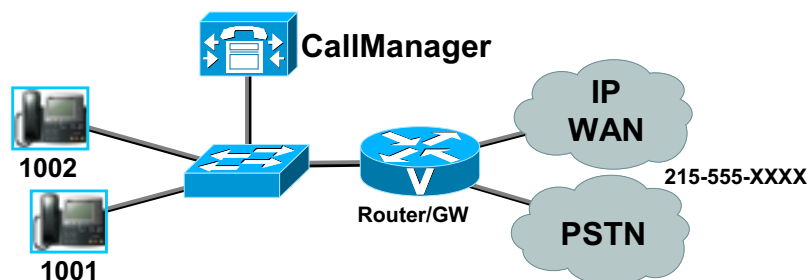
25

## CallManager Dial Plan Functions

Flexible Call Routing—Multiple paths to destination

Digit Manipulation—Adding and stripping digits

Call Restrictions—Who can dial where

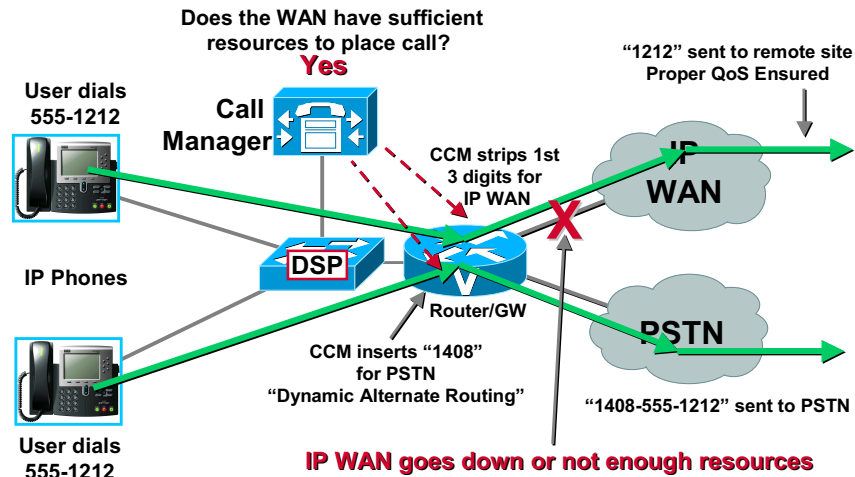


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## Dial Plan Goal Transparent Automatic Route Selection

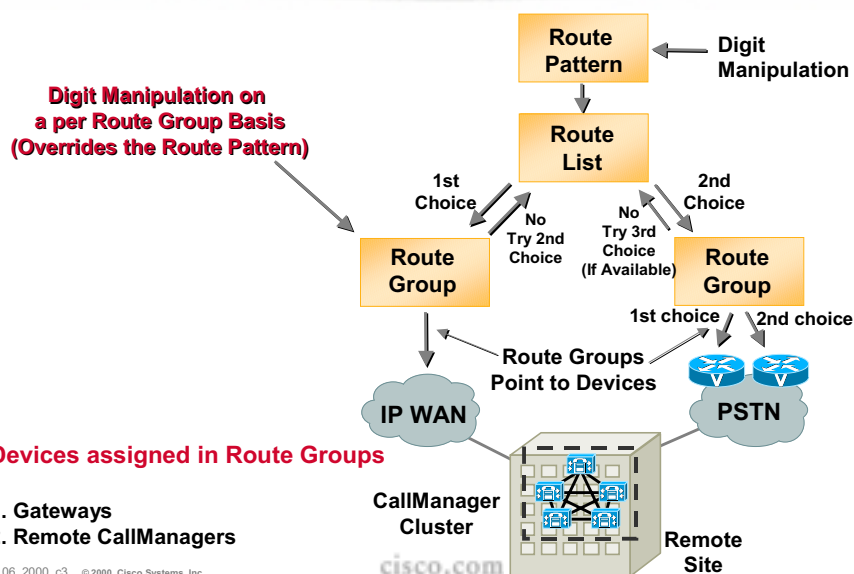


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## CallManager Dial Plan Architecture

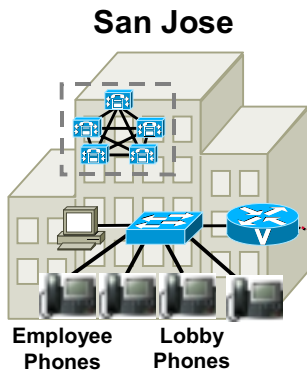


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# Configuring Calling Restrictions



Access Code of "9"  
for local PSTN calls

## Partition Assignment

"Local" = All SJ IP Phones  
"PSTN" = "9" Route Pattern  
"Foreign" = "8" Route Pattern

## Calling Search Space

"Local-Only" = Local  
"PSTN-Only" = Local + PSTN  
"Unrestricted" = Local, PSTN, Foreign

## IP Phone Calling Search Space Assignment

Staff-A IP Phones = "PSTN-Only"  
Staff-B IP Phones = "Unrestricted"  
Lobby IP Phones = "Local"

**Employees**—May dial anywhere

**Lobby Phones**—Only can dial internal to SJ

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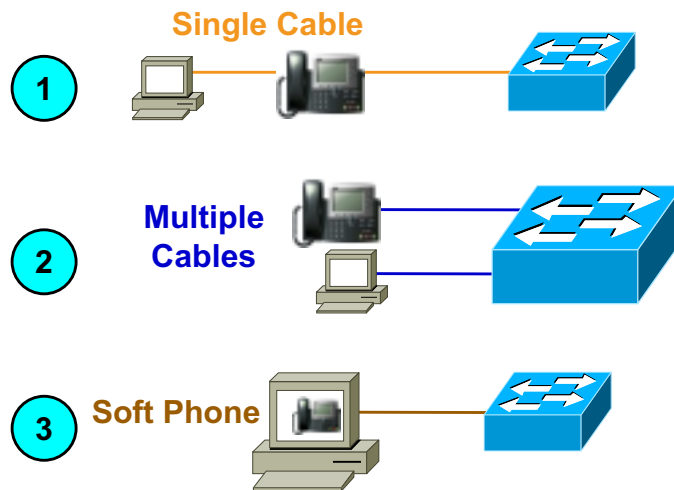
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# End-Point Connectivity Options

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## End-point Connectivity Options



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## Power to IP phones 3 Ways to Power IP Phones

### ➤ Inline Power

- ✓ Needs Powered Linecards for Catalyst Switches
- ✓ Uses Pairs 2 & 3 (same as Ethernet) for delivering power



### ➤ External Power

- ✓ Needs External Power Patch Panel
- ✓ Patch Panel delivers power over Pairs 1 & 4



### ➤ Wall Power

- ✓ Needs DC Converter for connecting IP Phone to Wall Outlet



**Combination of ways can be used for redundancy**

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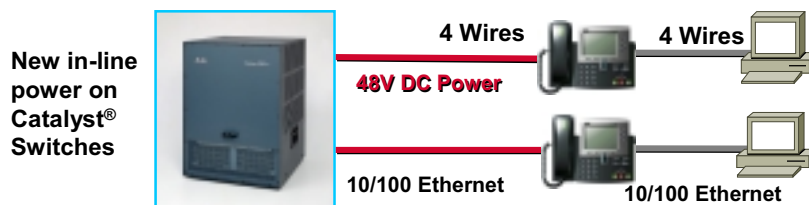
32



## Automatic Subnet Placement and In-line Power



### Catalyst Multiservice Port Provides Automatic Phone VLAN Configuration



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## IP Addressing

### IP Address Plan

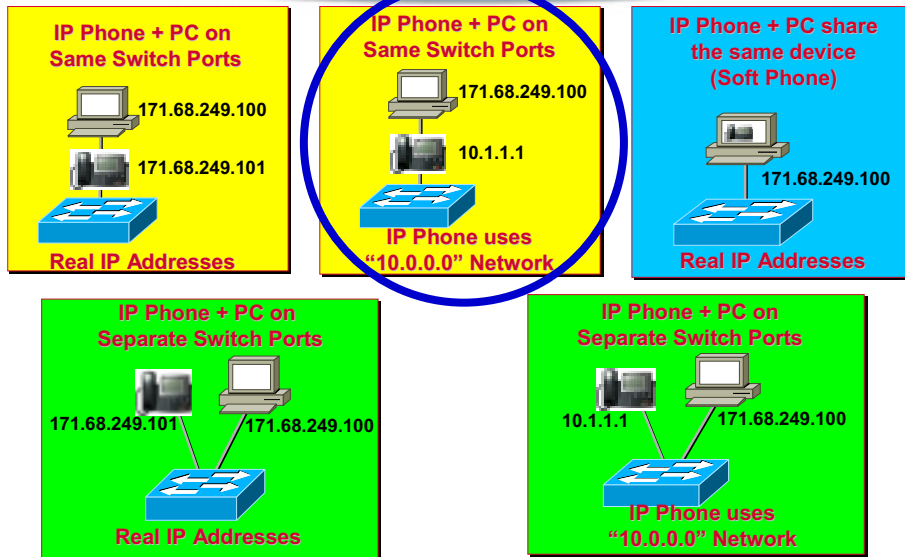
- **Each IP Phone needs an address**  
Configure phones statically or use DHCP
- **Addressing Options:**
  - Double current address space
  - Phones on separate subnets
  - Phones in a different address space  
(Real Addresses or Private Addresses)

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## IP Addressing Deployment IP phones



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## Catalyst 6000 Power Reference Chart

Product	Power Required
Sup1A + PFC + 2GBIC's	2.5A
48-Port 10/100 Ethernet	2.7A
Cisco IP Phone	0.15A
Fully Loaded Inline Power Module w/48 Phones	10A
8-Port GE (w/GBIC's)	2A
16-Port GE (MT-RJ)	2.5A
16-Port GE (w/GBIC's)	2.8A
24-Port 100FX (MT-RJ)	2A
24-Port Analog FXS Gateway	1.6A
8-Port T1/E1 Gateway OR DSP Farm	2A
Multi-layer Switched Feature Card (MSFC)	0.8A

**6K Chassis Will Always Reserve Power for Redundant Supervisor; Unless Some other Card Is Plugged in Slot 2**

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## No. of Phones $\Leftrightarrow$ Power Supply

Single PS or 2 PS's Configured in Redundant Mode	Total No. of Phones Supported	2 PS's Configured in Non-Redundant Mode	Total No. of Phones Supported
2500W	240 (5 Inline Power Cards with Phones)	2500W	384 (8 Inline Power Cards with Phones) Fully Loaded Configuration
1300W	96 (2 Inline Power Cards with Phones)	1300W	230 (4-5 Inline Power Cards with Phones)
1050W	60 (1-2 Inline Power Cards with Phones)	1050W	160 (3-4 Inline Power Cards with Phones)

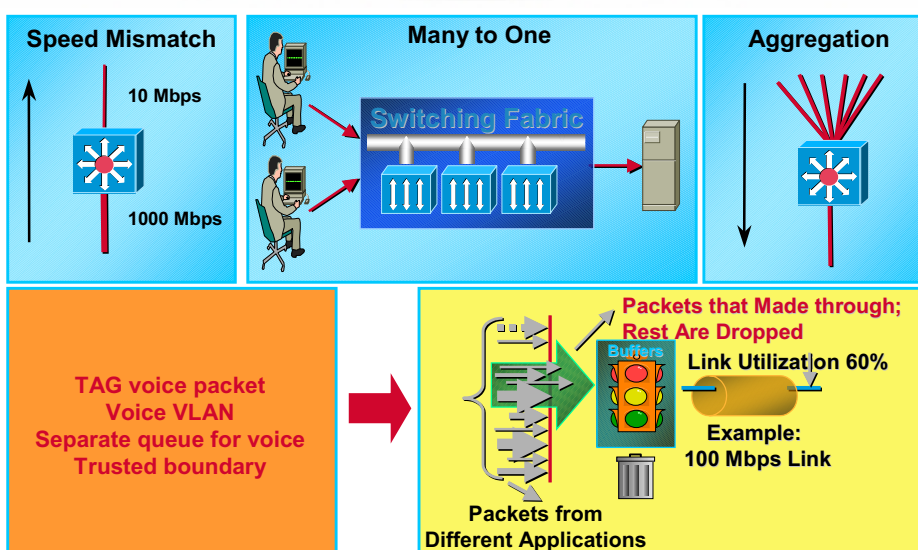
Number of Phones Shown in Table above Assumes no other Linecards;  
if other Cards Are Added, Adjust the Numbers Based on the Power  
Requirement of the Card as Shown Earlier in Reference Chart

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## Quality of Services Campus QoS

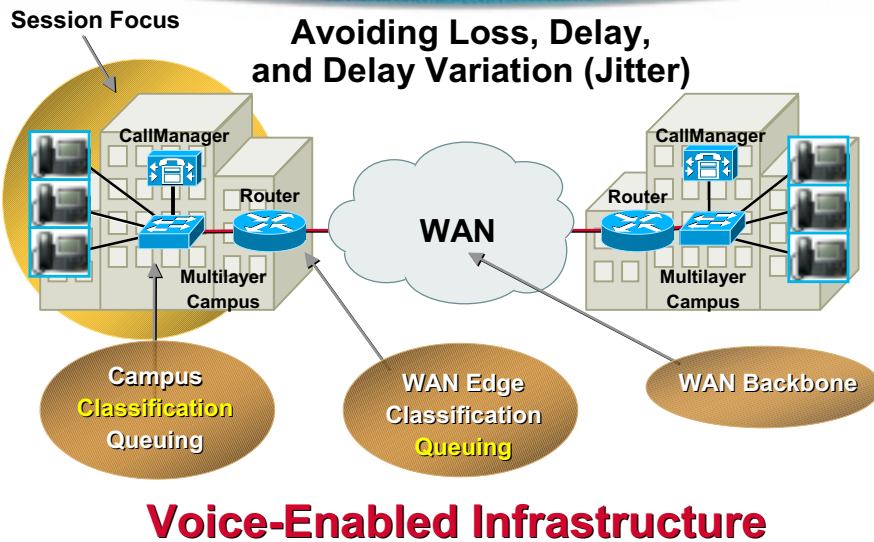


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## Domains of QoS Consideration



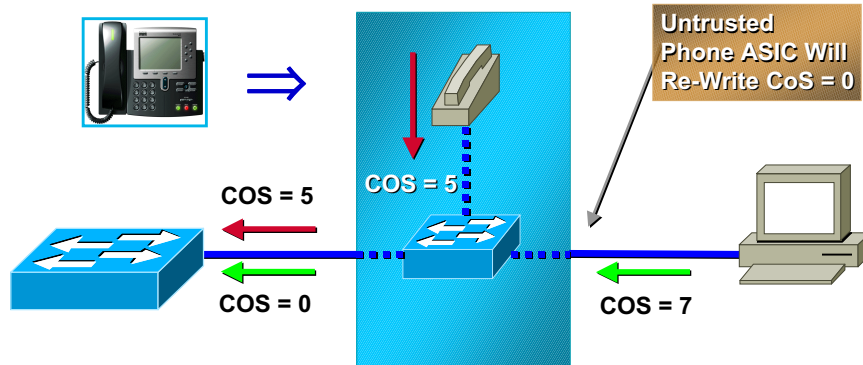
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## PC Is Not Trusted Normal Mode (Default)

e.g. **set port qos 2/1 trust-ext untrusted**



**Phone Sets PC CoS to Zero**

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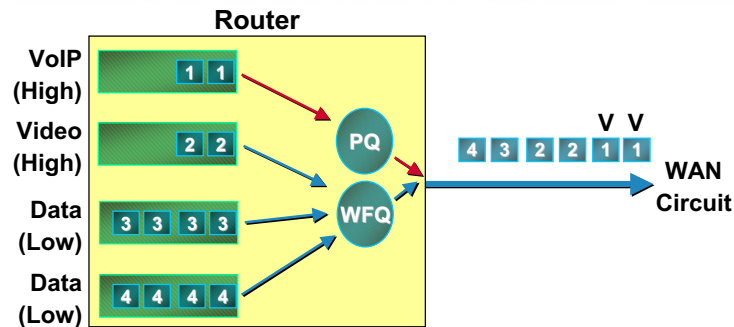
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# Quality of Services

Protecting voice from data



## Classification Mechanisms

IP Precedence  
DiffServ Code Point  
RSVP

“Identifying” Voice as Important

## QoS Queuing Features

IP RTP Priority  
Low Latency Queuing

“Giving Priority” to Voice

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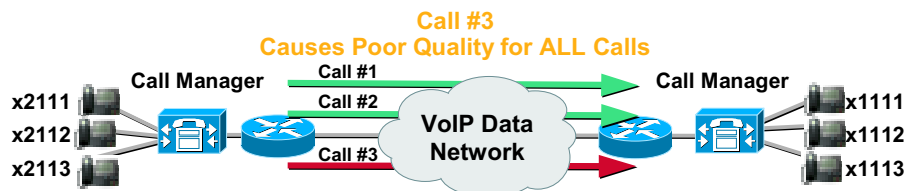
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# Quality of Services

Protecting voice from voice

**Example:**  
WAN Bandwidth Can Only Support 2 Calls  
What Happens when 3rd Call Attempted?

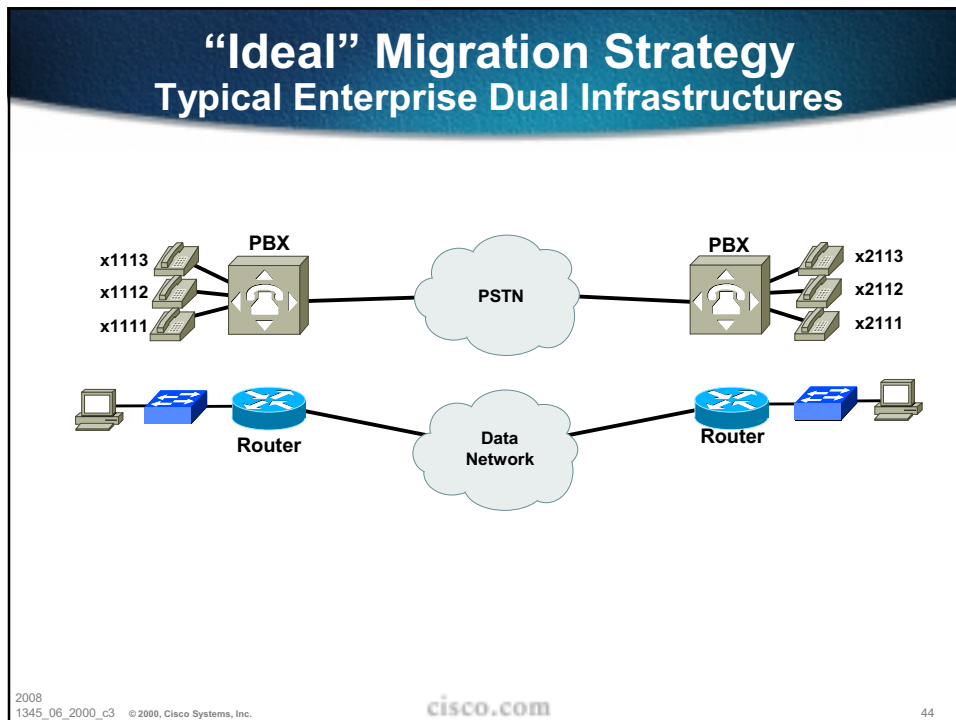
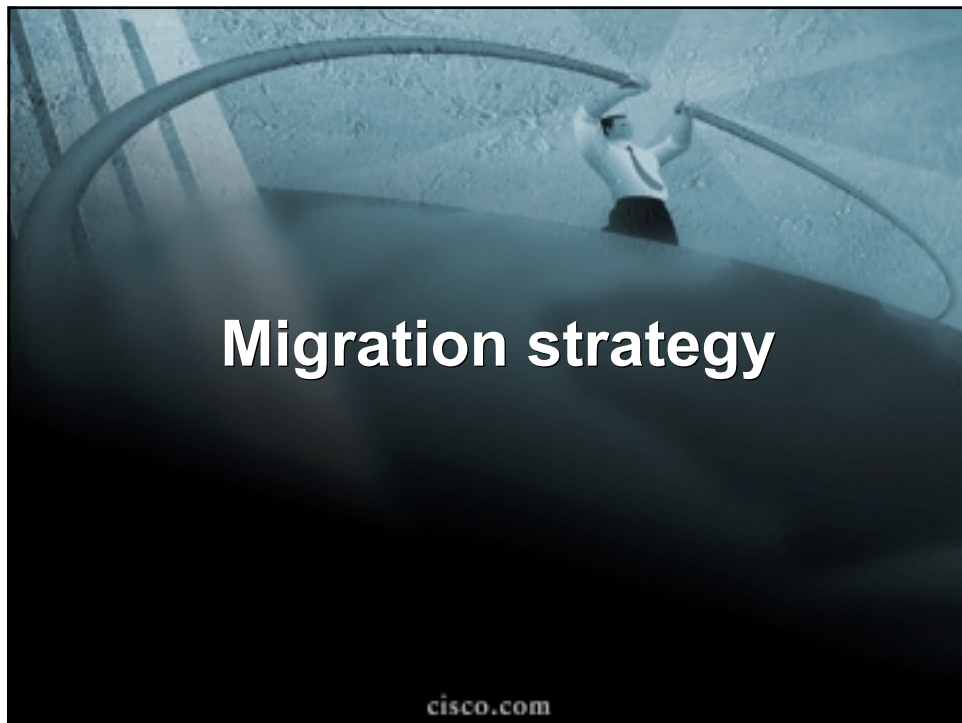


Use gatekeeper between Call Manager  
Use Call Manager Location within Call Manager

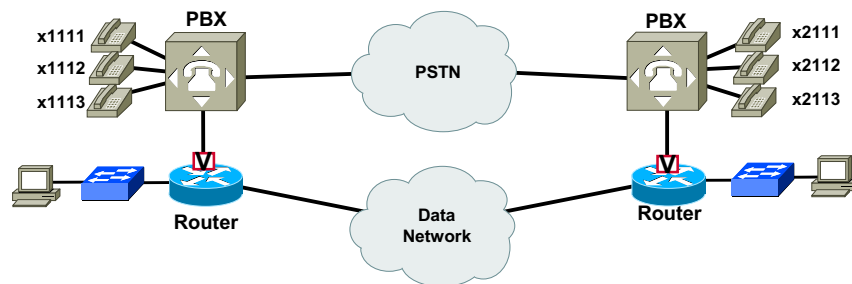
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## Step 1 Toll Bypass

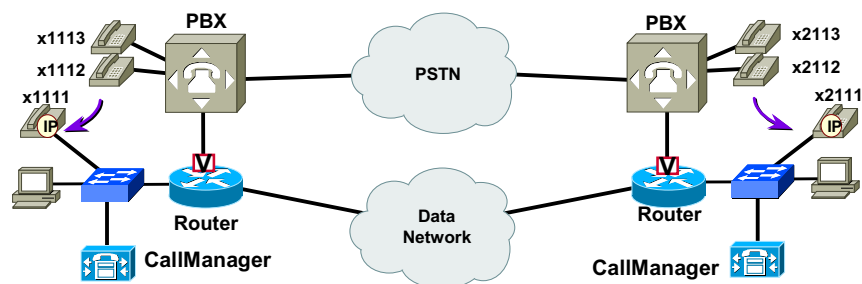


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## Step 2 Migration to the Cisco IP Telephony Solution



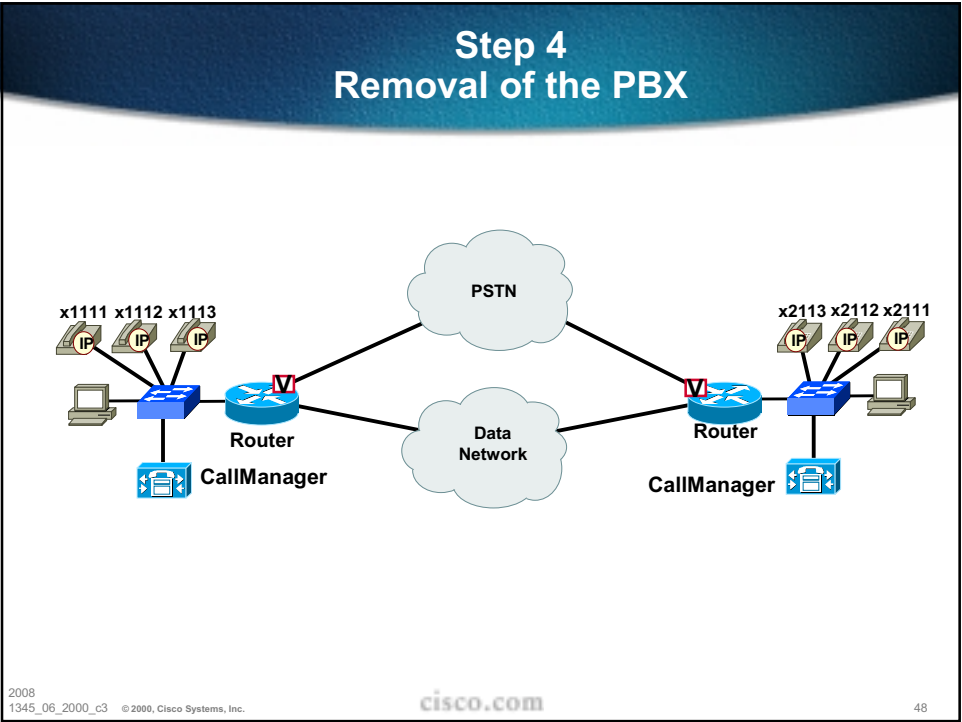
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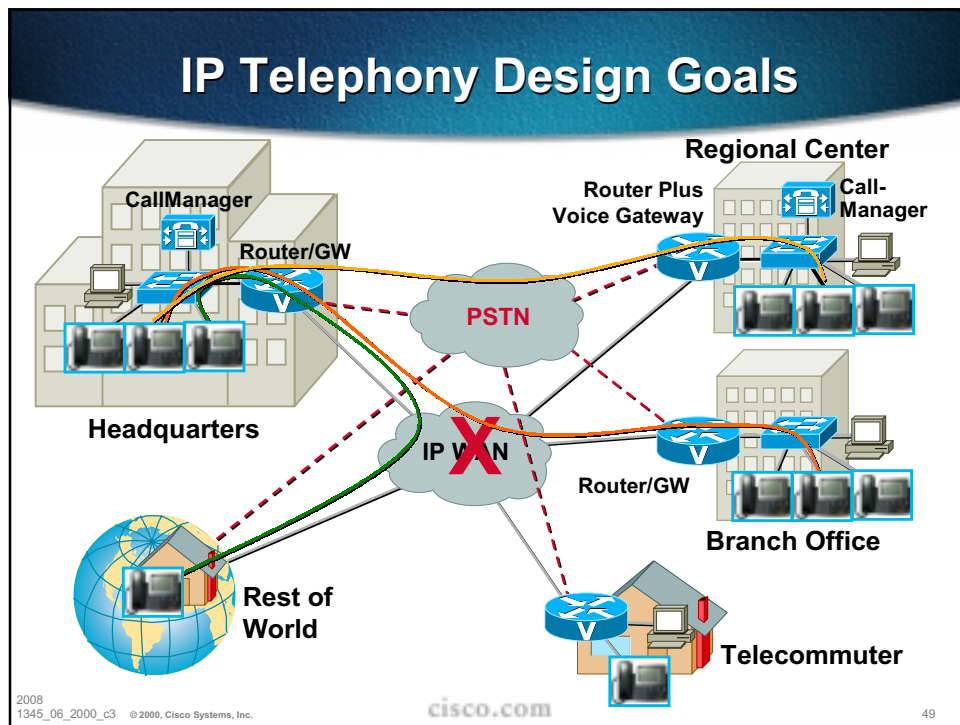
46

## Step 3 Full Migration to the Cisco IP Telephony Solution

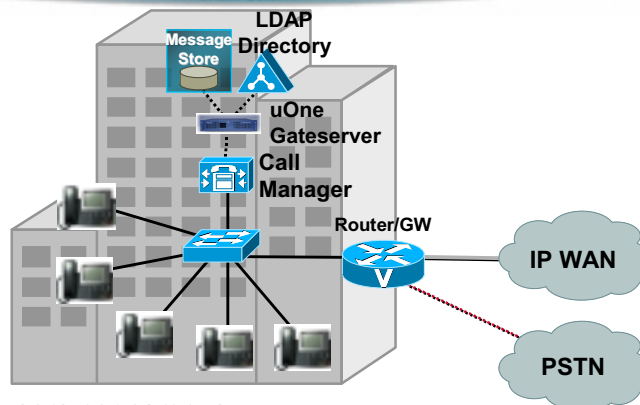
The diagram illustrates a full migration to the Cisco IP Telephony Solution. It shows two sites connected via a central Data Network. Each site consists of a PBX connected to a Router, which is connected to a CallManager. The PBX is also connected to three IP phones (labeled x1111, x1112, x1113 on the left and x2113, x2112, x2111 on the right). The Router is connected to a laptop and a server. The Data Network is represented by a cloud labeled 'Data Network'. The PSTN is represented by a cloud labeled 'PSTN'.







## Individual Campus Deployments



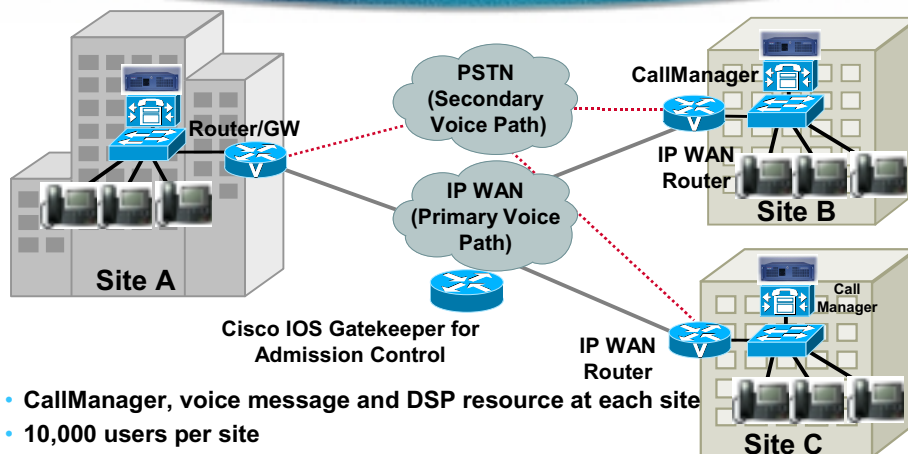
- Up to 10,000 users per campus
- CallManager and voice messaging at each site
- Up to five distributed CallManagers in a cluster
- Redundancy and equipment will vary with campus size

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## Multi-site Deployments Distributed Call Processing



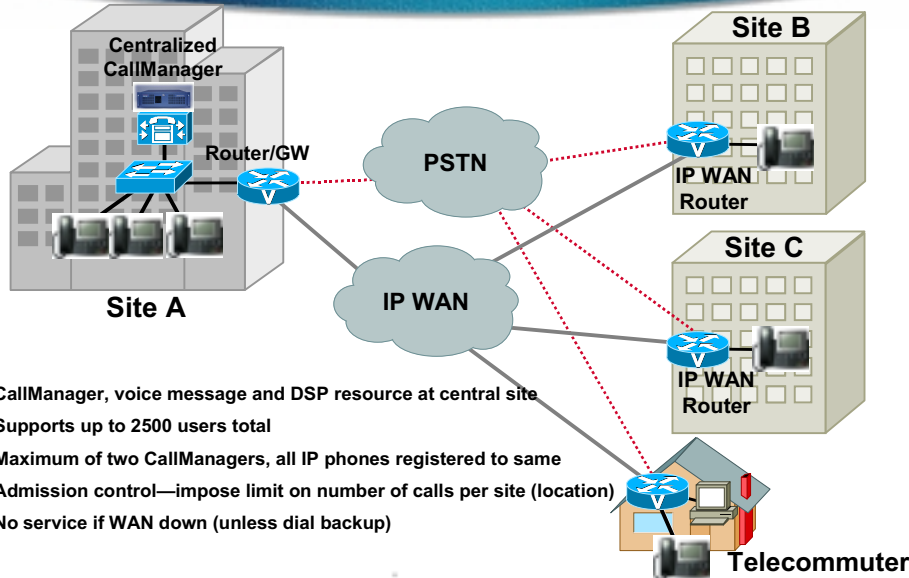
- CallManager, voice message and DSP resource at each site
- 10,000 users per site
- 10 sites maximum networked via IP WAN
- Admission control—H.323 gatekeeper based
- Transparent use of PSTN if IP WAN down or lacks resources

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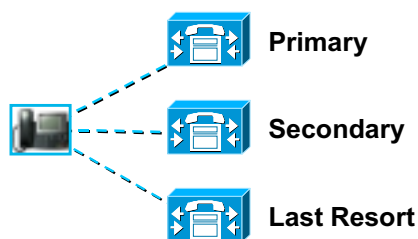
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## Multi-site Deployments Centralized Call Processing



## CallManager Failover



Each Device (IP Phone and Skinny Gateway) Has a Prioritized List of Up to 3 Call Managers to which It Can Connect

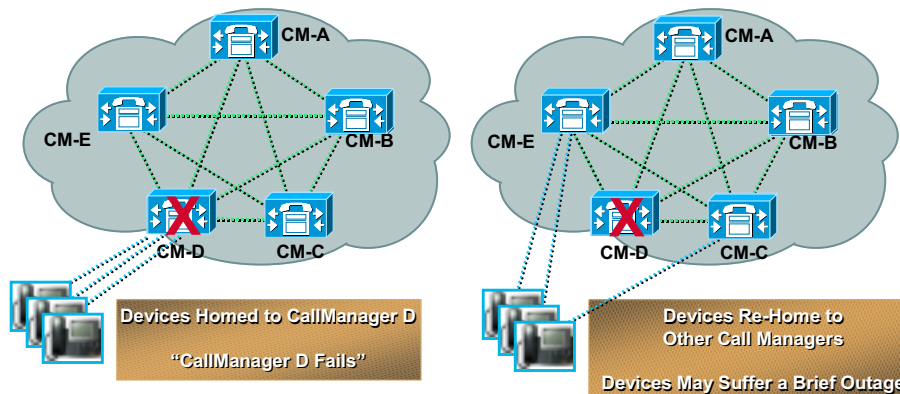
This Is Called a "CallManager Group"

This List is Downloaded During Device Initialization

# CallManager Clusters

## N+1 Failure Recovery Scenario

CallManager Cluster Appears as "One" CallManager

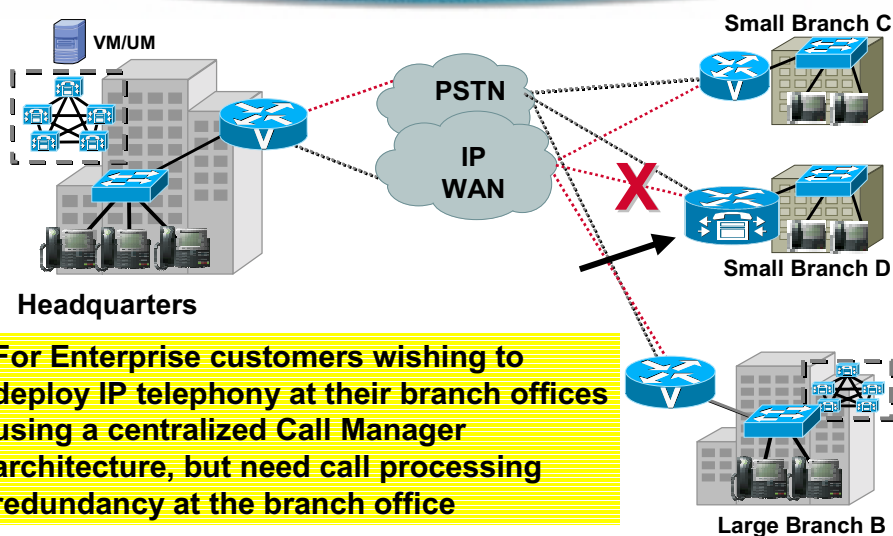


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# Survivable Remote Site Telephony



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