

Migrating to IP Telephony - The Gotchas



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Tutorial Outline

1. The “Other” Factors in VoIP
2. Evaluating the IP Telephony Closet
3. Power in the Closet
4. Assessing the LAN for IP Telephony
5. Assessing the WAN
6. Securing the IP Telephony Network
7. Software Issues
8. Organizing for IP Telephony

Further Education

1. "VoIP and IP Telephony" - 2 day seminar
2. "Deploying VOIP and IP Telephony in the Enterprise" - 2 day seminar (This seminar covers advanced material and is the follow on to the previous seminar)

"Ask the Experts" is being held at the BCR Training exhibit booth on Monday and Tuesday from 4 to 6 PM

Information Resources

www.voiploop.com - weekly BLOG on
communications subjects

www.webtorials.com and www.bcr.com -
15 articles on VoIP and IP Telephony

Section 1

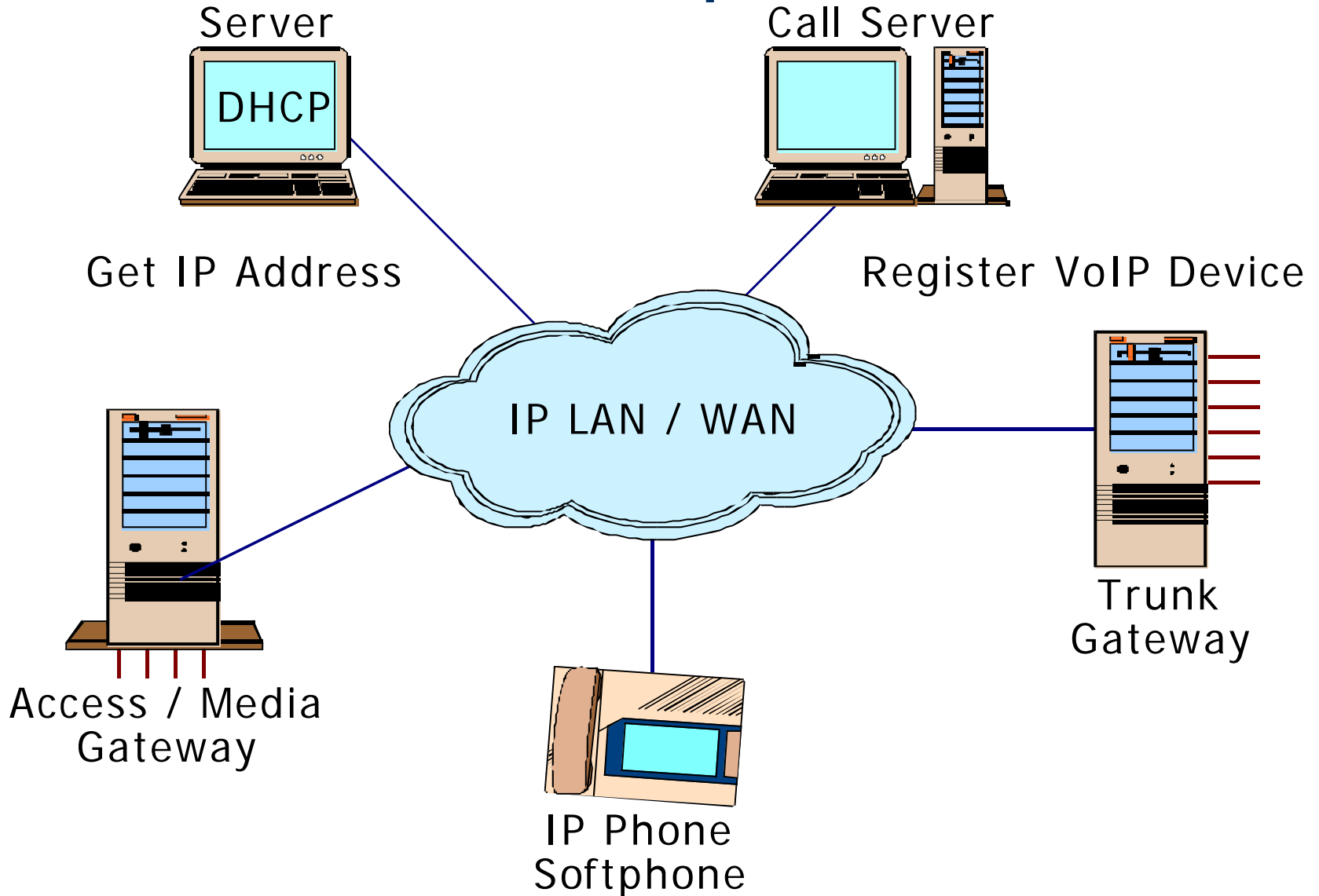


The “Other” Factors in VoIP

End User Perceptions

- Does not care whether the responsibility is Infrastructure or Applications
- Concerned about
 - Time to dial tone
 - Call quality
 - Call connect/disconnect times
 - Call drops
 - Application reliability and availability

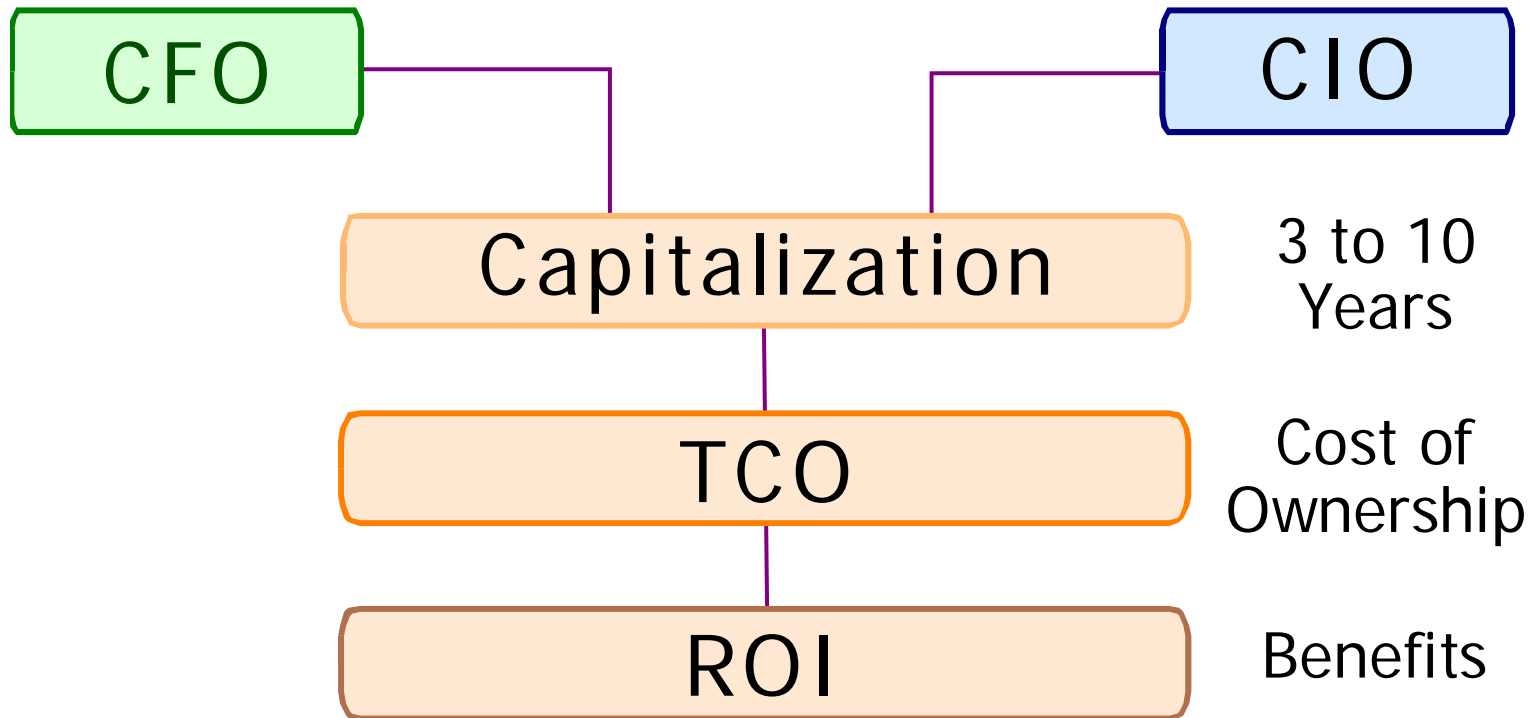
VoIP Components



Managing Resources

- Status
- Configuration
- Performance
- Usage
- Security
- Location

Financial Analysis



TCO ✎ Underestimated








ROI ✎ Overestimated

Total Cost of Ownership (TCO)

- Implementation costs
 - Capital
 - Staff
 - Facilities
- Savings
 - Capital
 - Staff
 - Facilities
- Result is Return on Investment (ROI)
- How long a period?
 - Expense in one year
 - Capitalize in three to five years
 - Capitalize up to seven years
 - Government use

TCO / ROI Issues

1. Lifetime

-  Hardware
-  Software
-  Training
-  Cost of Upgrades
-  Replacement / Obsolescence Time
-  Post Lifetime Support
-  Forced Replacements

NOTE: PBXs can last 15 to 20 years; Routers and servers are eclipsed by new product every one to three years.

TCO / ROI Issues (cont'd)

2. Moves, adds and changes
3. Asset management
4. Voice infrastructure reduction
5. Converged staffing and certification
6. Remote access (teleworkers)
7. Modification to legacy systems
8. UPS power and utility costs
9. Where are the meaningful and tested models?

Request for Proposal Outline(1)

- Proposal Introduction
- Bidder Qualifications
- Legal and Insurance Requirements
- Proposal Conditions
- Proposal Format
- Existing System Description
- System Requirements
- Endpoint Requirements

Request for Proposal Outline(2)

- Maintenance and Support
- Training
- Installation and Cutover
- Optional Elements
- *Software Licensing and Support*
- *Security*
- *Outsource Management and Administration*
- *Software Administration*
- *Use of Subcontractors*

Section 2



Evaluating the IP Telephony Closet

What to Consider in the Closet

- Cabling
- Floor space capacity
- Rack space
- Heat generation
- Extra air conditioning
- 220v vs. 110v
- Power receptacles

Convergence Cabling

- Telephone Grade (Category 1)
 - Distance (1,000's m)
 - Bandwidth (Kbps to Mbps)
 - Power over Cable
- Data Grade (Categories 3, 5, 6)
 - Distance (100 m)
 - Bandwidth (10 Mbps to 1 Gbps)
 - Power over Cable for 10/100 Mbps
- Fiber Optic
 - Distance (1,000 m+)
 - Bandwidth (Mbps to Gbps)
 - Backbone / Desktop
 - Security
 - No Power over Cable

Space Planning (1)

- MDF room will probably be oversized due to movement of equipment to individual floor LAN closets.
- IDF will have to house equipment racks in addition to wiring blocks .
- LAN closet space will have to be expanded and more closets built if IDF not used.
- No space changes for legacy phones (except for gateway equipment).

Space Planning (2)

- Telecom and data racks are not necessarily the same size
- Server blades are deeper, 40" vs. 24"
- LAN closets may need to be expanded by 2+ feet for new server blades
- Faster chips need more power and produce more heat
- Higher density electronics requires focused air conditioning

Configuring the Closet

- What is the sequence of configuration?
- Are the wiring blocks cabled correctly?
- Were there components that the vendor assumed I already had in place?
- How do I know when the closet is ready?

Air Conditioning the Closet

Heat Output

- Sum up the watts for IT equipment _____
 - LAN in-Line power-input power x.6 _____
 - Mid-span-input power x .4 _____
 - Lighting at full watts _____
 - UPS power rating x .09 _____
 - ADD ALL TOGETHER _____
- TOTAL WATTS _____

Air Conditioning the Closet

Cooling Solutions

- 100 to 500 watts: Place grill vents at top and bottom of closet door to area with HVAC
- 500 to 1000 watts: Ventilation fan above and grill at bottom of closet door with HVAC area
- 1000+ watts: Put equipment in enclosed rack with hot air exhaust scavenging system so hot air does not re-circulate (air intake through closet door grill with HVAC area)
- 1000+ watts: HVAC not accessible, therefore requires computer air conditioner adjacent to equipment

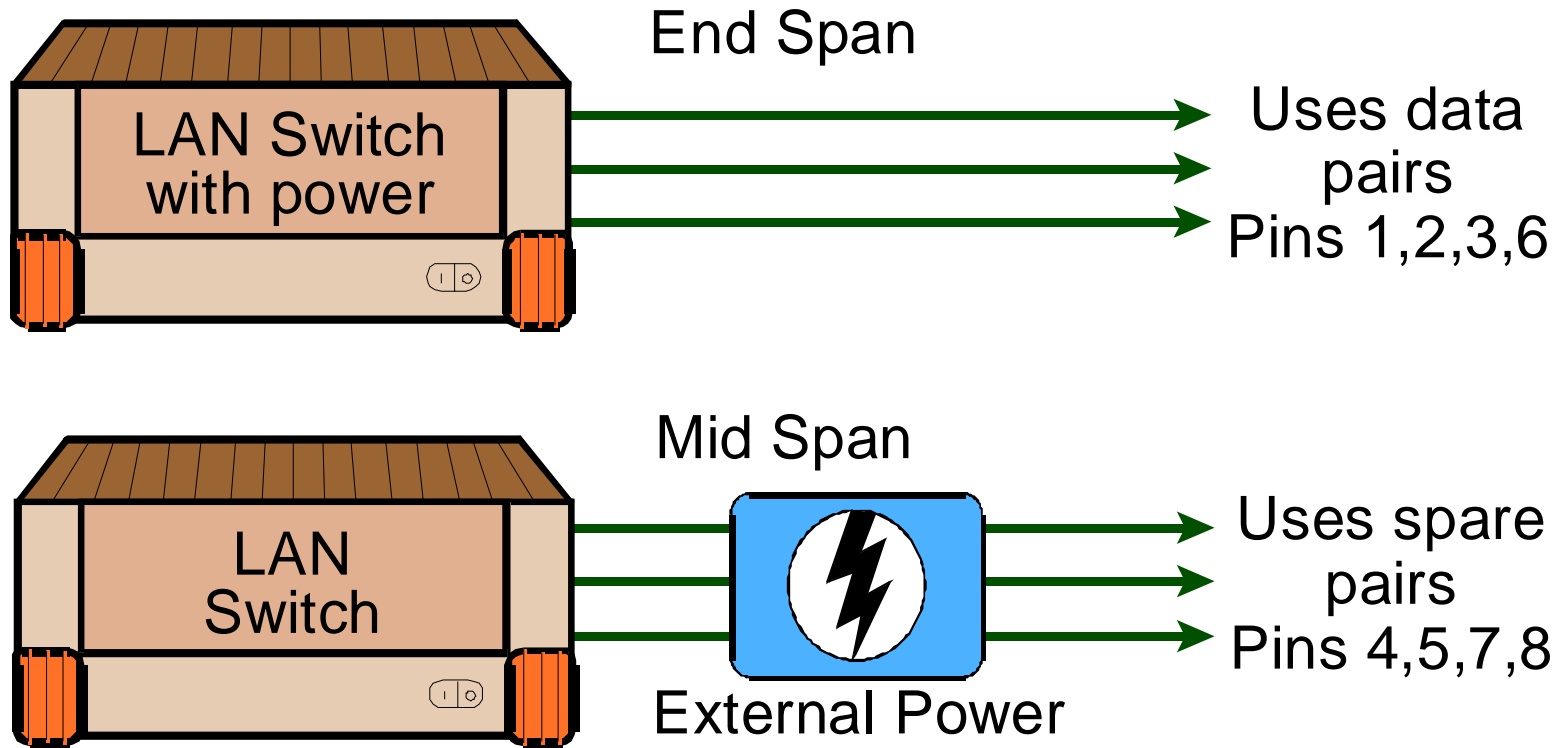
Section 3



Power in the Closet

PoE Design (802.3af)

12.95/15.4 Watts per Port

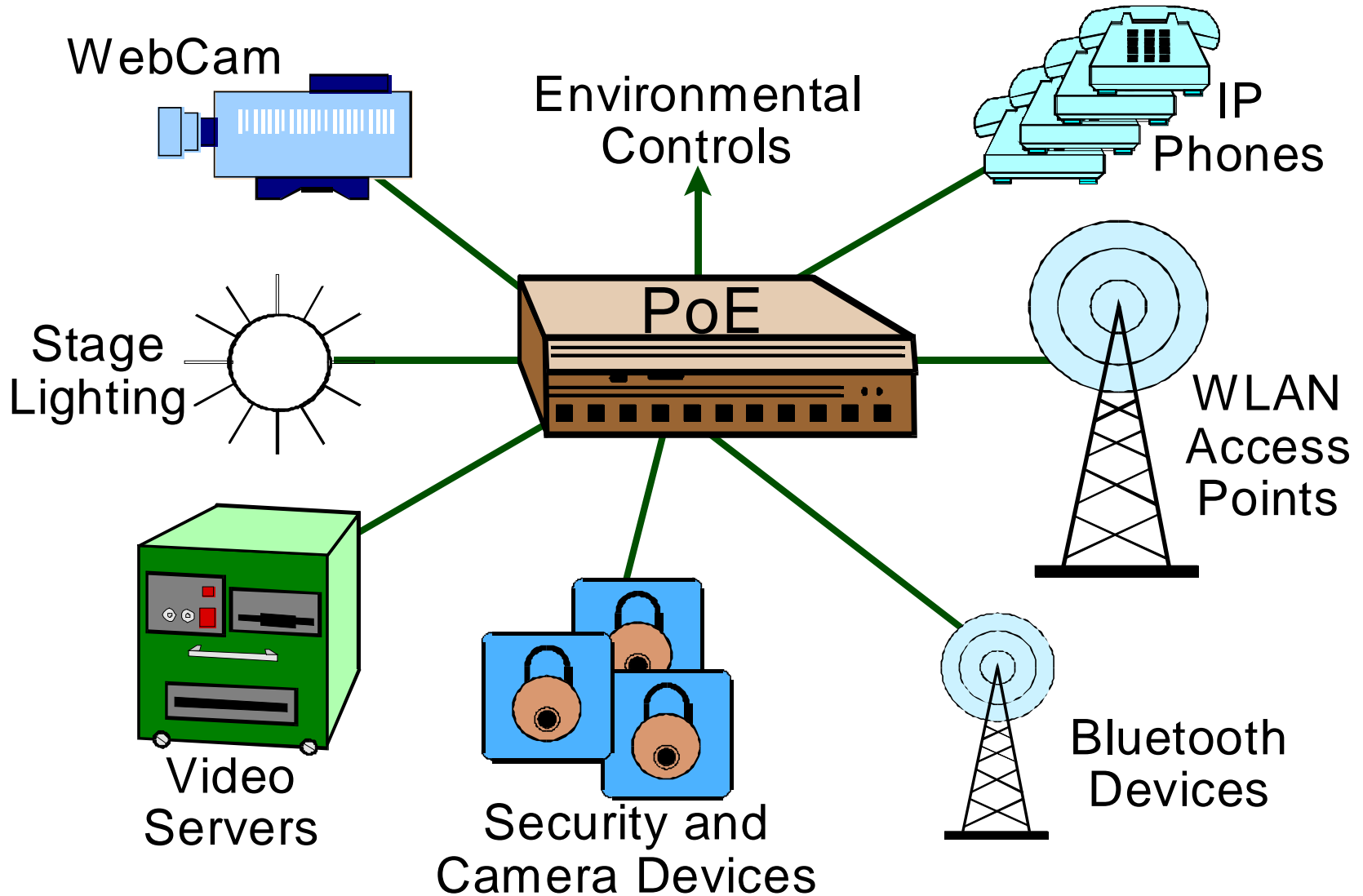


48 IP Phones @ 6 W = 288 Watts
@ 15.4 W = 740 Watts
in addition to LAN Switch power

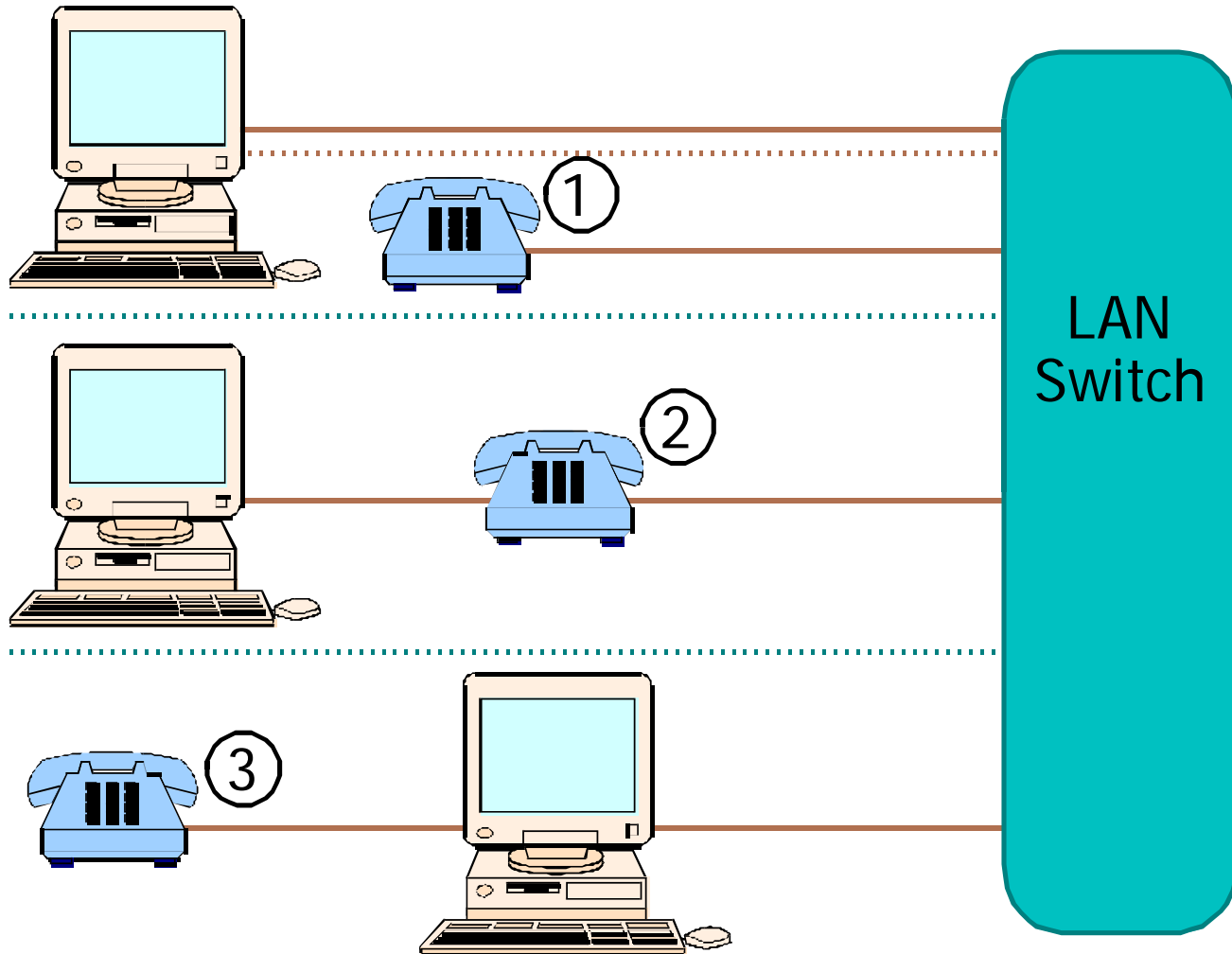
Power over Ethernet (PoE)

- May use data pairs (1, 2, 3, 6)
- Can use two unassigned pairs(4, 5, 7, 8)
- 802.3af uses positive polarity power
- Cisco uses negative polarity power
- Many products support both methods delivering 12.95 watts at cable end
- BIG QUESTION:
Are your cables ready for PoE?

PoE As a Power Source



IP Phone Power



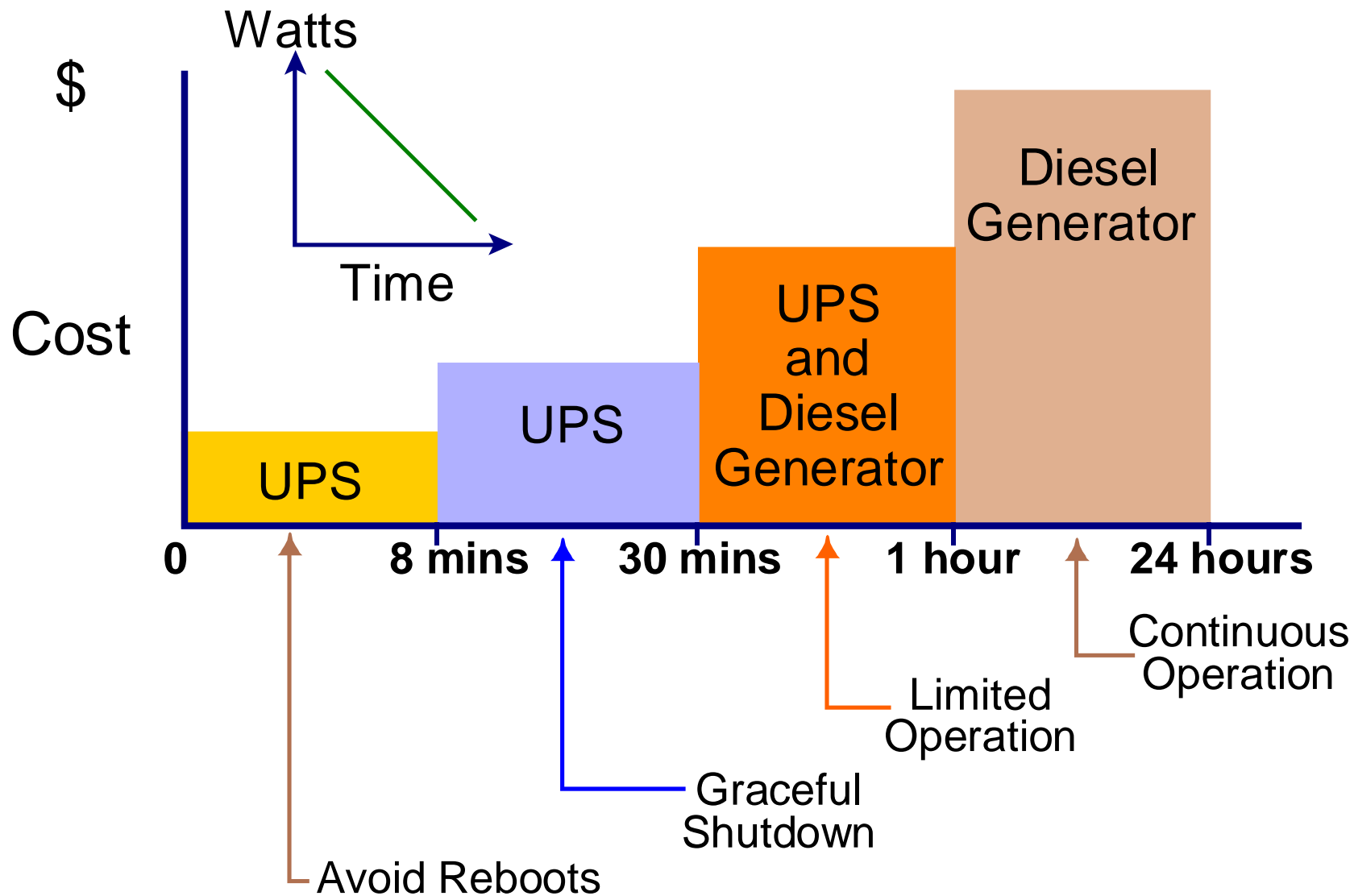
- Single Port
- Multiport
- Lifeline
- Power

U.S. Power Reliability

- IT departments average 15 outages per year
- 90% of the outages are less than five minutes
- 99% of the outages are less than 60 minutes
- Overall IT power availability = 99.98%

Source: American Power Conversion Technote #26

UPS Run Time Evaluation



Power Expenses

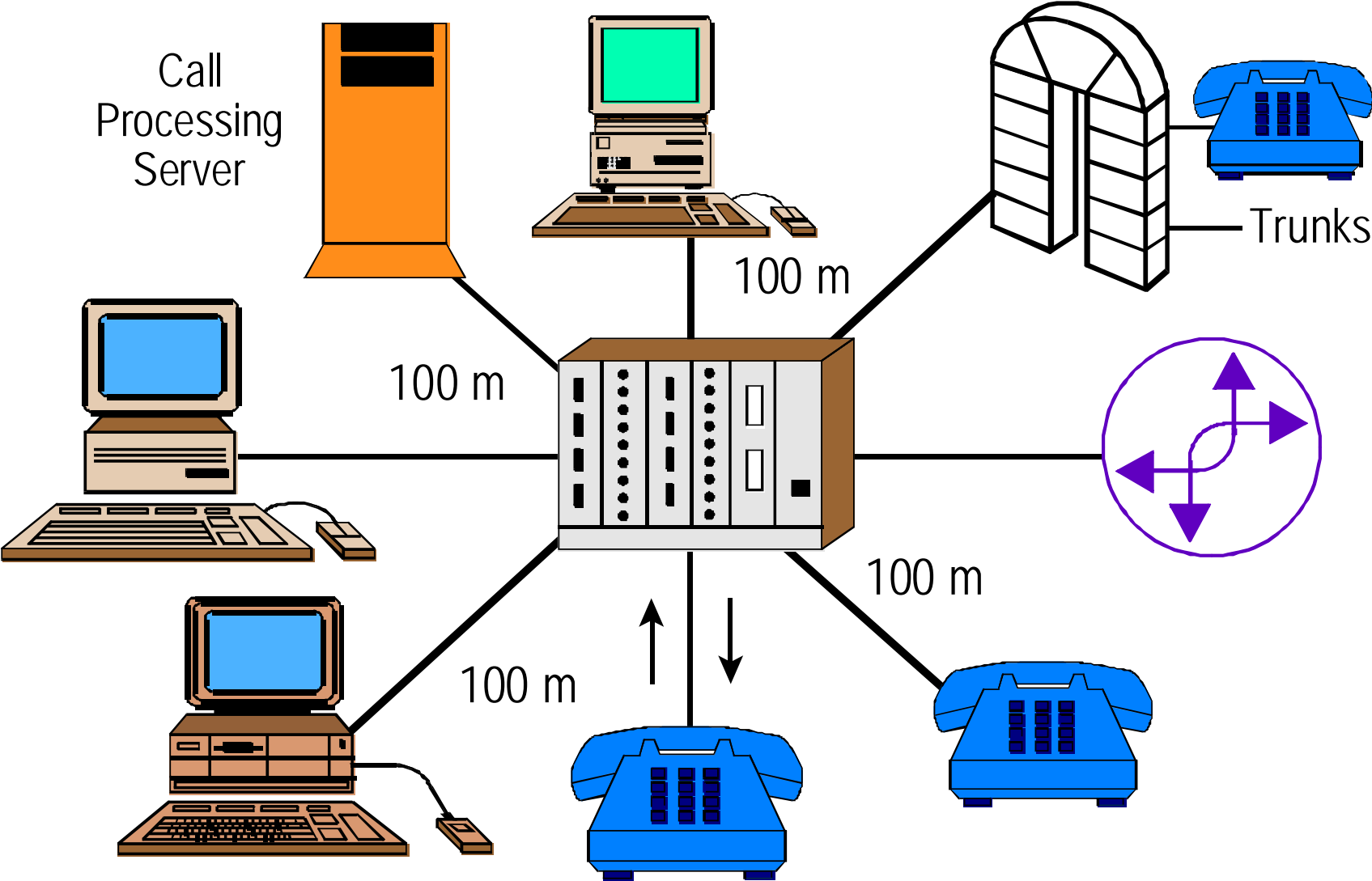
- Cost of power is rising permanently and not included in IT budgets
- Recent increases from 30% to 50%
- Shut power down on weekends?
- Rewire for closet only power and air conditioning
- UPSs require regular testing, monitoring, battery replacement and environmentally safe disposal

Section 4



Assessing the LAN for IP Telephony

Ethernet IP-PBX Configuration



Which LAN Configuration?

Parallel

VLAN

Converged

Secure

Secure

Poor Security

Traffic
Isolation
Voice/Data

Traffic
Isolation
Voice/Data

Combined
Voice/Data
Traffic

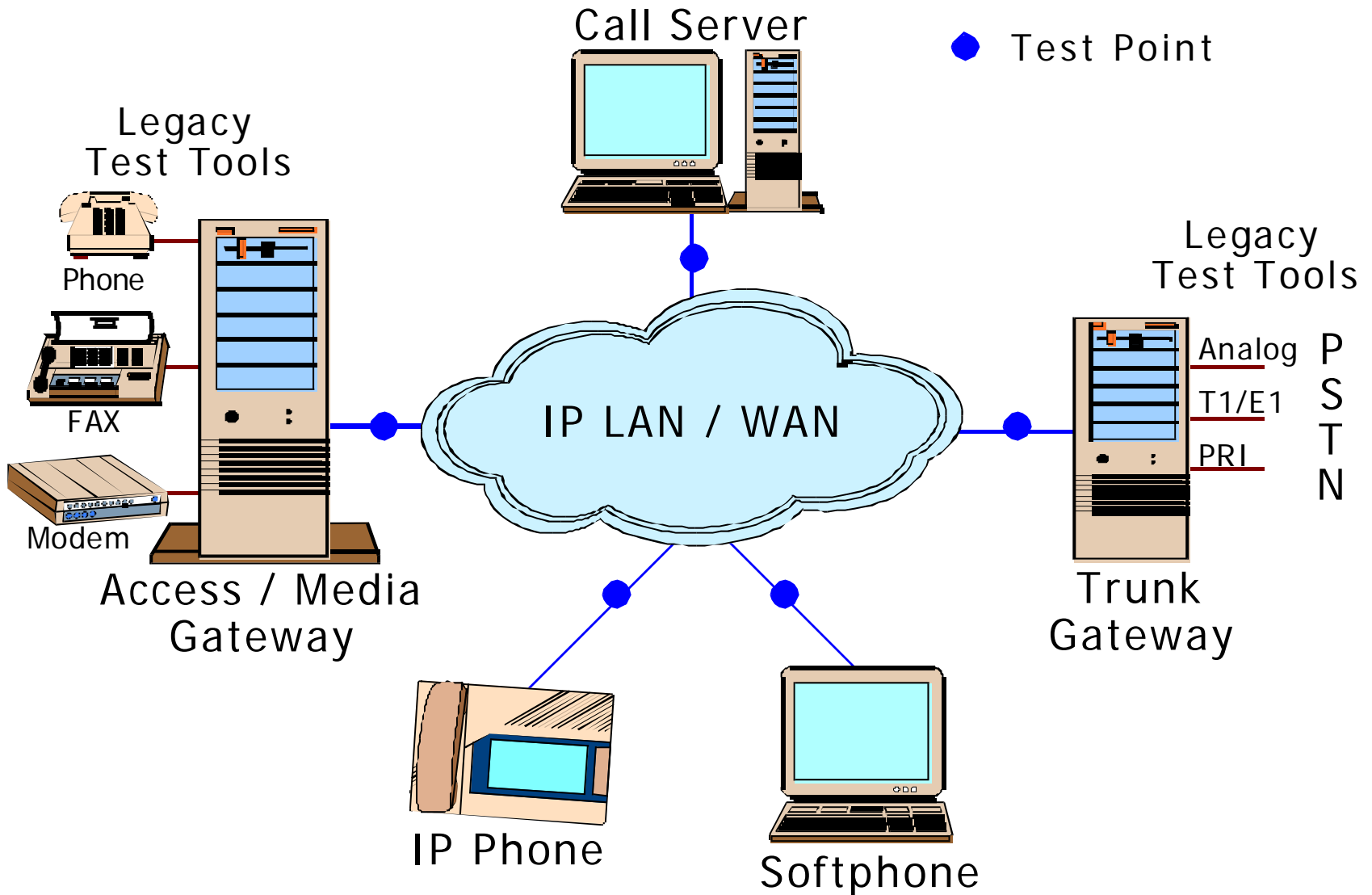
Two or More
Switches

LAN Switch
w/802.1q

One Switch

Test Points

● Test Point



Measuring Voice Quality

- Objective measurement
 - E-Model
 - Perceptual models
 - PSQM
 - PESQ
- Subjective measurement
 - Mean Opinion Score (MOS)
 - MOS is scoring by human listeners
 - End point locations satisfying standards for ambient noise (ITU-T P.800 and P.830)

Mean Opinion Score (MOS)

- A numeric measure of the voice quality
- 5 = perfect; 4.4 = toll quality
- 3.5 = marginally acceptable
- 30+ people listening to sounds score the MOS
- Industry moving to device measurement of MOS

CODEC Voice Scores

<u>Standard</u>	<u>Speed</u>	<u>MOS</u>	<u>Delay</u>	
G.711	64 Kbps	4.4	0.75 ms	(5 ms)
G.726	32, 24, 16 Kbps	4.2 @ 32 Kbps	1 ms	(10 ms)
G.728	16 Kbps	4.2	3 to 5 ms	(10 ms)
G.729/A	8 Kbps	4.2	10 ms	(14 ms)
G.723.1	6.3, 5.3 Kbps	4 @ 6.3 Kbps 3.5 @ 5.3 Kbps	30 ms	(37 ms)

Mean Opinion Score (MOS) by people: 5 = Excellent
4 = Good
3 = Fair
2 = Poor
1 = Bad

Delay in () includes processing.

Goals for Acceptable Phone-to-Phone Voice Quality

FACTOR	PSTN	VoIP TOLERANCE
ERRORS	Very low and ignored	Ignored No retransmission
ONE-WAY DELAY	1 - 30ms	50 - 100ms
DELAY VARIANCE (JITTER)	0 - 5ms	10 - 20ms
LOSS	0%	1/2 - 2%
OUT OF SEQUENCE PACKETS	Does not occur	Correction required but adds to delay

IP-PBX Design for Ethernet

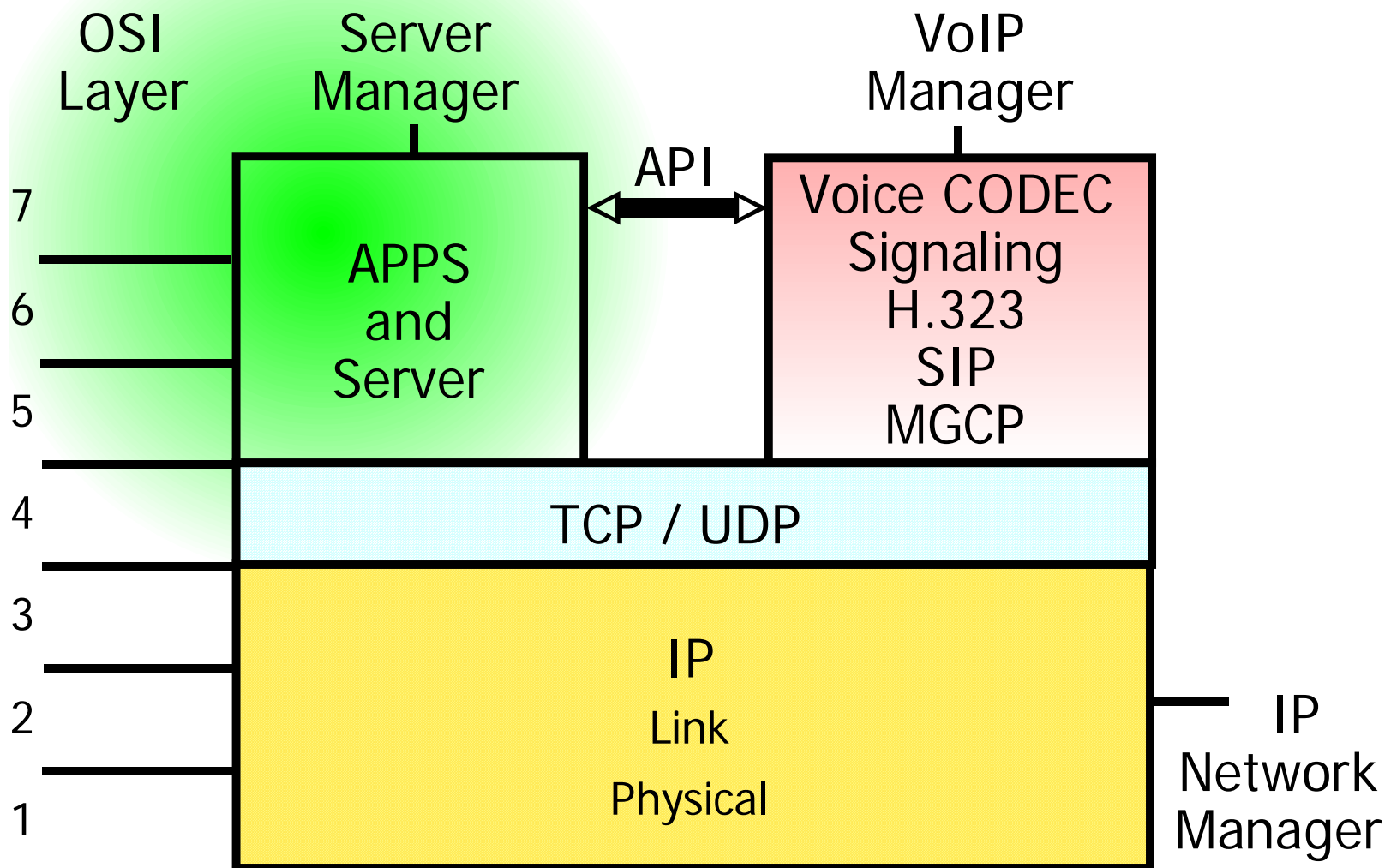
- Assign 32 (compressed) to 80Kbps (G.711) per voice conversation
- Limit the number of LAN Switches in tandem to four or less
- Category 3 / 5 cables limit coverage distance, therefore there will be more closets.
- Most IP-PBX products are voice-only designs with VLAN recommended.
- Check IP phone feature setup and compatibility

Section 5



Assessing the WAN

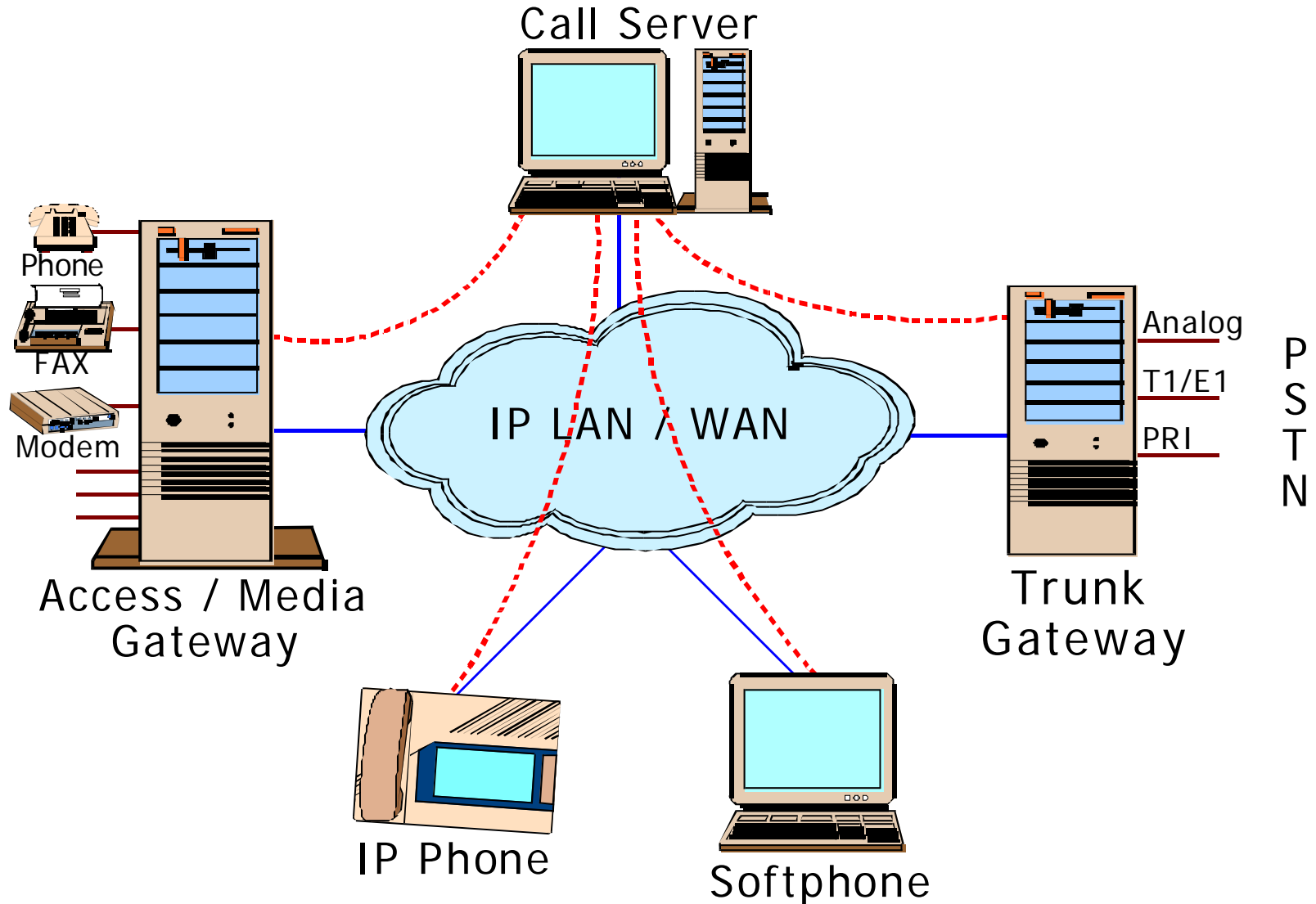
New Model from Data View (Voice Is An Application)



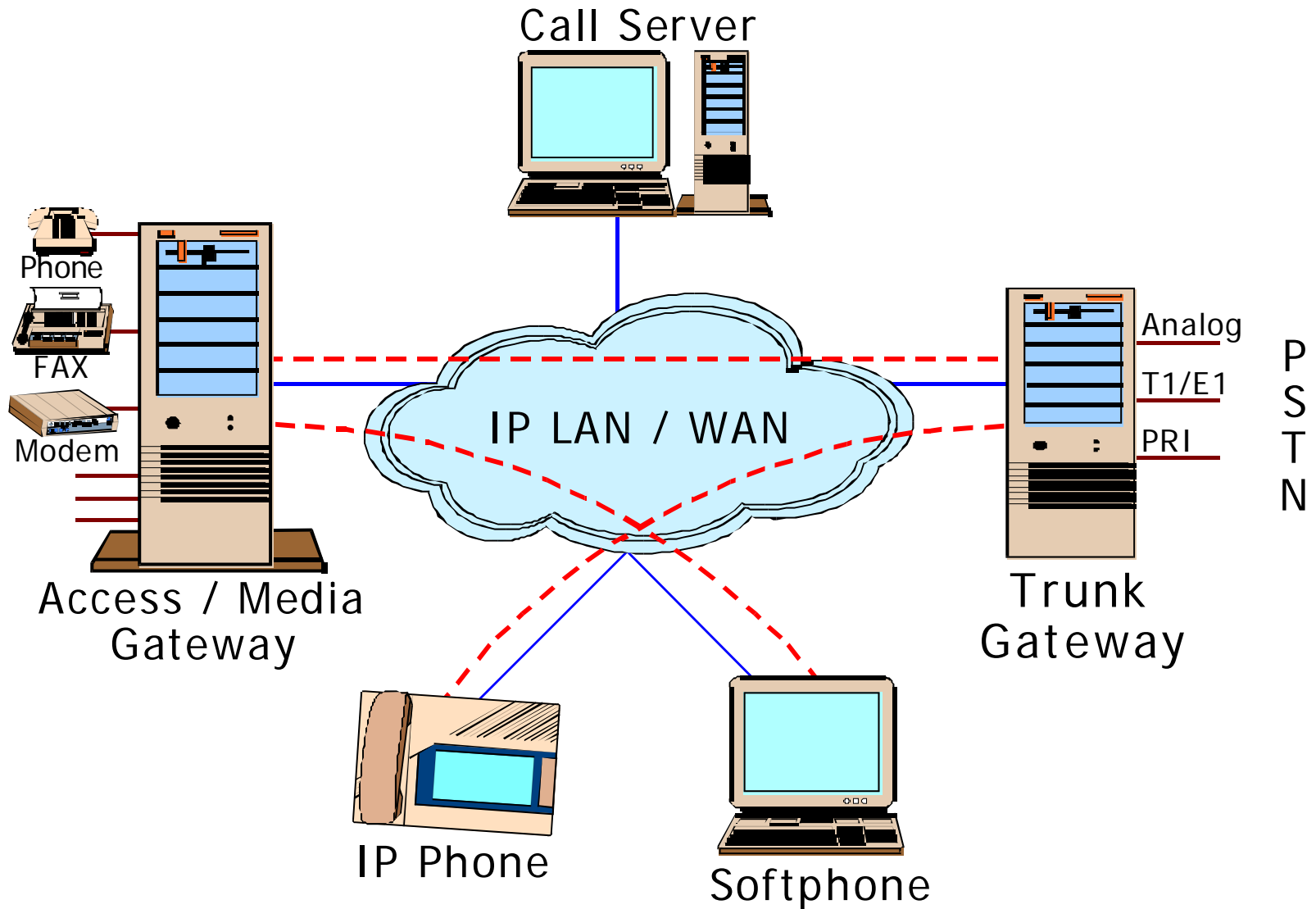
Causes of VoIP Quality Reduction

- CODEC type
- Packet size
- Silence suppression
- Clipping during silence suppression
- Packet header compression
- Link utilization and speed
- Packet loss
- Jitter buffer size
- Competing traffic

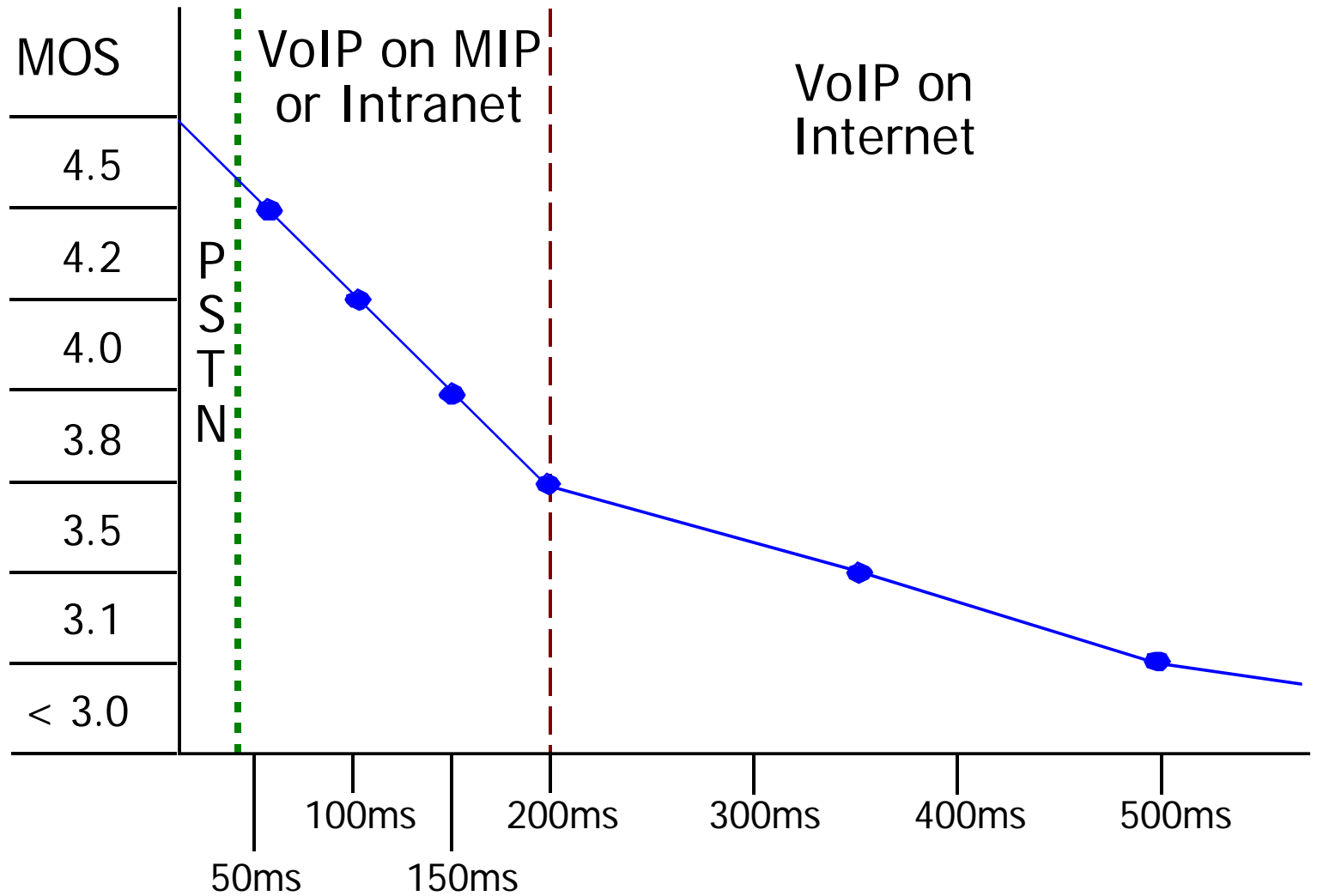
H.323 and SIP Signaling Paths



RTP Speech / Talk Paths

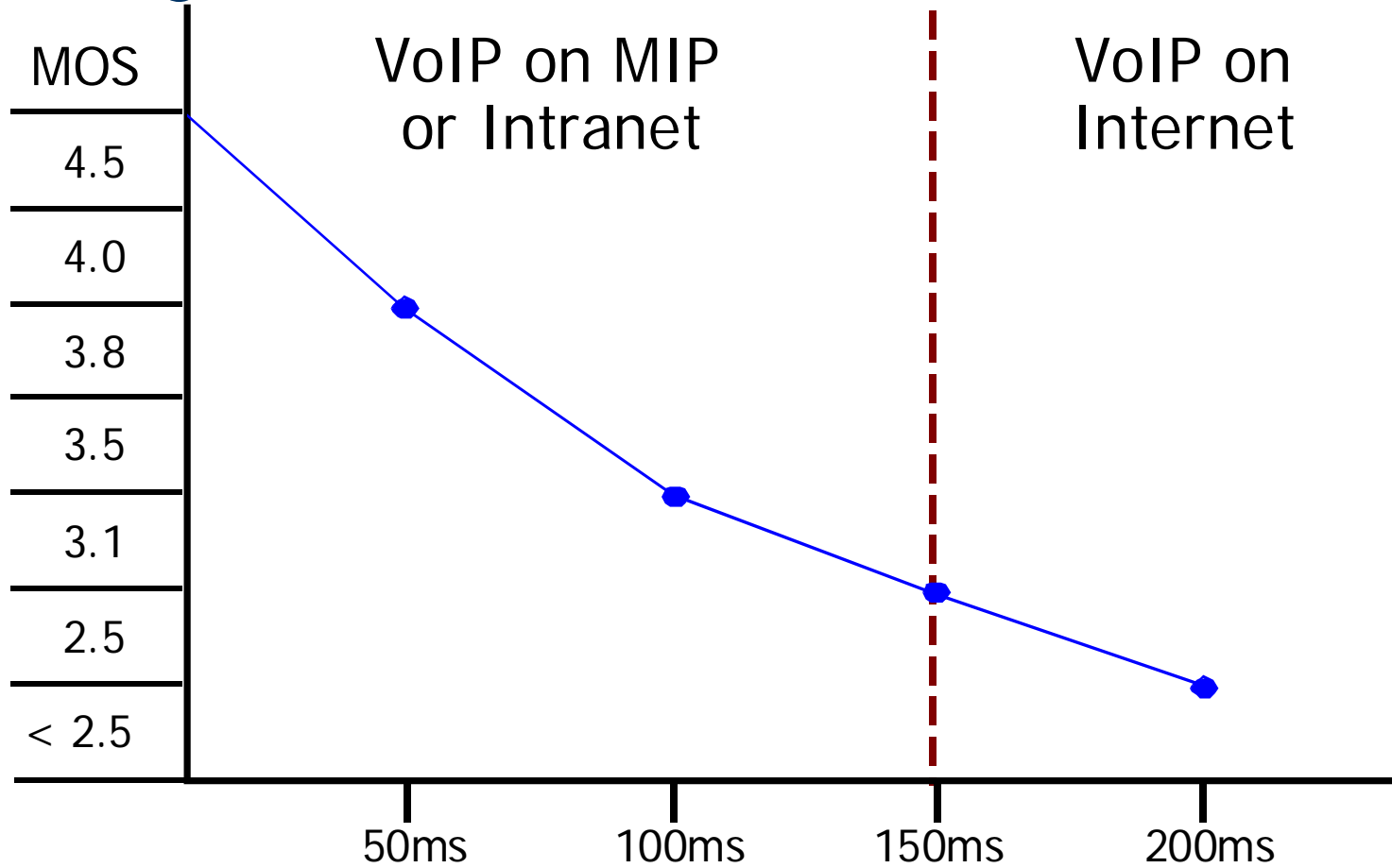


One-Way Delay MOS



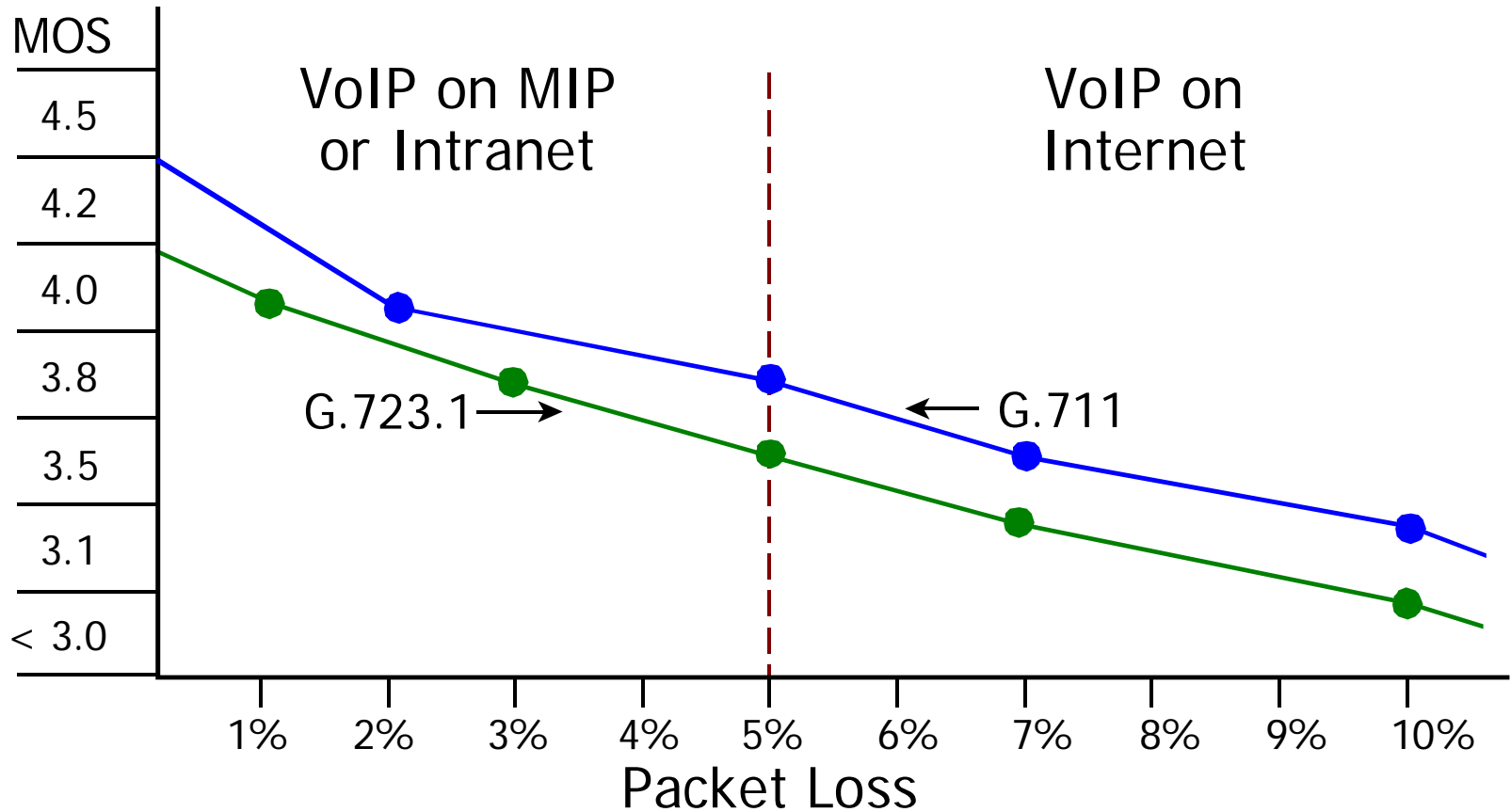
Delay includes all devices and network components, i.e., this is the phone-to-phone delay.

Delay Variance (Jitter) MOS



Jitter is a component of the one-way delay.
PSTN has little or no noticeable delay variance.

Packet Loss MOS



G.711 = No Compression G.723.1 = 5.3Kbps Compression
As voice packet goes from 20 to 40 bytes per packet,
packet loss sensitivity increases.
Note: No loss on PSTN

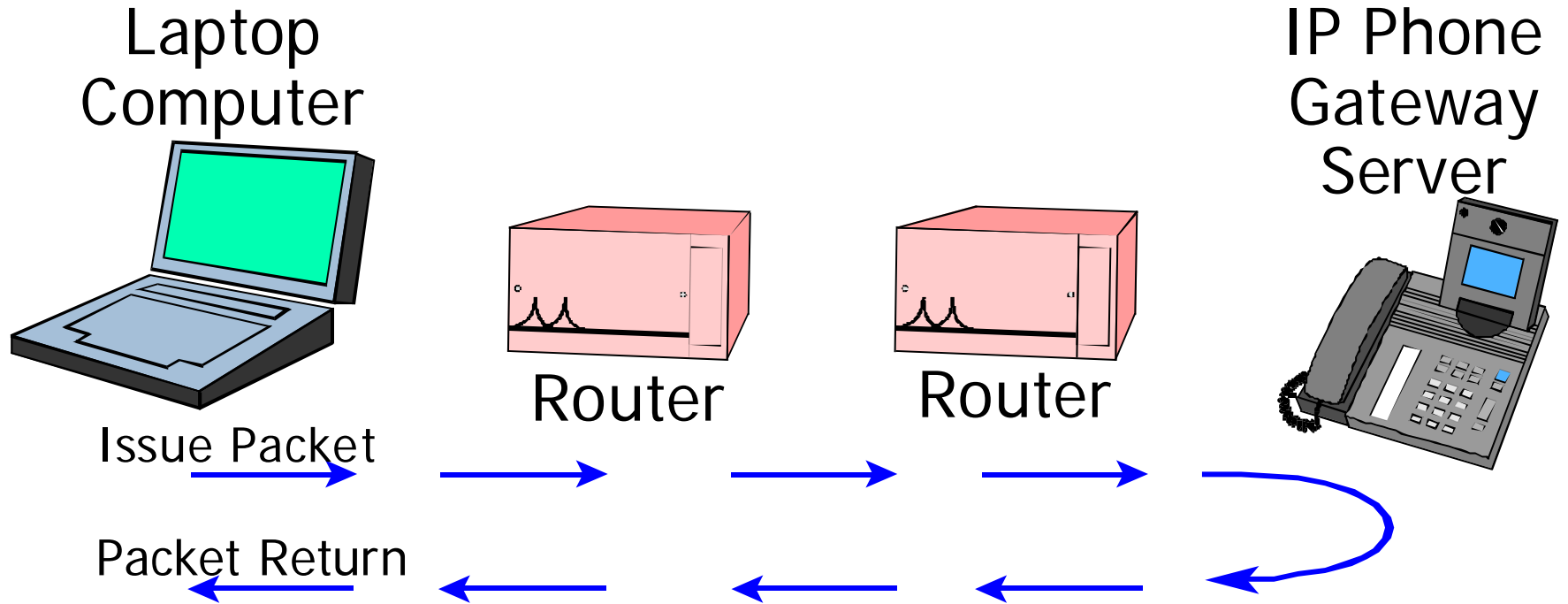
Network Assessment

- Measure LAN and WAN utilization
- Perform tests like PING to determine delay, jitter and packet loss
- Simulate signaling and call traffic to calculate bandwidth available
- Measure over one week, in 15 minute increments, to determine data busy hours relative to voice busy hour

Network Assessment Tools

- Send test packets, usually small, to the remote location that then echoes the packets back to the central site
- Central site performs the measurements
- Central site creates the performance reports

Assessment Tool Configuration

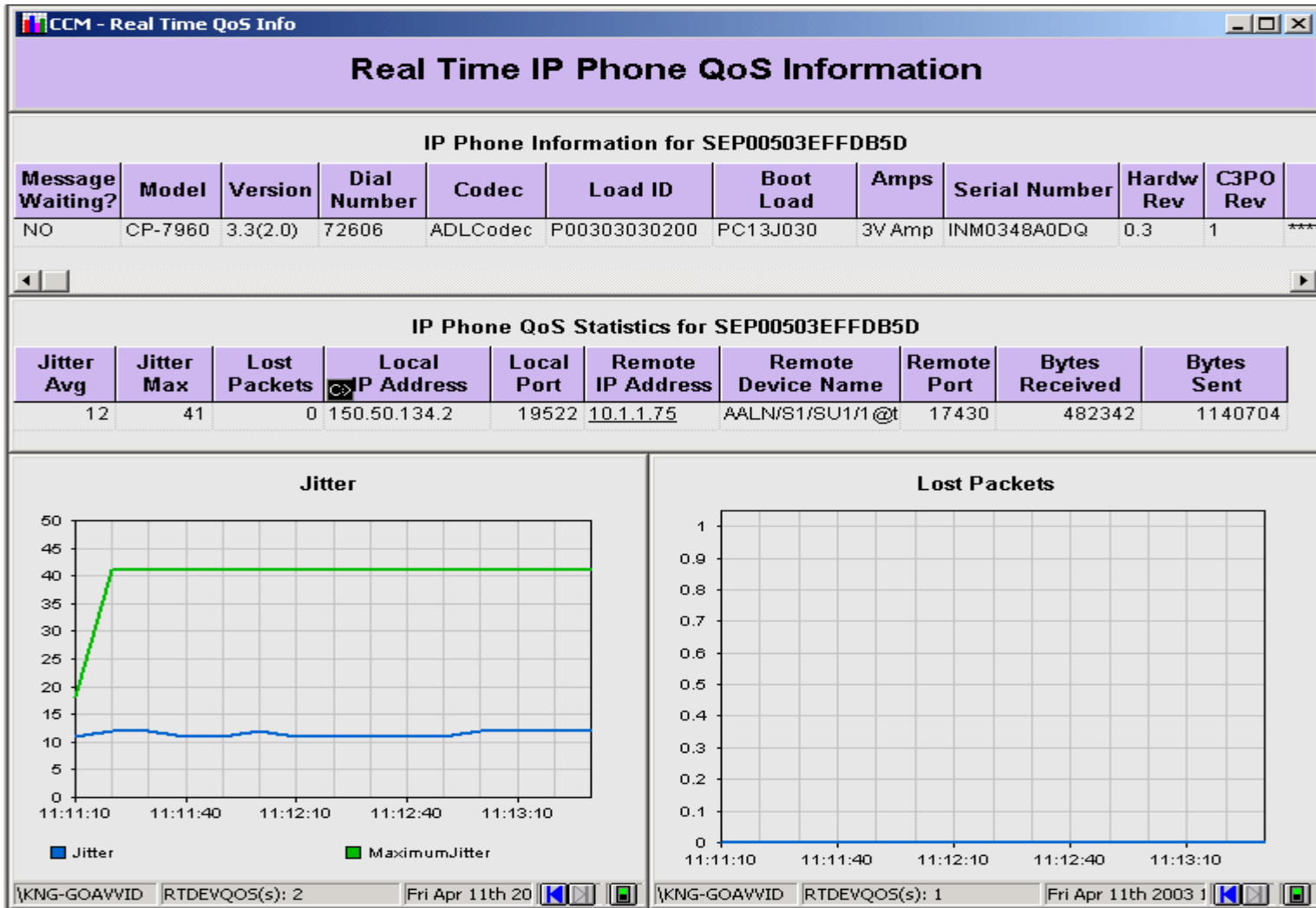


- Measure delay
- Measure delay variance
- Determine packet loss
- Measure packet bursts
- Isolate device problems
- Discover device configurations

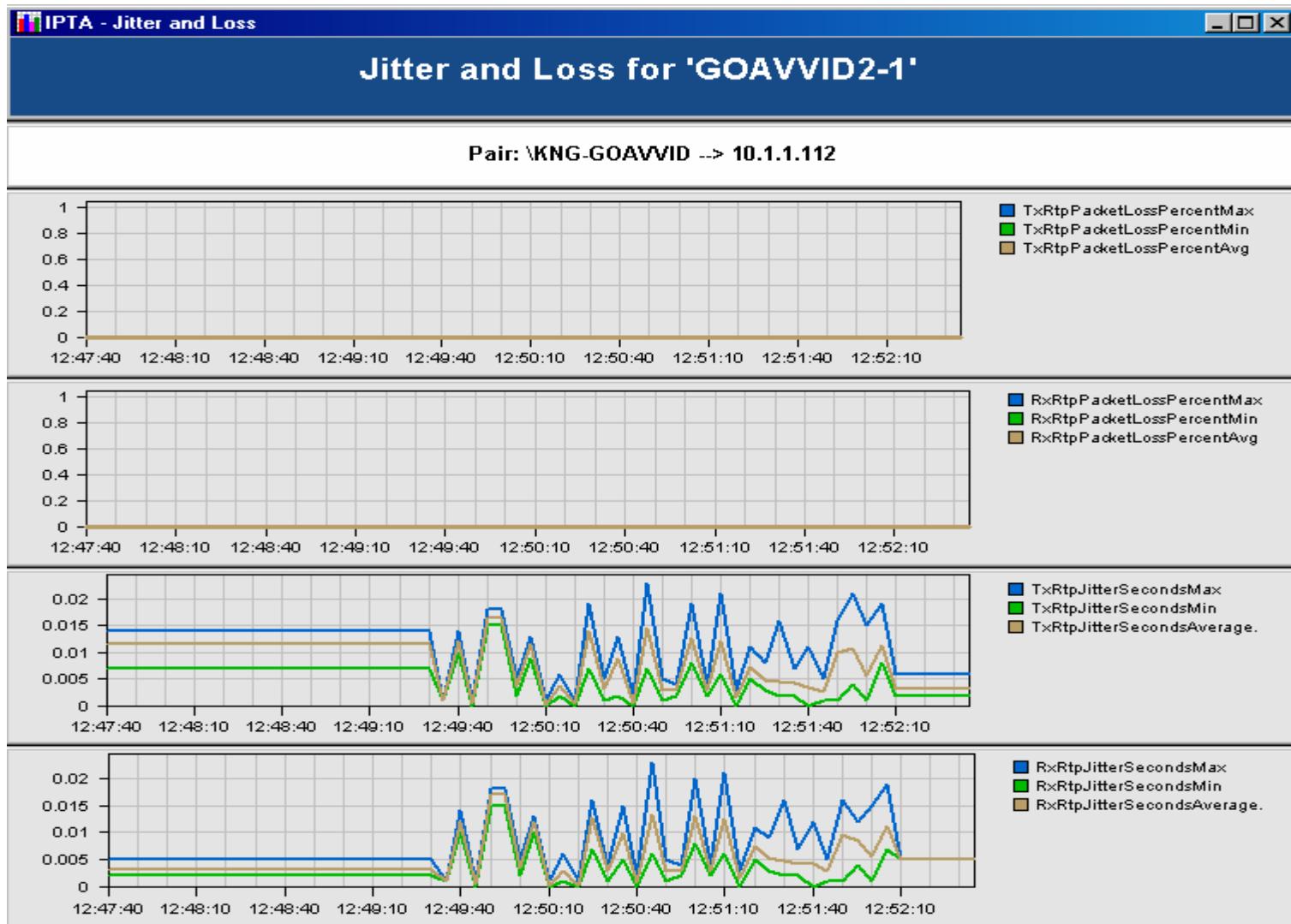
Assessment Tool Options

- Hardware device at remote locations with a centralized system
- Software agents at the remote locations with a centralized system
- Use existing software functions (ICMP) at remote locations with a centralized system
- May be offered/required as a service by the IP Telephony vendor

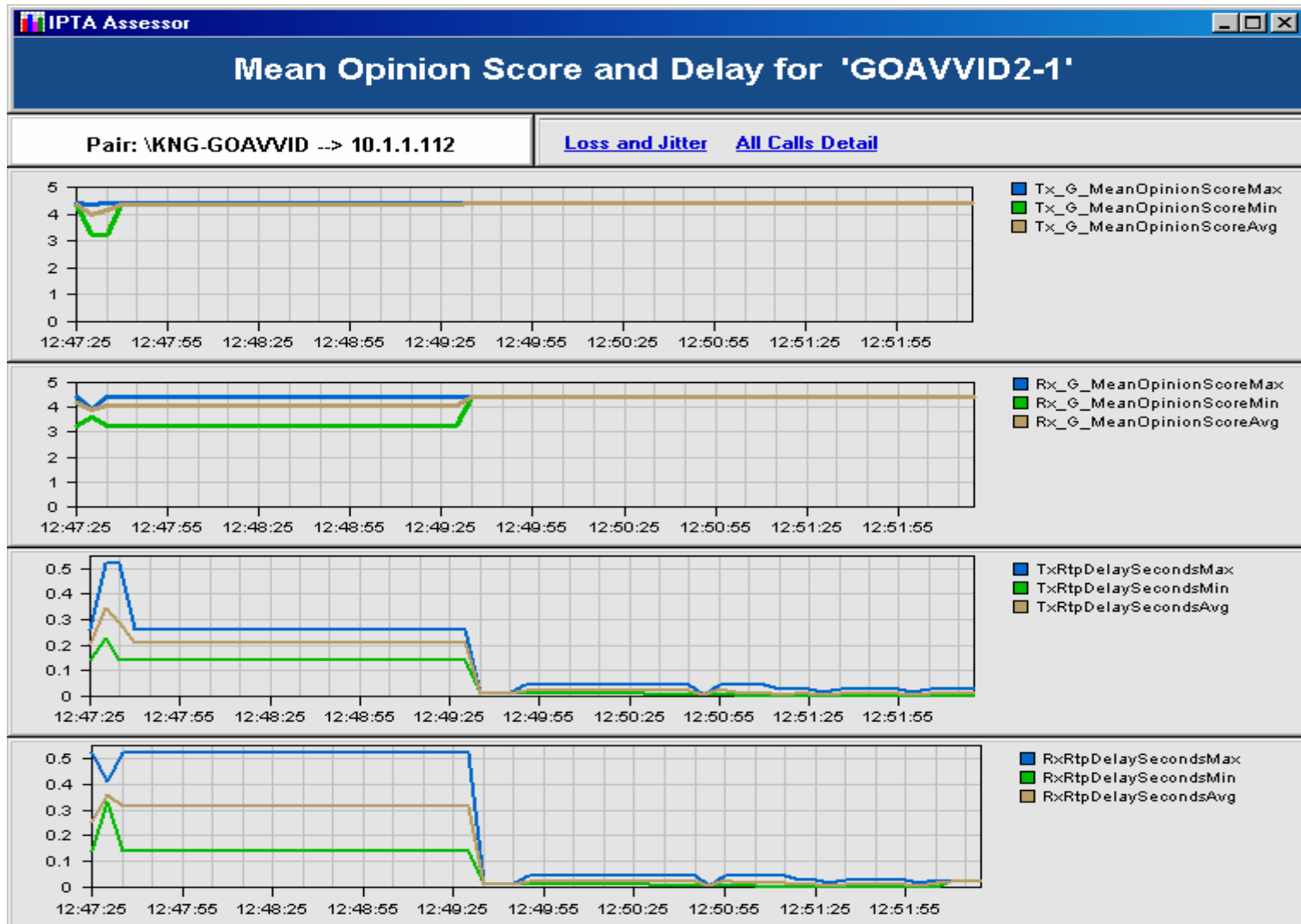
QoS Reporting



Packet Jitter and Loss



MOS Score and Delay



IP Network Changes

- QoS for voice (router and LAN switches)
- Reduce delay
- Increase bandwidth
- VLANs for voice
- Reduce router hop count
- Change routing protocol (RIP, OSPF)

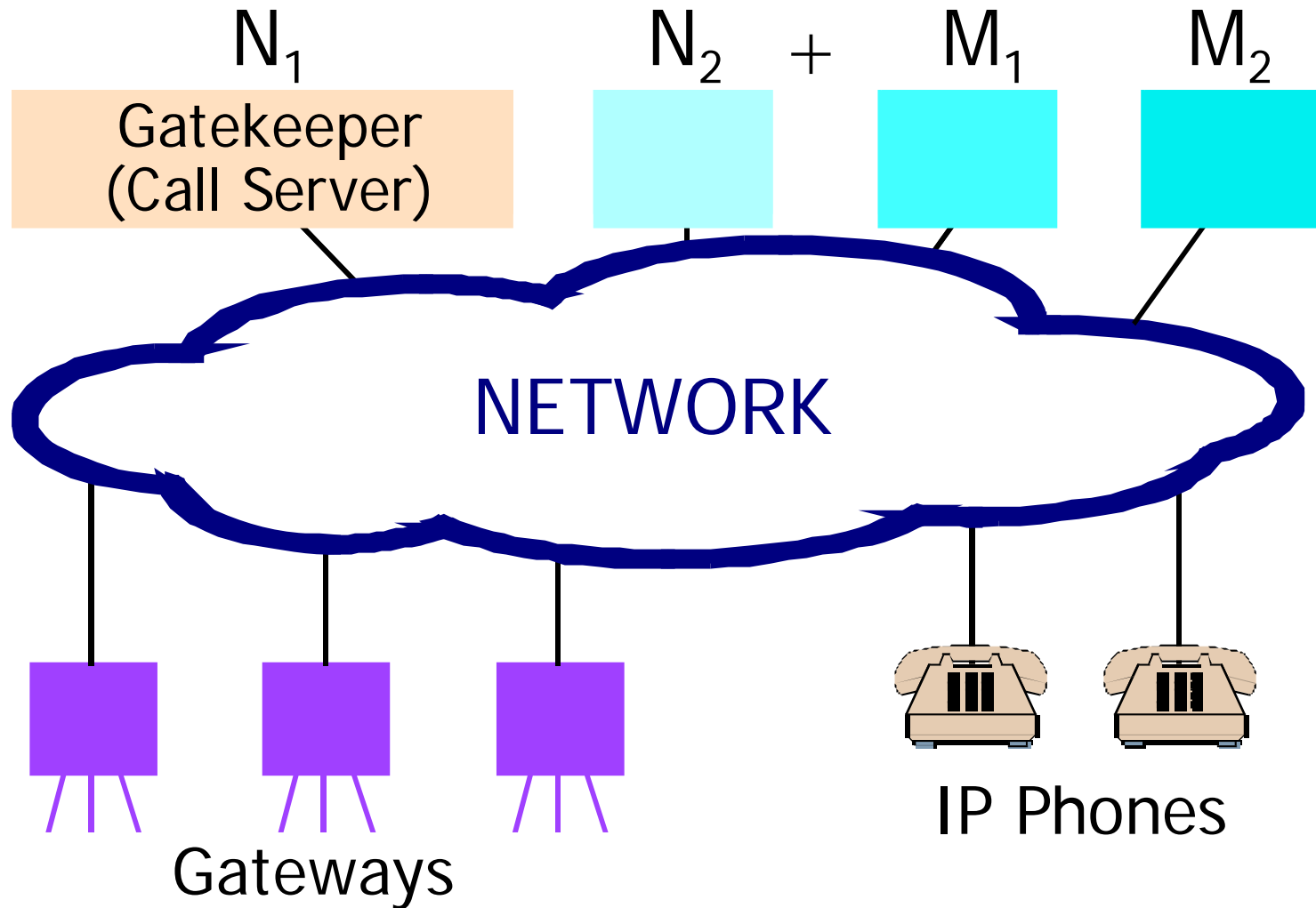
VoIP Equipment Changes

- Less compression
- Smaller packets (10 vs. 20, 30, 60 ms)
- Turn off silence suppression
- Larger jitter buffer
- Elevate priority of voice programs in softphones
- Use WINDOWS XP with softphone

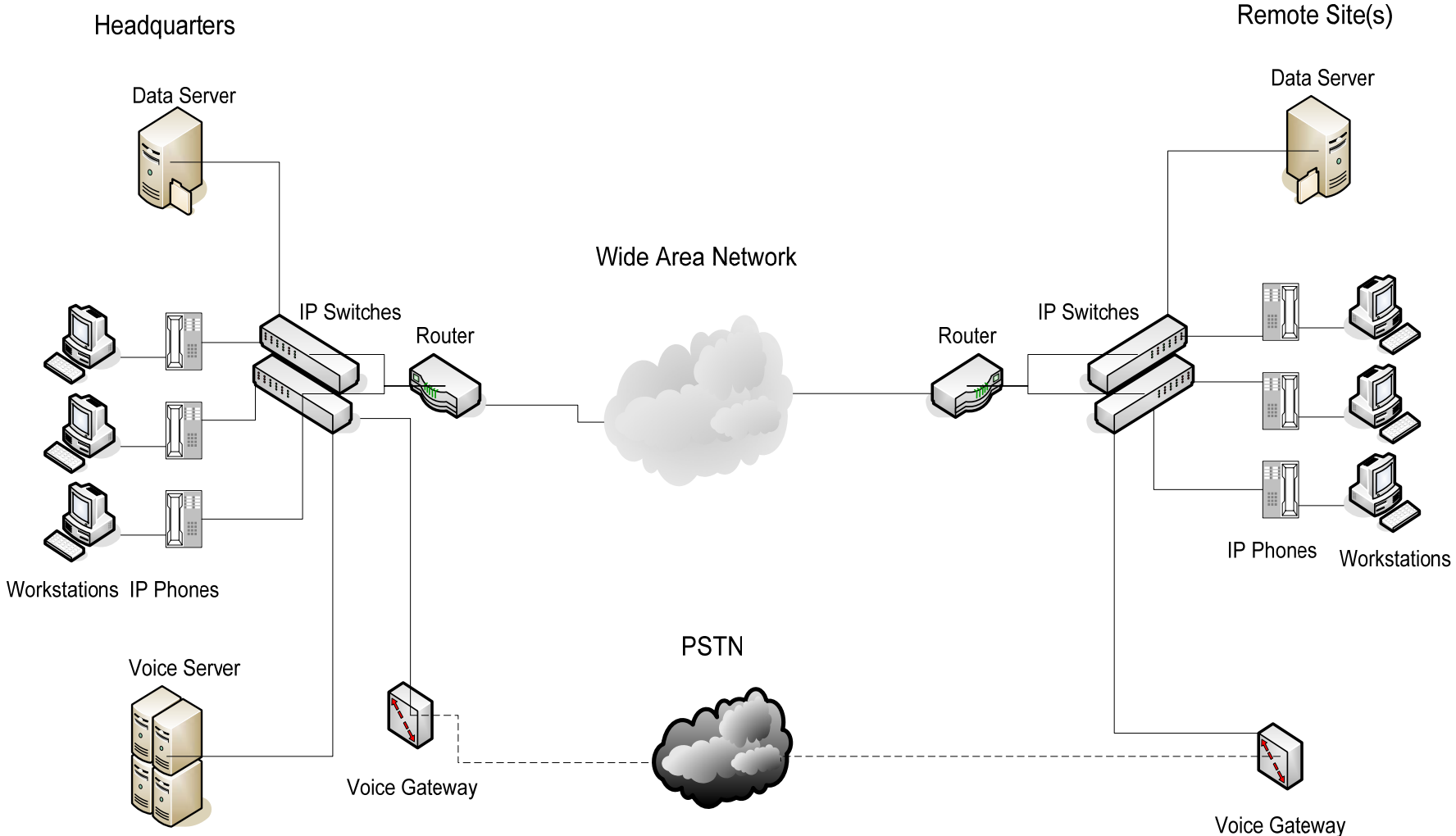
The Five 9s (99.999%)

- Hardware availability calculated by parts count method (two years to get field experience)
- Power availability
 - Requires UPS with auto restart
 - Generator backup
 - UPS monitoring
 - Four-hour UPS response service
- Software availability
 - No standard for calculation
 - Software stability is an issue
- Network availability
 - Redundant components
 - Automatic switchover

N + M Server Reliability



Converged Voice and Data Communications



Designing Resiliency

- Reduce network complexity.
- Eliminate single points of failure.
- Limit the number of connections for the network redundancy.
- Provide cross connections so that any component can be isolated without physical disconnection.
- Practice restart/recovery procedures.
- Use automatic re-routing protocols.
- Operate all paths for traffic-shared load.

Seven Key Points

- 🕒 IP network design significantly affects voice quality
- 🕒 QoS works, but it is not the only solution
- 🕒 Not all VoIP standard implementations are equal
- ↔ IETF and ITU work from different directions on VQT
- ↔ Machine measurement of voice quality is different from human measurement
- ↔ VoIP equipment, IP equipment and the network need changes to improve voice quality
- ↔ Measurement standards are still maturing and the VoIP equipment vendors need to catch up

Section 6



Securing the IP Telephony Network

Security Definition

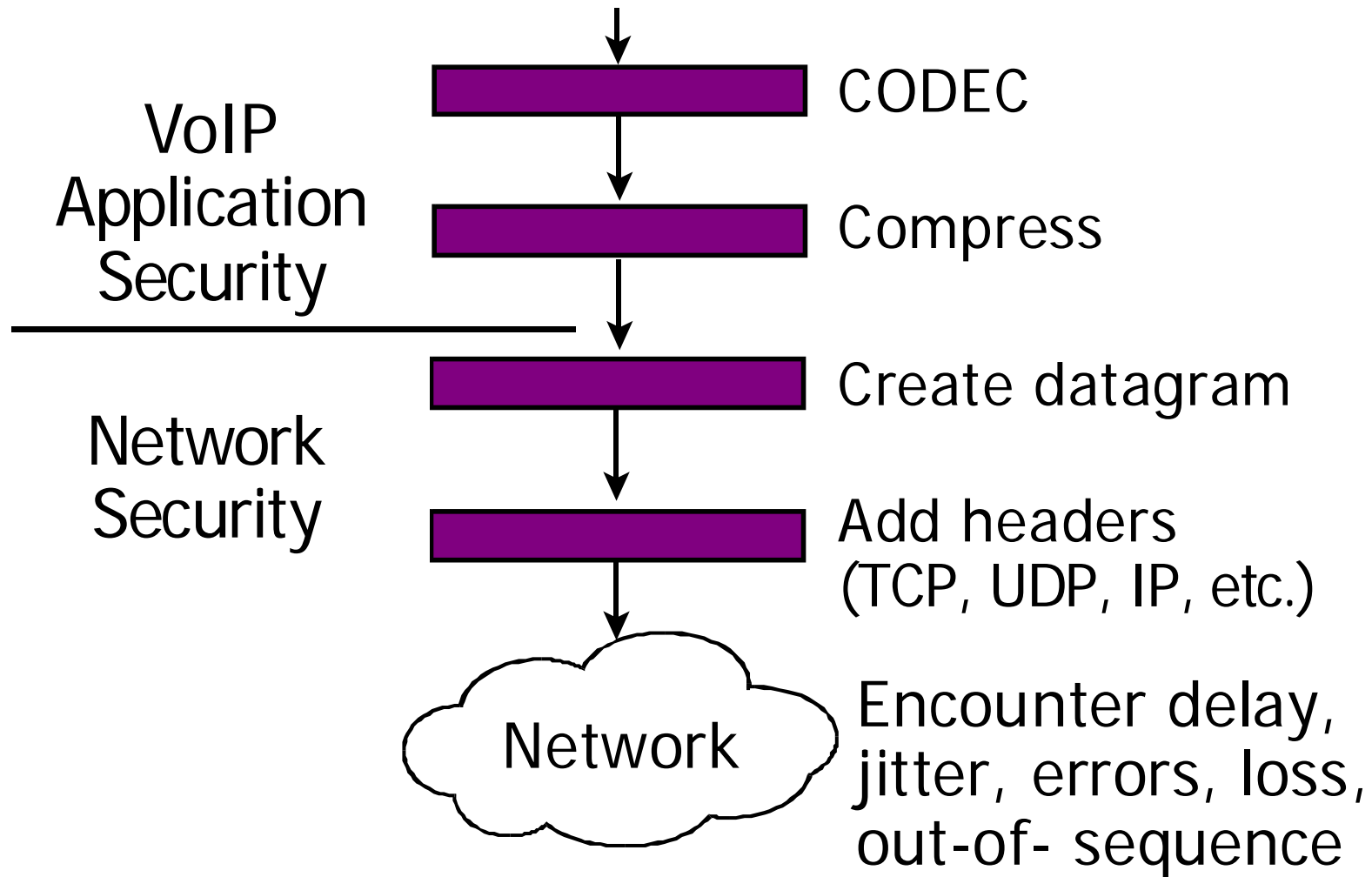
The protection of resources requires
constant vigilance.

You are never finished.

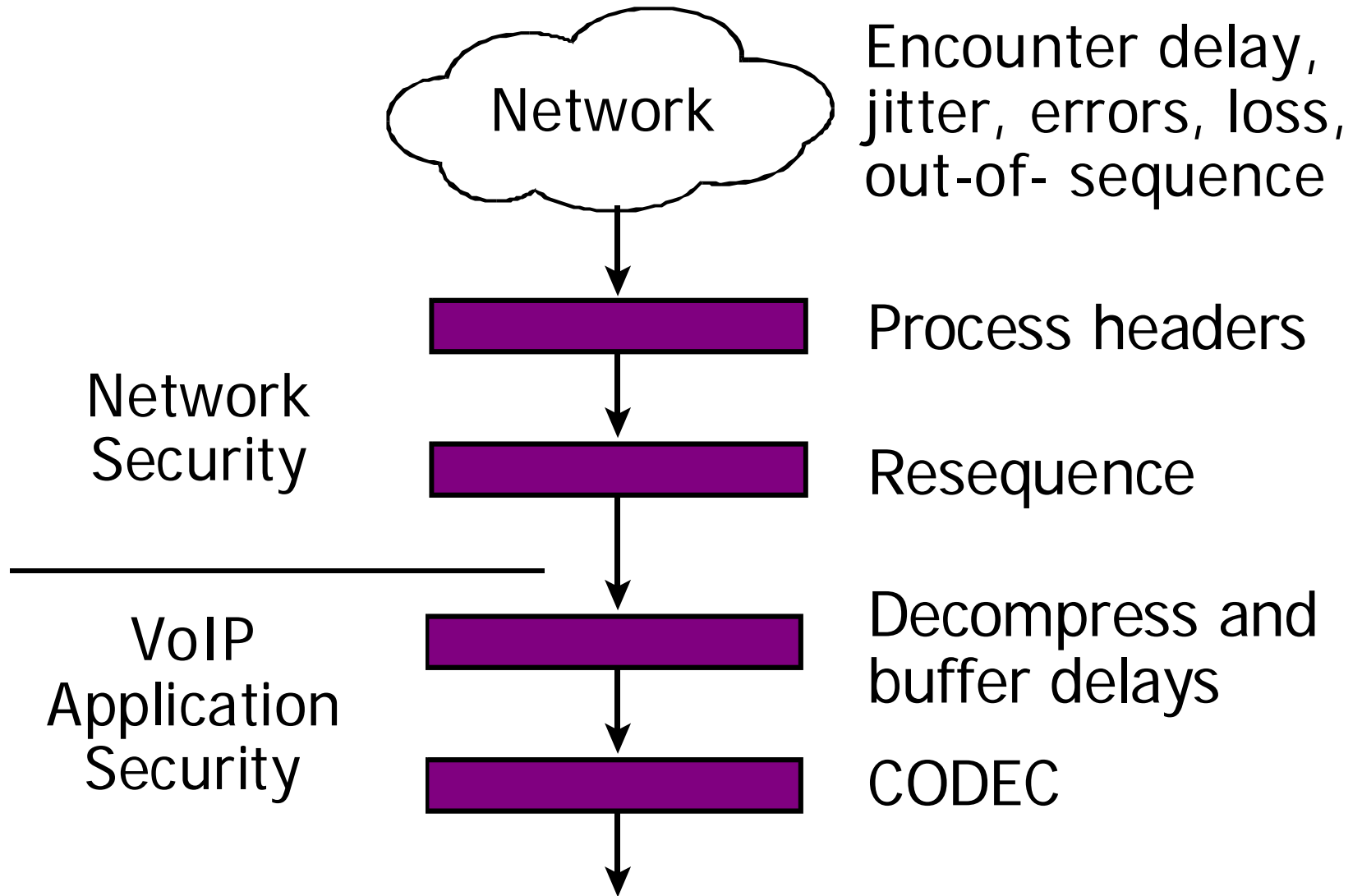
The Protocol Design Security Problem

- Ethernet and IP networks were not designed with integrated security
 - Ethernet, TCP, UDP, and IP Protocols are vulnerable
 - FTP, SMTP, Telnet, HTTP, etc. do not have built-in security features
 - These are peer-to-peer protocols that do not require the intervention of a server

IP Network Security (part 1)



IP Network Security (part 2)



VoIP Security Challenges (part 1)

- Functions/features are installed in products first, then security
- Twice as many IP devices
- Denial of Service attacks disable calls
- Very reliable operation expected (911)
- QoS can conflict with security

VoIP Security Challenges (part 2)

- Multiple signaling standards
- Call quality important
- Network Address Translation (NAT) and Port Number Translation issues
- Longer call latency for encryption
- Dynamic UDP port assignment per call

Server Vulnerabilities

- Issues:
 - Operating system/support software issues
 - Application implementation
 - Application manipulation (toll fraud)
 - Unauthorized administrative access
 - Protocol attacks
 - Denial of Service
- Example:
 - See www.ee.oulu.fi/research/ouspg/protos/testing/c07/sip/

Gateway Vulnerabilities

- DoS against phone gateways
- DoS against trunk gateways
- Toll fraud
- Signaling delays
- Internal/external call blocking
- Viruses, Trojan horses, malware

IP Phone Vulnerabilities

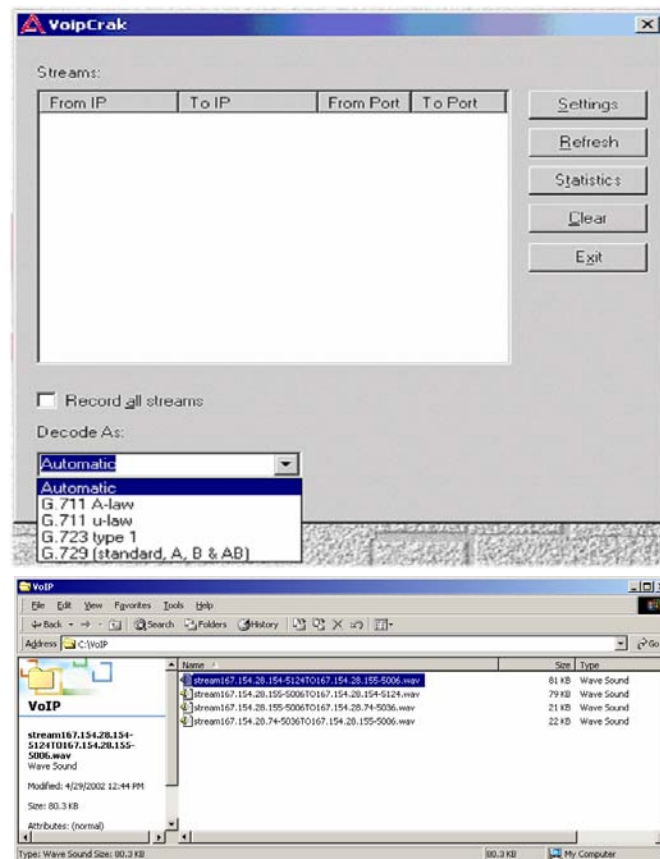
- Issues:
 - Rogue “softphones”
 - Implementation attacks (DoS and access)
 - Simplistic remote access attacks
 - Local access attacks
 - Unauthorized firmware/applications
 - Protocol attacks
 - IP phones are cheap and easy to work with
- For examples:
 - See www.sys-security.com

Malicious Behavior

- Call disconnect floods
- Eavesdropping
- Service denial (DoS)
- Call server bypass
 - Internal P2P calls
 - External gateway calls billed to enterprise
 - Skype is an example

Eavesdropping on Media

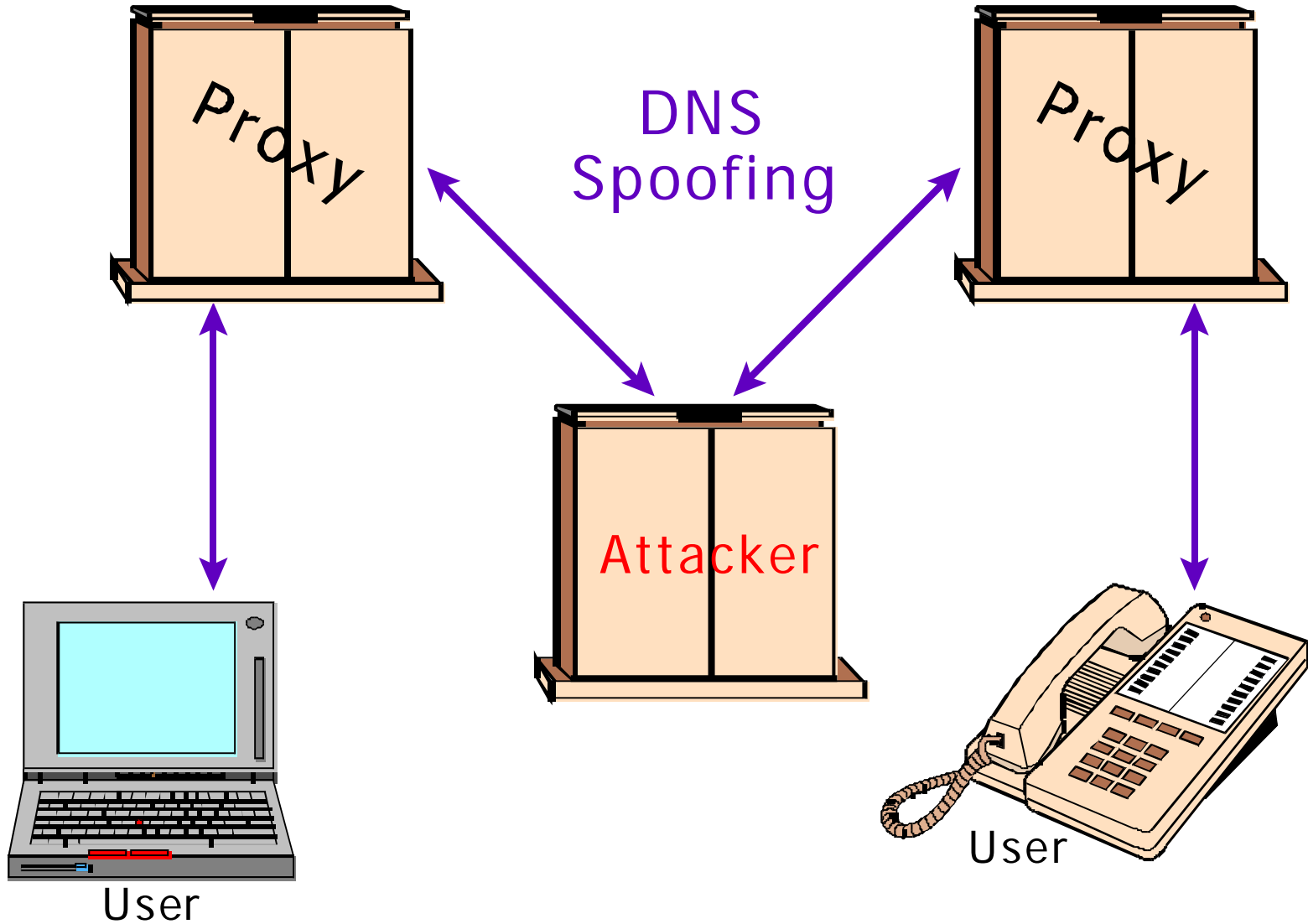
- Vomit
 - Publicly available
 - Decodes G.711 into .WAV
- VoIPCrack
 - Not public
 - Decodes multiple Codecs



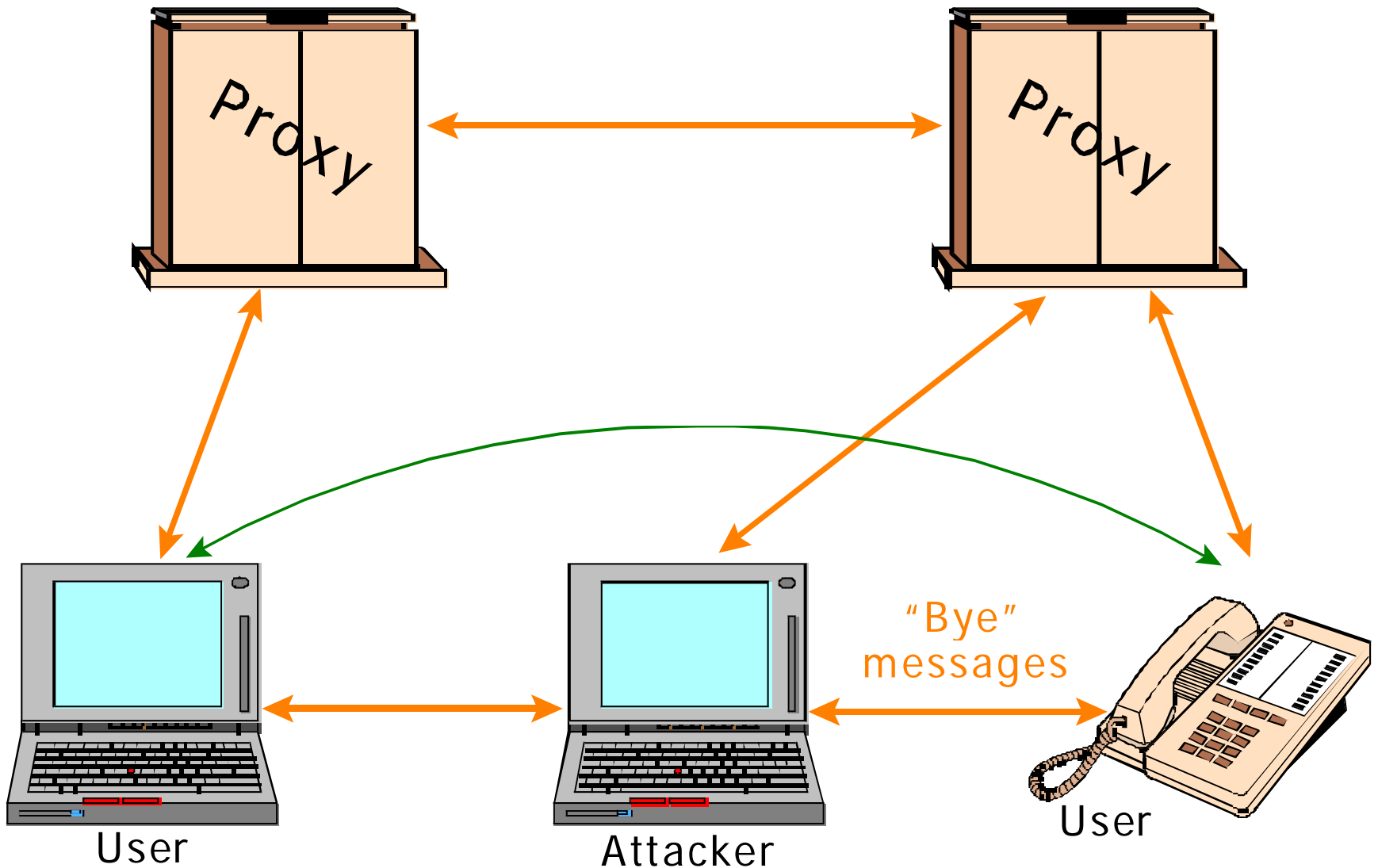
Function/Feature Tampering

- Can be enabled without authorization
- Blockage against caller(s)
- Eliminated for call destination
- Application server blockage
- Spoofing Caller ID

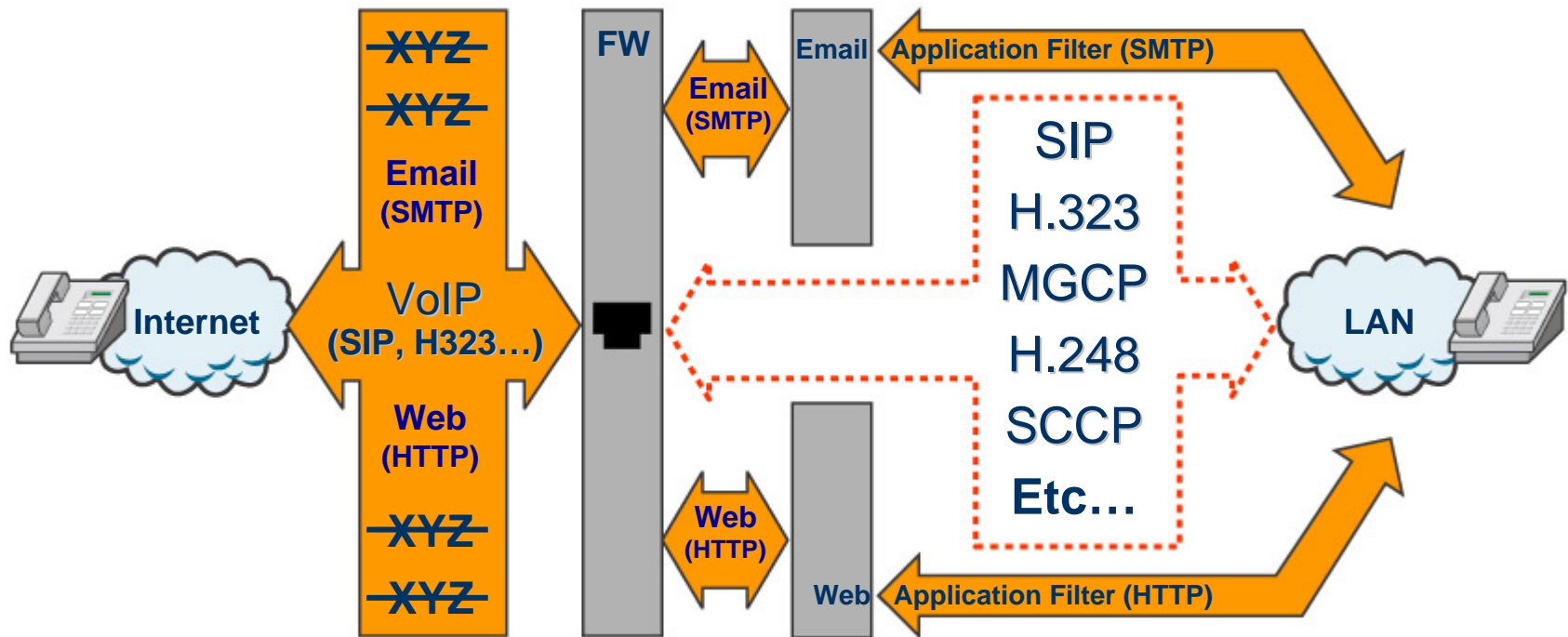
Call Server Impersonation



Session Teardown Flood



Firewall Issues



- Must handle many signaling protocols
- Application aware
- High performance

Courtesy of SecureLogix

Encryption Where?

- Signaling and Control
 - H.323
 - SIP
 - MGCP
 - Proprietary
- Content/Speech
 - Uncompressed
 - Compressed

Recommendations (part 1)

- Secure Voice Servers:
 - Try to use secure platforms (remove services)
 - Secure the operating system/services
 - Maintain patches
 - Use strong authentication for access
 - Separate LAN/VLAN for access
 - Control access by IP Phones and softphones
 - Consider using host-based security
 - Consider deploying a firewall or IDS/IPS

Recommendations (part 2)

- Engineer the Network for Security:
 - Build a switched network
 - Make use of VLANs
 - Secure network components
 - Configure perimeter firewalls to block VoIP
 - Limit the number of calls over media gateways
 - Use encryption over untrusted networks
 - Consider the use of firewalls and NIDS
 - Consider the use of encrypting phones

Safe IP Phones

- Disable unnecessary remote access features
- Update default administrator passwords
- Prevent local IP phone configuration
- Secure firmware upgrade process
- Use IP phones with security features
- Limit use of web server
- Enable logging

Safe Softphones

- As vulnerable as any PC
- Require virus protection
- Must be patched as often as a data PC
- Softphone software has little or no security
- Can be programmed to bypass the Gatekeeper for P2P calls (NetMeeting)
- Can spoof other devices

Section 7



Software Issues

Managing Software

- Operating system
- Applications (features and functions)
- Non telephony applications
- Versions, releases and patches
- Keeping OS and applications coordinated among many sites

What You Don't Know Will...

- Verify the pricing for accuracy
- Keep asking for all costs to be identified
- Get prerequisites defined
- Proposal pricing formats may be hard to compare
- Watch for “and you also need...”
- There is no commodity pricing structure
- Pricing follows data model

The Changing Licensing Scene

- Endpoint (phone, gateway) or user licensing
- Trunk license
- System licensing for the box software
- Seat licensing for messaging, ACD
- Right to use (RTU) licensing for features, functions - survivability, protocols, applications

Network Identity Services

NAMING

DNS

Domain Name System



The network
"Phone Book"
(yahoo.com =
66.94.234.13)

**Needed for
screen
phones, SIP**

ADDRESSING

DHCP

Dynamic Host
Configuration Protocol



Automatically
assigns IP
addresses to
phones

**What about
VLANs,
scope
options**

FILE DELIVERY

TFTP

Trivial File Transfer
Protocol



Provides
firmware and
configs to IP
devices

**Software and
configurations
for IP phones
can change**

TIME

NTP

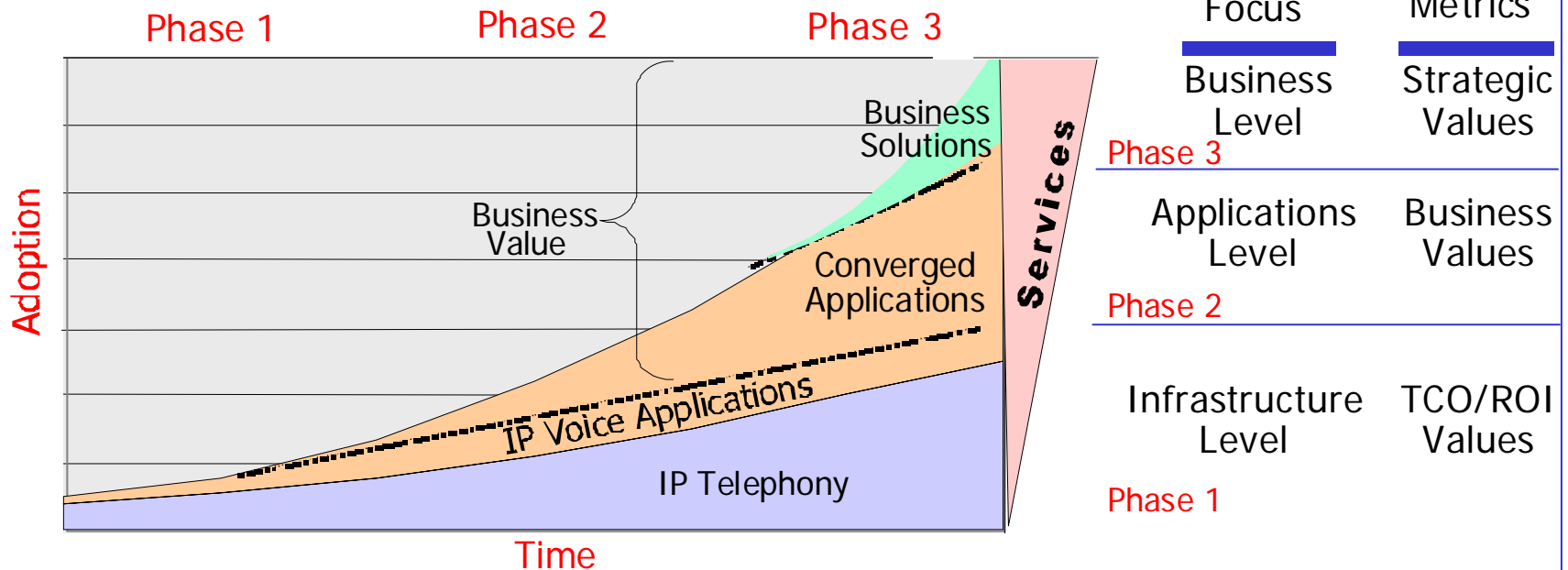
Network Time Protocol

Time clock

**Essential for
TIME!!!**

Converged Applications Residence

IP Telephony and Convergence Evolution



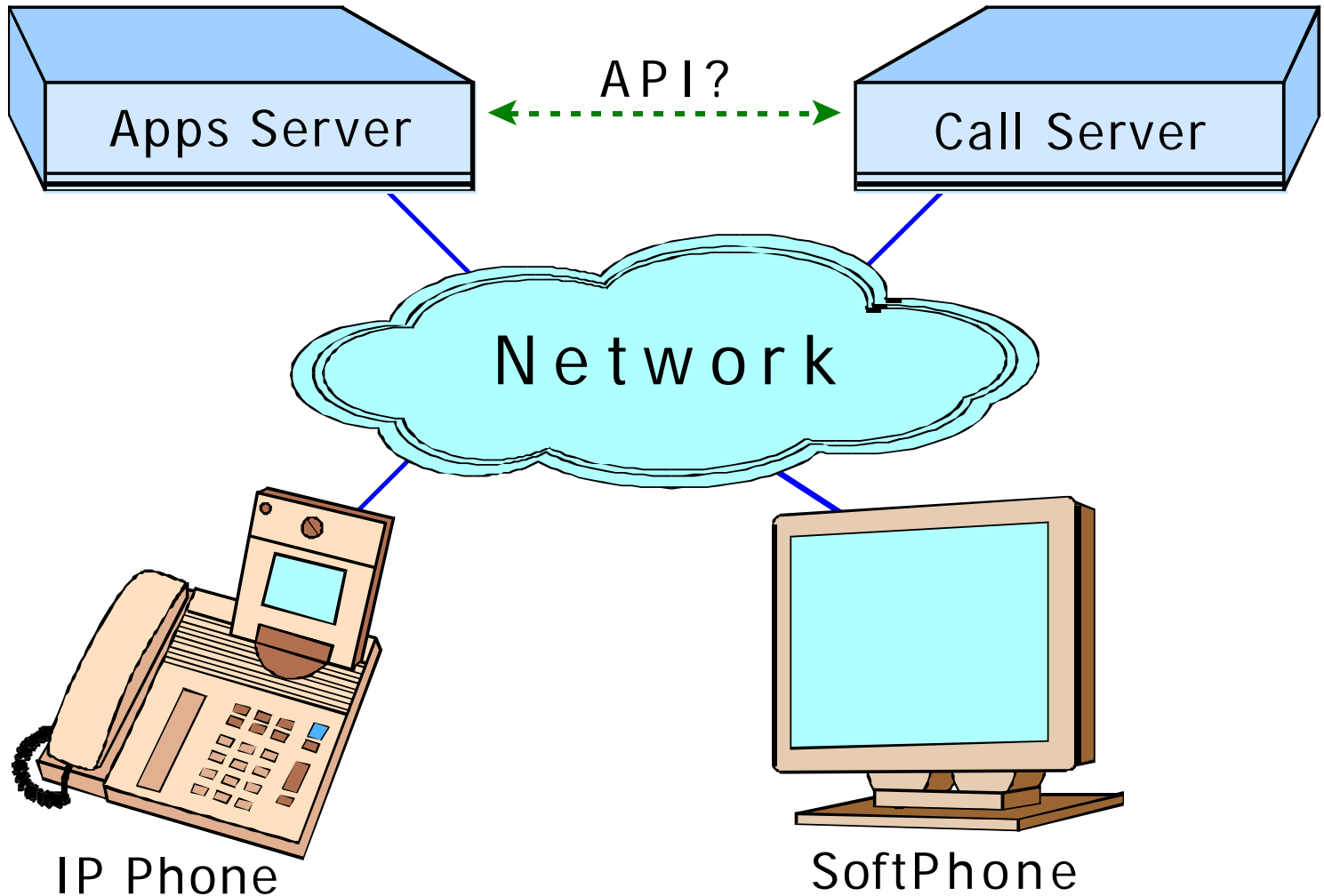
Converged applications can reside almost anywhere.

Courtesy of InfoTech

Applications on Top of VoIP

- Common functions and features of a PBX are not the applications that will be used to justify an IP PBX
- IP PBX vendors are offering new features like Presence and call center functions under the user's control
- New applications will be server based and will probably reside outside the call server
- New applications will probably be produced by third-party software vendors and enterprise organizations
- Applications will be specific to vertical markets

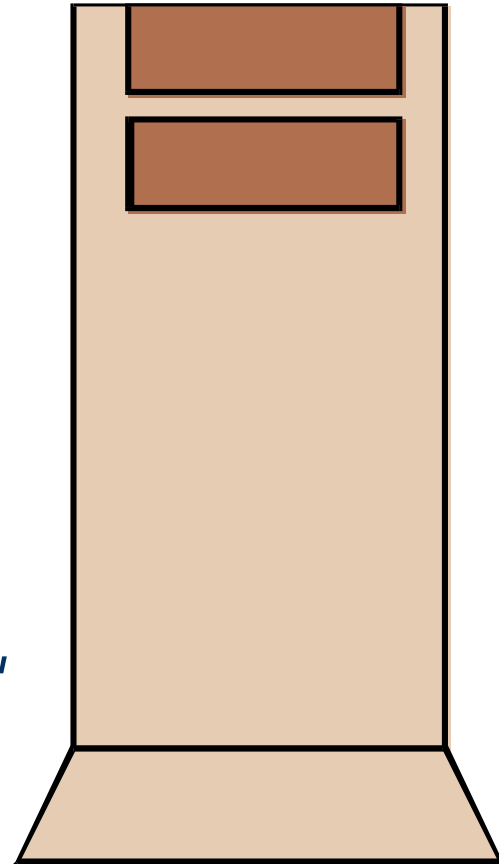
Application Residence



Microsoft Office LCS

(LCS = Live Communications Server)

- Instant messaging
- Buddy list
- Collaboration
- Outlook address books
- Interface with Outlook, WORD, Powerpoint, Excel, SharePoint, OneNote
- Built on desktop / laptop



The Patching Decision

- Enterprises don't patch enough
- Enterprises patch too much
- Viruses infect faster than ever
- Patches don't always work
- Enterprises don't test the patches
- Patches are necessary, but volume is out of control

Section 8

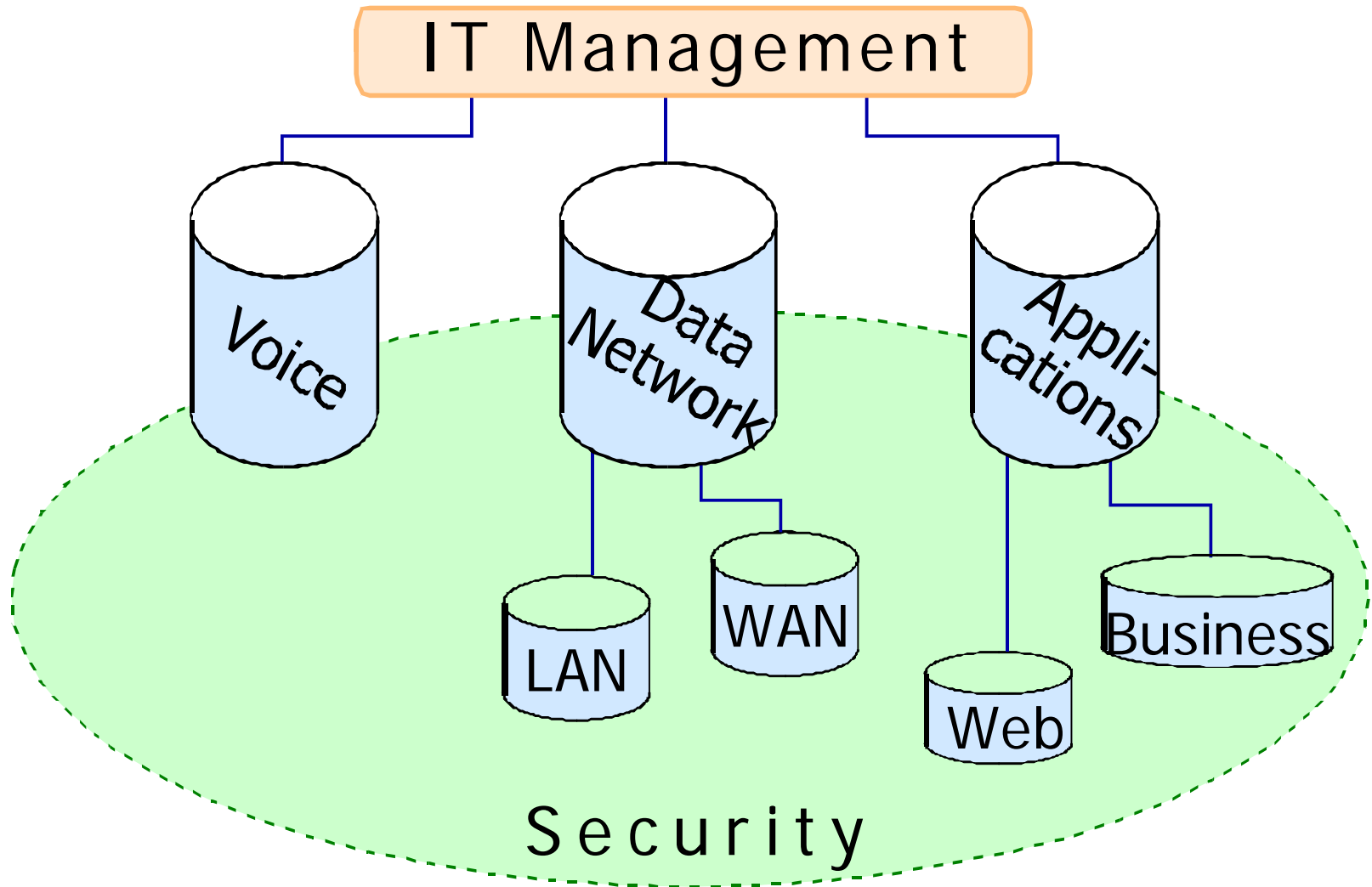


Organizing for IP Telephony

Is IT Ready for Convergence?

- Data vs. voice staff
- Cross training in technologies
- Certifications
- Voice applications support
- Legacy and data network test tools
- Network assessment tools

Information Consolidation (Silo Management)



Enterprise Issues

- Unified management reduces finger pointing
- Different budgeting mind sets
- Quality of service delivery
- Cultural and history differences
- More expensive staff members
- More servers
- Size does matter

New Staff Skills

- Voice learns data
- Data learns voice
- Signaling and speech protocol proficiency
- Basic electricity and circuits for data staff
- More sophisticated tools
- Monitoring more information
- Voice security

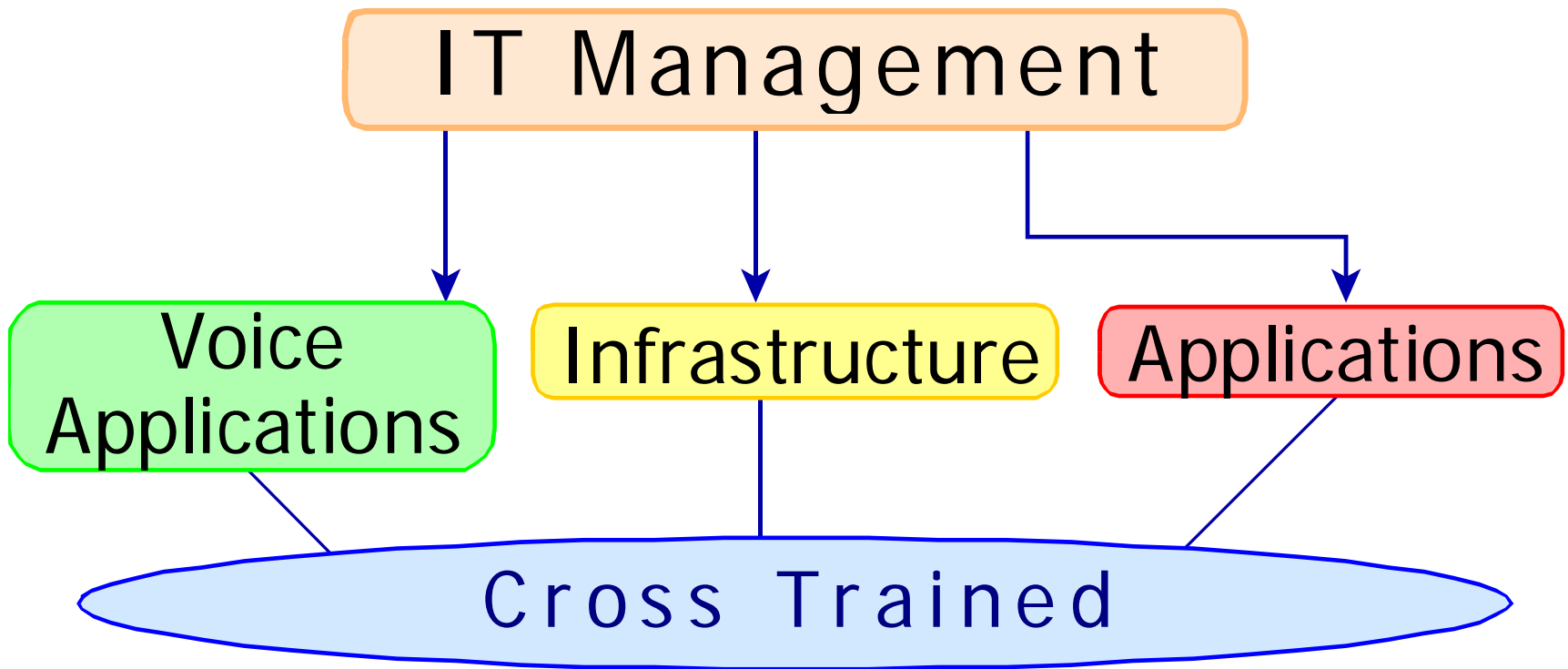
Learning On the Job (Penalties)

- Cost overruns
- Poor planning
- Failed implementation
- Service disruptions
- Dissatisfied users

Certifications

- Applications
- Operating systems
- Infrastructure
- IP Telephony
- Costly to educate
- Higher salaries
- Usually vendor specific

True Staff Convergence



Voice Infrastructure Specialist (1)

- WAN network management
- ***QoS classification, marking, queuing, policing, enforcement***
- ***Voice***/data security
- VLAN administration and management
- ***Power over Ethernet***
- ***Backup power (UPS)***

Voice Infrastructure Specialist (2)

- Cabling (Cat 1-6) and electrical signals
- ***Carrier trunking (T1, PRI, analog)***
- Wireless networks (WLAN, cellular)
- ***Network assessment***
- ***Performance and service level management***

Voice Application Specialist (1)

- Manage all servers (call, V-mail, apps)
- Manage call center (ACD, CTI, VRU)
- ***Support hard IP phones***
- ***Support softphones***
- ***Provide all PBX features and functions***
- ***Support VoIP gateways***

Voice Application Specialist (2)

- *Produce and manage VXML and SALT enabled applications*
- *Call quality monitoring and reporting*
- *Support extension mobility and hoteling*
- *Integrate application servers (Microsoft LCS and....)*