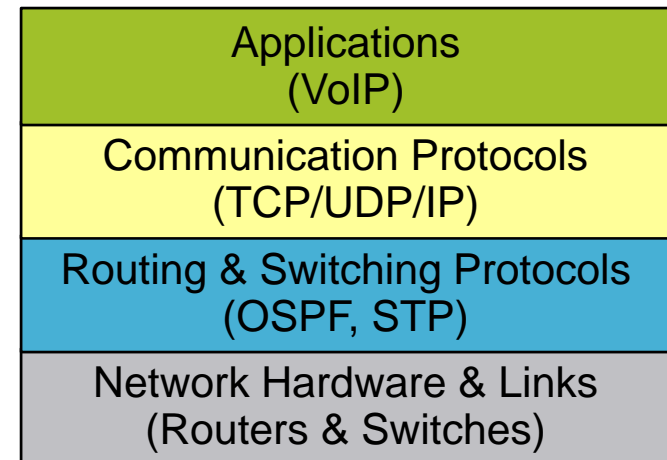


# Troubleshooting VoIP in Converged Networks

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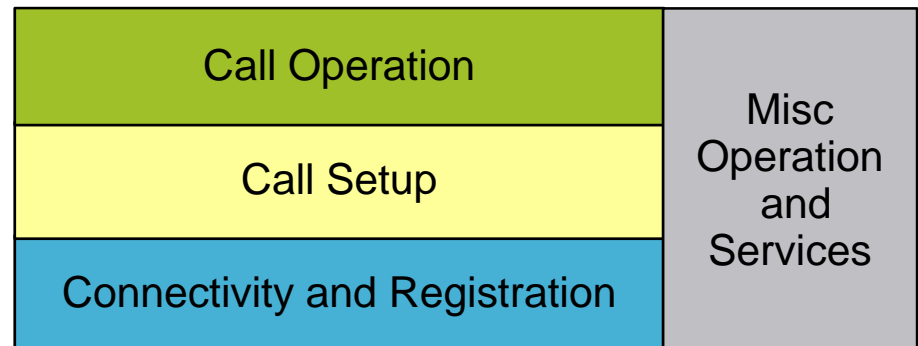
# Objective

- Provide examples of common problems
- Troubleshooting tips
- What to monitor
- Remediation
- Tips you can use in your network



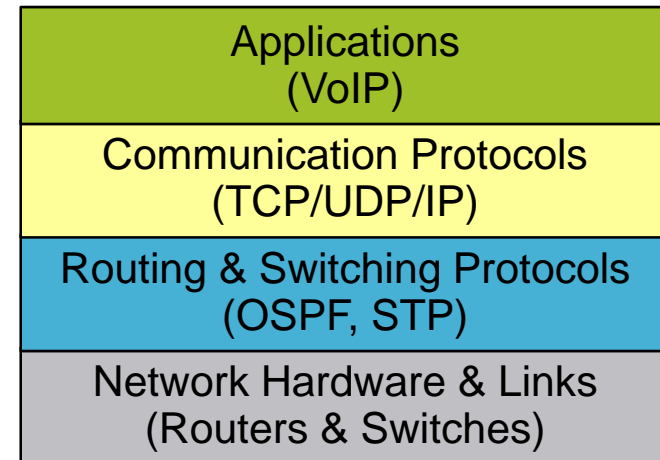
# Troubleshooting Steps

- **Subdivide the problem**
- **Isolate the origin of the problem**
- **Building blocks of VoIP**
  - **Connectivity & Registration**
  - **Call Setup**
  - **Call Operation**
  - **Other Services**



# Complexity of VoIP

- **VoIP depends on proper network configuration and operation**
- **Routing & Switching**
- **TCP & UDP**
- **QoS**
- **Communication with Call Server**
- **Dial Plans**
- **Failures are often due to configuration changes (over 50%)**



# Connectivity - Power

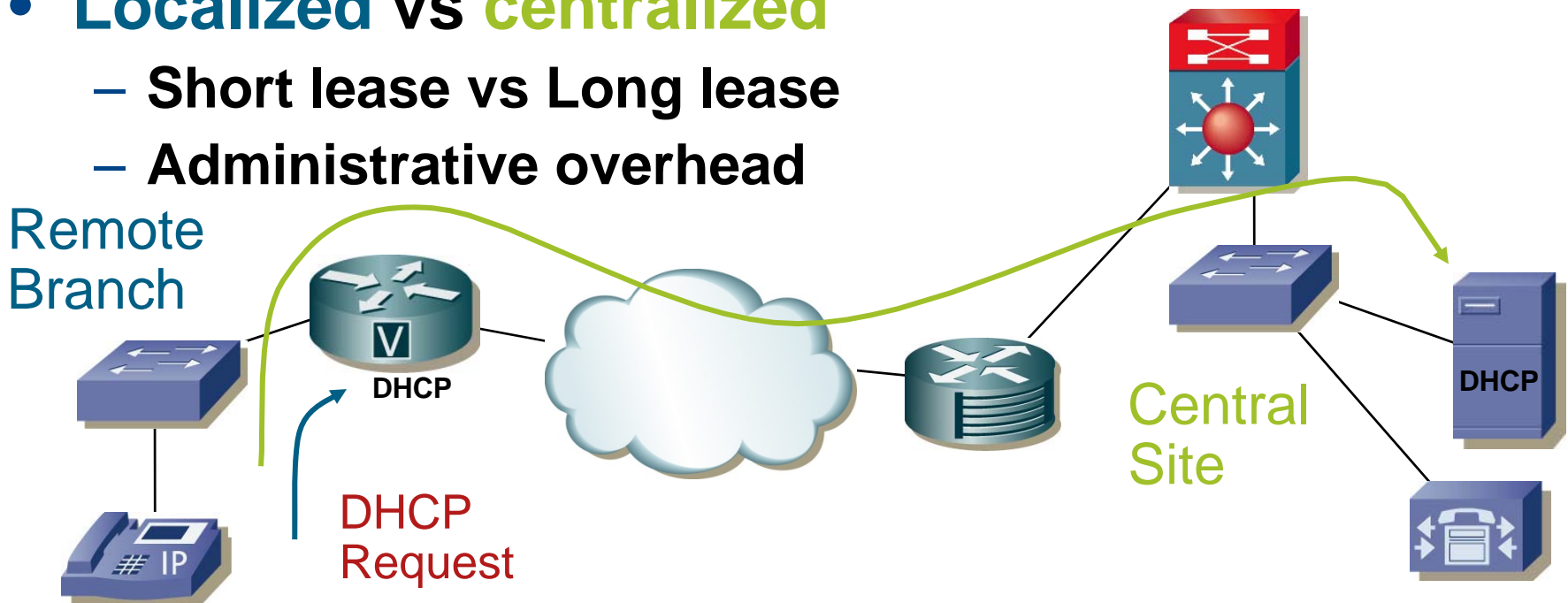
- **PoE problems**
  - Know power supply limits; upgrade when necessary
  - 802.3af may not negotiate with old PoE modules
- **Redundant power supply dies – some interfaces don't get power**
- **Monitor power supplies, utilization, and know limits**
  - Automated tools with thresholds and alerts
  - SNMP Traps on power supply failure and fan failure
- **UPS failures and bad batteries**
  - Monitor UPS operation and battery health

# Connectivity – VLAN

- **Voice VLAN mis-configured**
  - Phone comes up in the wrong VLAN
  - Static configuration on phone (eBay purchase)
  - Switch misconfigured
  
- **No Voice VLAN**
  - Phone connected to data port
  - Switch misconfigured

# Connectivity - DHCP

- Phones don't get a DHCP address
  - Helper address on router to forward DHCP requests to DHCP server
  - No DHCP server in voice VLAN
- **Localized vs centralized**
  - Short lease vs Long lease
  - Administrative overhead



# Connectivity – TFTP

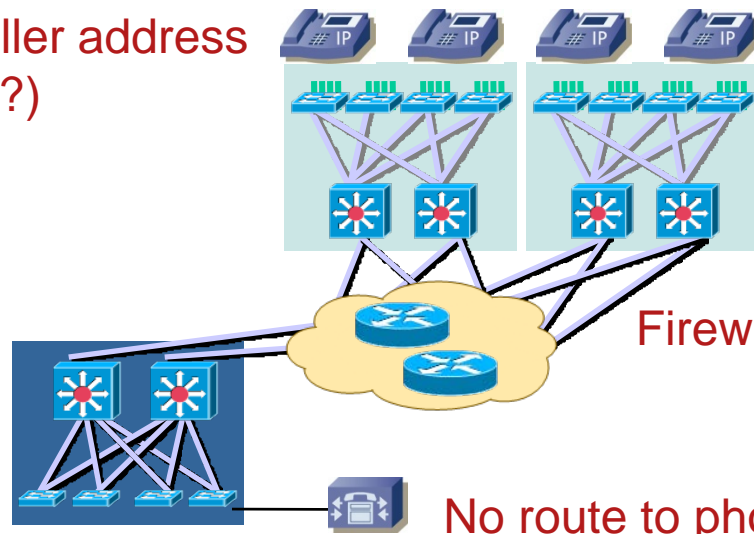
- **TFTP server failure**
  - Not reachable (or return path bad)
  - TFTP fails with long delay or lossy paths
- **Store image and default config on phone**
- **Run the same image everywhere – why fight different bugs?**
- **Long system boot times (due to power outage)**
  - Example: 20 minutes to get all phones working
  - Network infrastructure boot time
  - DHCP/TFTP/Call servers booting, then overloaded
  - Download congestion!

# Registration

- Can't connect to the Call Server
- Uses TCP - Firewalls, ACLs, & Routing
- Phone MAC address wrong in server
- Call Server capacity (after power outages)

Wrong call controller address  
(controller moved?)

No route to call controller

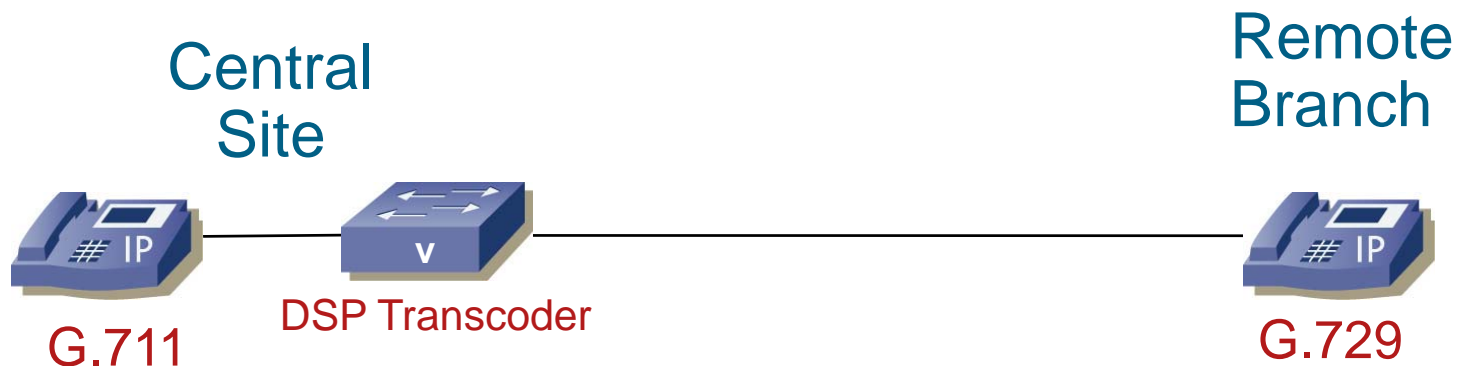


Firewall, ACL, or routing problem

No route to phones

# Call Setup

- Dial plans – improper destination mapping
- Routing problem between endpoints
- DSP required in each direction to match codecs
- Conference call fails – no more DSPs available
  - Monitor DSP pool utilization



# Call Operation - One-Way Audio

- **Firewall or ACL blocking a path**
- **Routing problem (asymmetric paths with ACL)**
- **Two-way, then one-way**
  - Routing or configuration change
  - DSP crash (when transcoding or conference call)
- **Cisco Skinny payload carries IP addr**
  - NAT must know to change the embedded address

# Call Operation - Delay, Jitter, Packet Loss

- **Causes:**

- Inconsistent or no QoS implementation
- Duplex mismatch or bad link
- Routing problems (loss) or multipath (jitter)
- Oversubscribed links (congestion)

G729

Good



60ms Jitter



10% packet loss



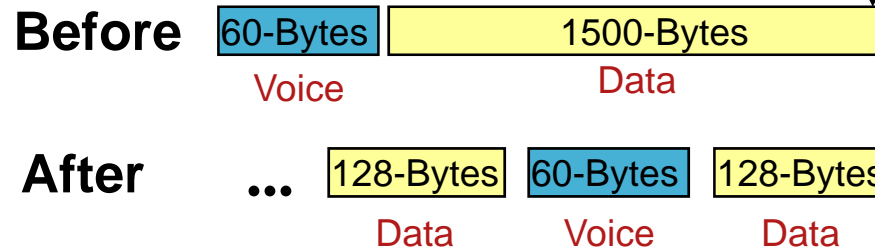
- **Know when it's happening**

- Be able to detect the cause of each problem
- Monitoring depends on vendor
  - RTCP stream (Avaya, Nortel)
  - Call stats on call server (Cisco)

# Call Operation - Jitter

- Per-packet load balancing on multiple paths that have different delays
- Link Fragmentation and Interleaving
  - Big packets delaying voice on low speed interfaces
  - Choose fragment size for delays of about 15 ms

Link Speed	Packet Size (bytes)					
	64	128	256	512	1024	1500
64Kbps	8 ms	16 ms	32 ms	64 ms	128 ms	187 ms
128Kbps	4 ms	8 ms	16 ms	32 ms	64 ms	93 ms
256Kbps	2 ms	4 ms	8 ms	16 ms	32 ms	46 ms
512Kbps	1 ms	2 ms	4 ms	8 ms	16 ms	23 ms
768Kbps	0.6 ms	1.2 ms	2.5 ms	5.1 ms	10.2 ms	15 ms

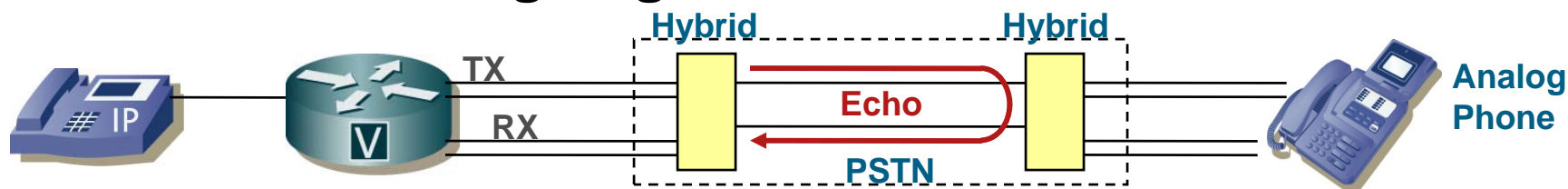


# Call Operation – Packet Loss

- **Duplex mismatch (very common)**
- **Congestion**
  - Incorrect or no QoS configuration
  - Oversubscribed priority queue
    - Designed for 4 concurrent calls
    - Facility expands and 8 concurrent calls occur
    - Policing on priority queue drops excess traffic
  - Monitor QoS queue drops
- **VoIP traffic not properly classified**
  - Dropped when congestion occurs

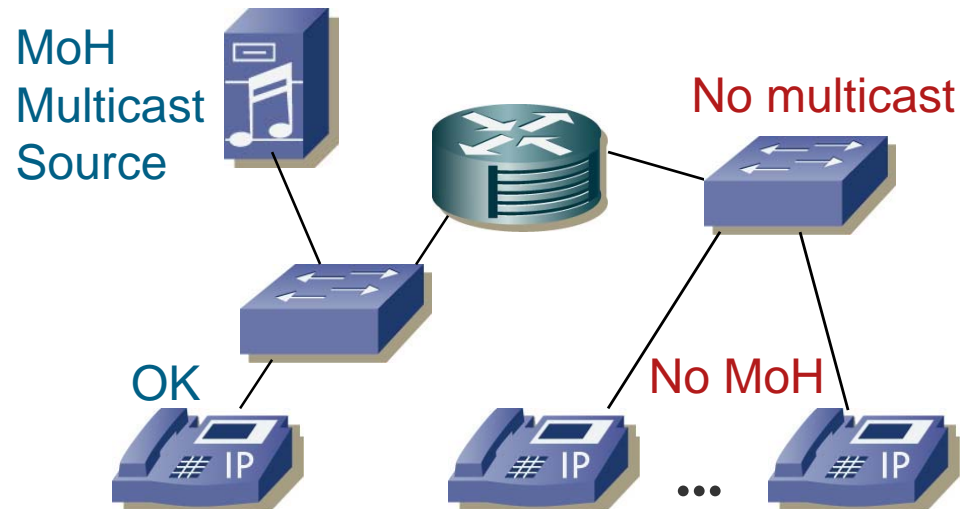
# Call Operation – Echo

- Listener vs talker echo (talker is more frequent)
- Due to signal crossover
- Poor quality phones at the remote site
  - Speaker output is fed back into the microphone
  - Sources: speakerphones, earpieces, cell phones
  - Increase echo cancellation timer
- 4-wire to 2-wire hybrid - electrical coupling
  - Decrease output gain; increase input attenuation
  - DSP transcoding bugs



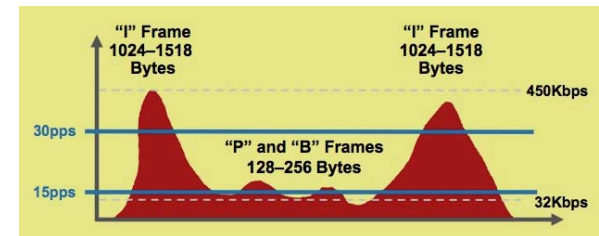
# Other Services – Music on Hold

- **Sporadic Music on Hold**
  - Unicast overload on call server (too many destinations)
  - Inconsistent multicast configuration
- **No Music on Hold**
  - Music on Hold not configured
  - Configuration error



# What about Video?

- **What type:**
  - Streaming or video conferencing?
  - Unicast or Multicast?
  - Primarily dynamic or static? Audio?
- **Like voice: delay, jitter, packet loss**
- **Unlike voice**
  - Dropouts are less important
  - Bursty
- **QoS recommendations**
  - Queue below voice due to burstiness
  - Interactive - DSCP 34 (AF41); Streaming - DSCP 32 (CS4)
  - Allocate video bandwidth + 20%



# Summary

- **The network is the foundation**
- **VoIP is a complex system – many interdependencies**
- **Monitor key parameters with automated tools**
- **Use the Operational Model to subdivide the problem and aid troubleshooting**

