



Customers.
Performance.
Loyalty.



Peer-to-Peer VoIP

Jeff Fried - CTO, Empirix

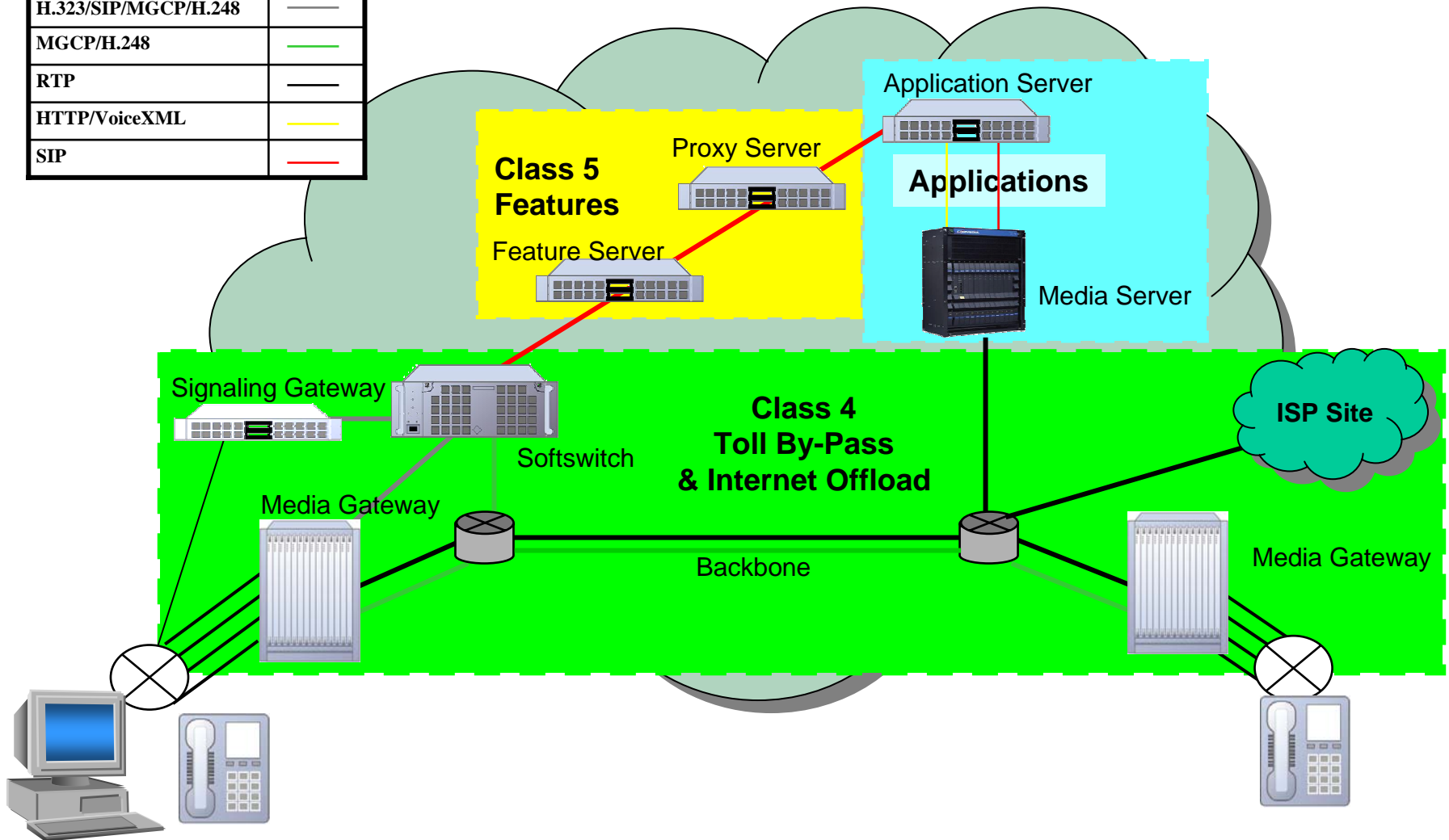
Interop NY 2005

- ⇒ What is peer-to-peer VoIP?
- The quality perspective
- Enterprise VoIP adoption and peer-to-peer
- Network performance implications

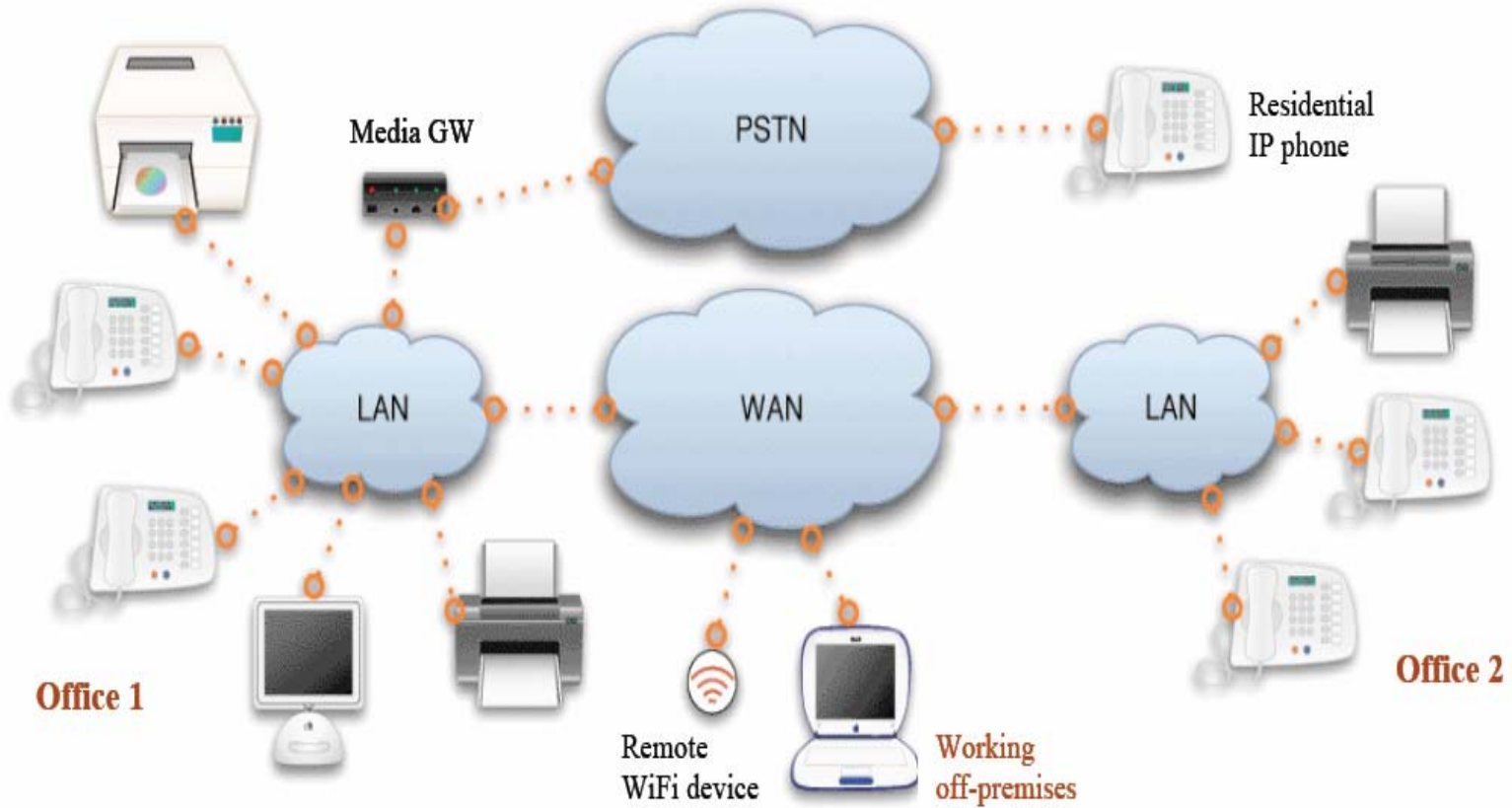
- Experience/analogy with peer-to-peer file-sharing systems: Gnutella, Napster, Kazaa, FastTrack,
 - These have shown great resilience, scalability, and “stickiness”
 - Performance characterization, network impact, and security remain very active “research” areas
- Traditional “Internet telephony” shortcomings
 - Voice Quality
 - Call Completion rates (NAT traversal, directories)
 - Lack of features (messaging, find-me,)
 - General quality, troubleshooting, and support issues

The "Traditional" NextGen Environment Customers. Performance. Loyalty.

| | |
|----------------------|---|
| H.323/SIP/MGCP/H.248 | — |
| MGCP/H.248 | — |
| RTP | — |
| HTTP/VoiceXML | — |
| SIP | — |



Example of Peer-to-Peer Architecture



Source: Peerio, 2005

EXTREMELY RAPID ADOPTION

A variety of systems

- **Skype, Peerio, Liphone, IChat IV, ...**
- **any SIP/H.323 client**

Protocols: some new, some old

- Billing/Mediation (OSP = Open Settlement Protocol)
- Signaling Protocols (Proprietary, SIP, H.323)
- Security (encryption, authentication, signature, secure hash)

Broader than VoIP or IM

Regulatory noise still growing

- CRTC (May 12 decision to regulate VoIP) FCC (public safety and more), ..

- What is peer-to-peer VoIP?
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Quality encompasses most of the “-ities”

- Reliability
- Usability
- Manageability
- Scalability
- Supportability
- Security
- Availability
- Performance
- Extensibility
- Maintainability

these are attributes of a system; they do nothing by themselves

Peer-to-peer VoIP is a “how” rather than a “what”

There are MANY quality implications of peer-to-peer approaches, both positive and negative

Main Quality Focus Areas for VoIP today

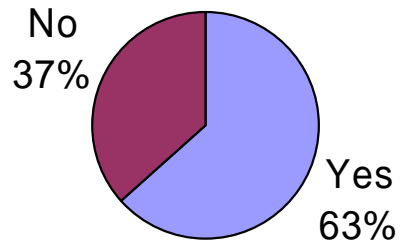
⇒ **Ensuring voice quality**

⇒ **Ensuring that new applications perform smoothly on VoIP infrastructure.**

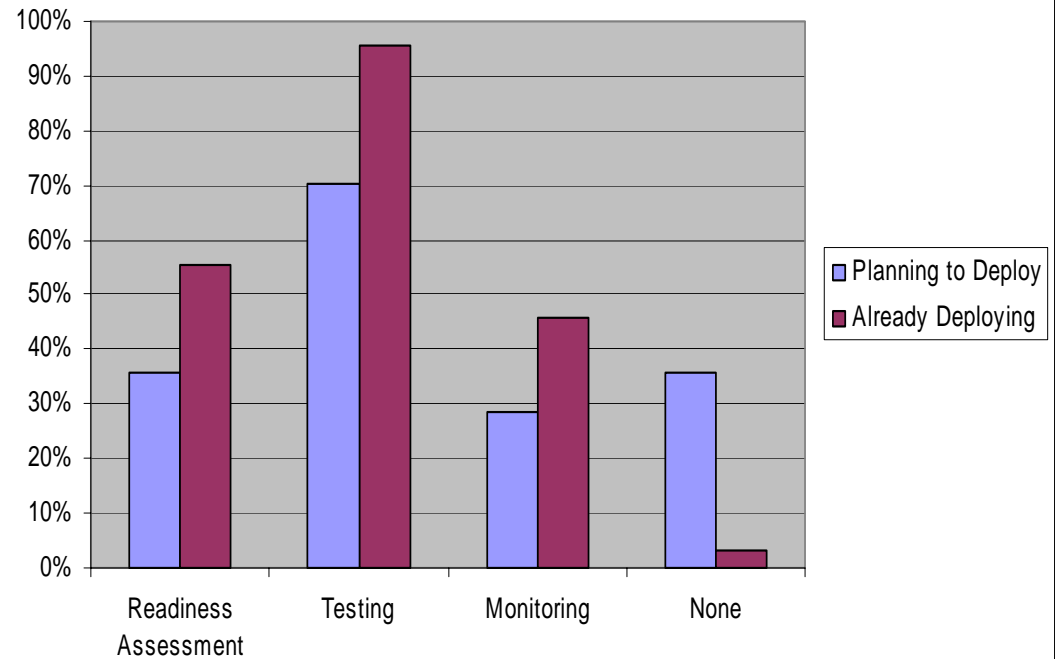
⇒ **Ensuring the ability to troubleshoot**

Are Enterprises ready to deploy VoIP?

Are you concerned about putting a VoIP phone on the CEO's desk?



Quality Assurance Techniques Used or Planned



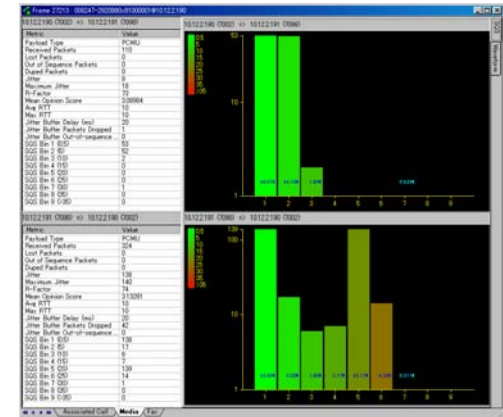
Source: Feb 2005 survey by Empirix, Inc (177 respondents)

Still a critical need for enterprises

- Look at all the metrics of RTP exactly as transmitted on the network
- Understand the end user's experience
- Become proactive about problem prevention

| Metric | Value |
|-----------------------------------|---------|
| Payload Type | PCMU |
| Received Packets | 324 |
| Lost Packets | 0 |
| Out of Sequence Packets | 0 |
| Duped Packets | 0 |
| Jitter | 138 |
| Maximum Jitter | 140 |
| R-Factor | 74 |
| Mean Opinion Score | 3.13281 |
| Avg RTT | 10 |
| Max RTT | 10 |
| Jitter Buffer Delay (ms) | 20 |
| Jitter Buffer Packets Dropped | 42 |
| Jitter Buffer Out-of-sequence ... | 0 |
| SQS Bin 1 (0.5) | 138 |
| SQS Bin 2 (5) | 17 |
| SQS Bin 3 (10) | 6 |
| SQS Bin 4 (15) | 7 |
| SQS Bin 5 (20) | 139 |
| SQS Bin 6 (25) | 14 |
| SQS Bin 7 (30) | 1 |
| SQS Bin 8 (35) | 0 |

- Packet Loss ?
- Jitter?
- Delay ?
- Voice Quality?
- MOS and R-Factor



Jitter distribution graph

Measurement is critical for problem resolution

Peer to Peer “quality attributes”

Inherent advantages

- Availability/Robustness
- Scalability

Inherent disadvantages

- Manageability
- Supportability

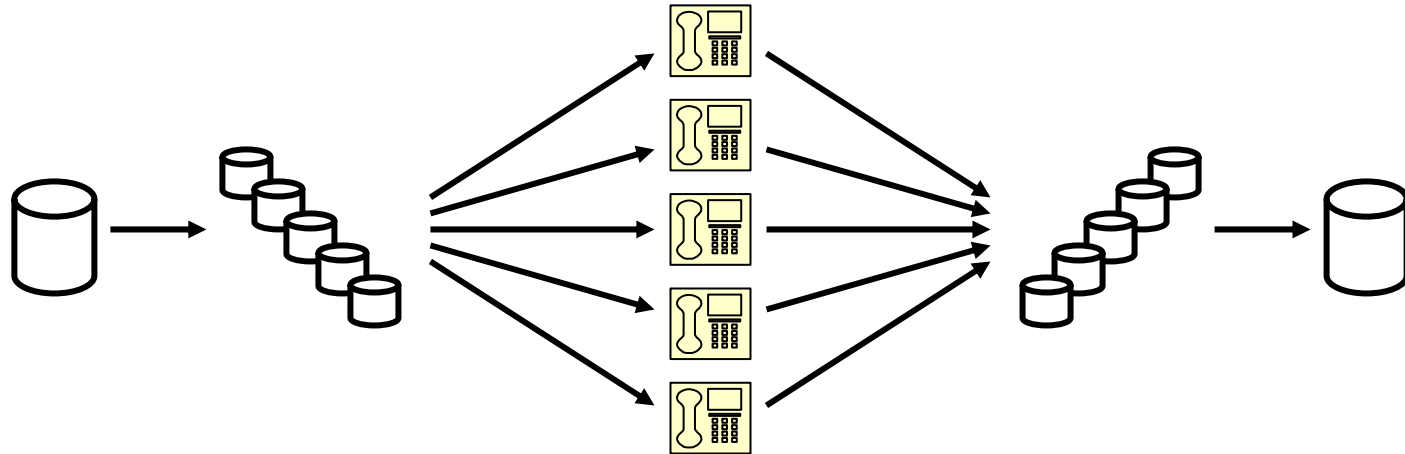
Current strengths

- Usability
- Extensibility

Current challenges

- Security
- Performance

P2P Serverless Network Operation:

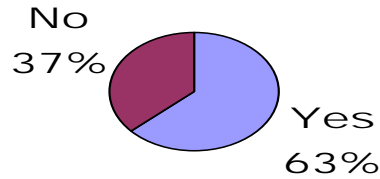


- Files are split into segments
- Encrypted segments are placed on nodes in the network
- Back-up copies are made and maintained
- Algorithms allow any device to rebuild the file instantly
- Files can be voice mail, user admin information, call detail, etc.
- Nodes can be phones, PC's, PDA's, cell phones, gateways, etc.
- No single point of failure / bottleneck
- No extra hardware costs or maintenance

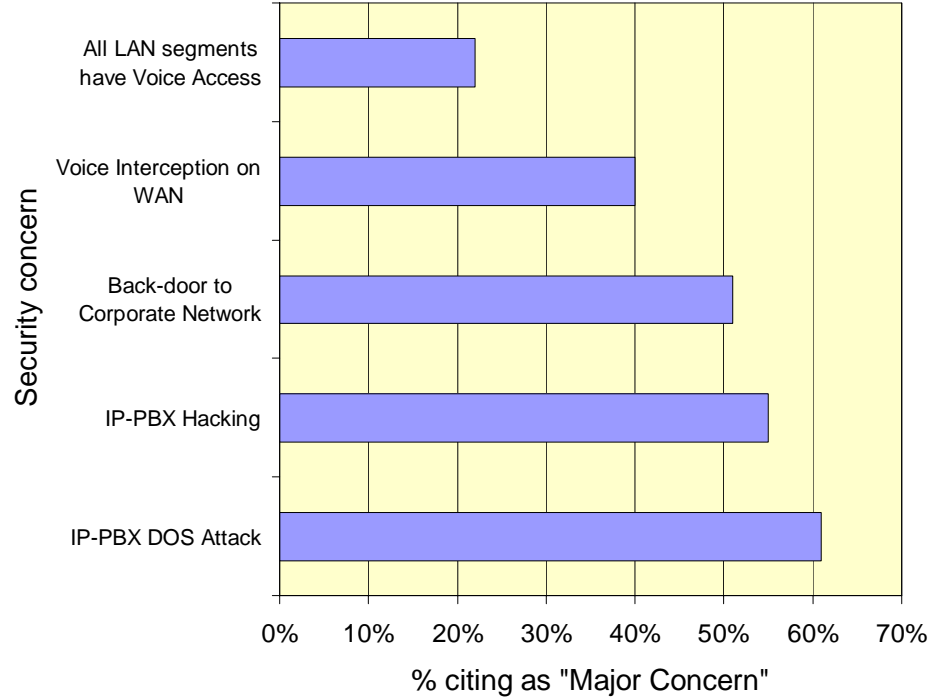
- Theoretically can be more secure than server-based systems
- Practically, there are lots of challenges
 - Bugs e.g. skype buffer overflow malformed URLs for URI types `callto://` and `skype://` and on “malicious” VCARD import
 - Impersonation e.g. can be “supernode” without consent
- Tunnel through firewalls
- No central control; hard to isolate and disable

Concerns don't match preparedness

Are you concerned about putting a VoIP phone on the CEO's desk?

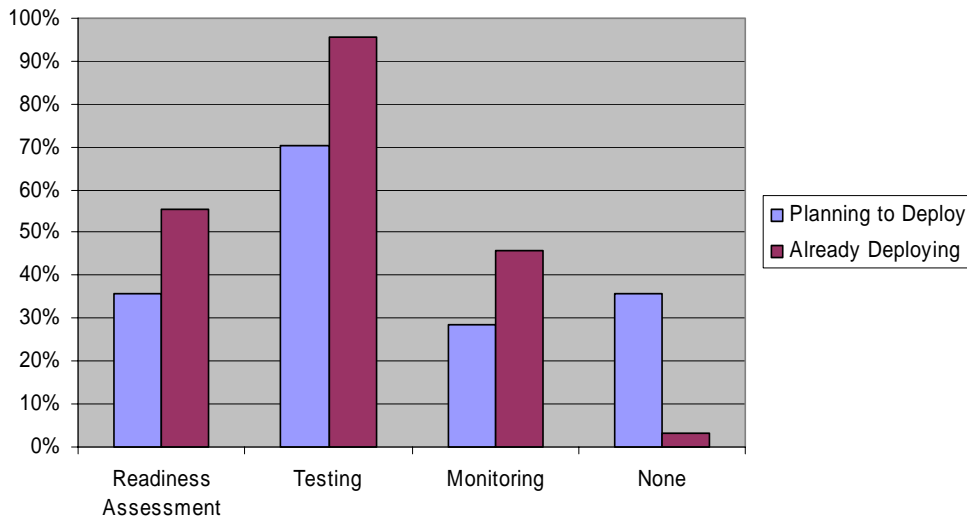


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Source: Webtorials "State of the VoIP Market" 10/04

Quality Assurance Techniques Used or Planned



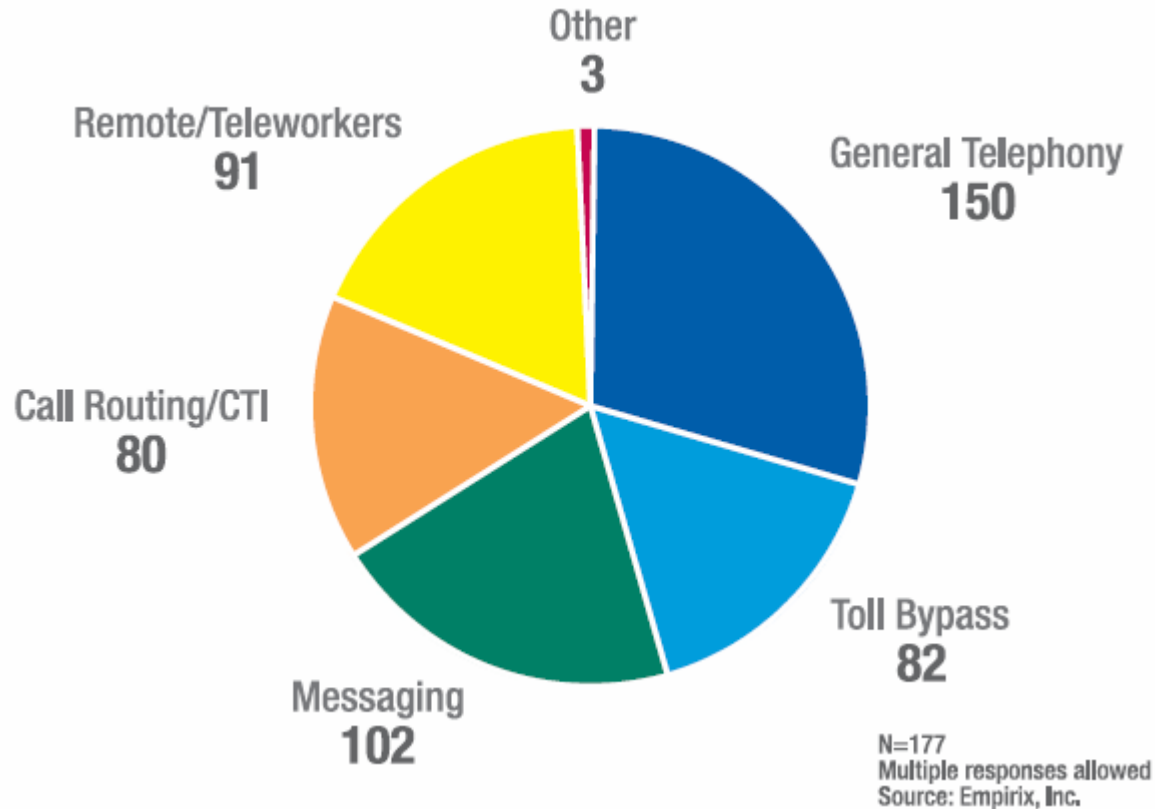
- NIST – National Institute of Standards and Technology
 - Publication 800-58: “Security Considerations for VoIP Systems”

- VoIPSA – Voice over IP Security Alliance
 - Promoting education & awareness, research, testing methodologies & tools
 - Extensive membership: vendors, VoIP providers, researchers, Security Vendors, Test tool vendors
 - First two projects: threat taxonomy, security requirements
 - www.voipsa.org

- PROTOS group - University of Oulu in Finland
 - Using Protocol Fuzzing to discover a wide variety of DOS and Buffer Overflow vulnerabilities
 - Have exposed HTTP, LDAP, SNMP, WAP, and VoIP vulnerabilities
 - Commercial H.323 and SIP implementations vulnerable
 - www.ee.oulu.fi/research/ouspg/protos/index.html

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Applications are Driving VoIP Deployments



Top VoIP Applications cited:

- VoiceMail/Unified Messaging
- Remote/Teleworkers
- Call Routing/CTI
- Conferencing
- Call handling/forwarding
- Integrated Contact center application
- Call log
- Directory lookup
- Find me/follow me
- Meeting scheduler
- Customer service alerts
- Video conferencing
- Emergency lookup
- Personal calendar
- Instant messaging

Availability

- No dial tone, no ringing, busy signal, abnormal termination
- Telephony (IP-PBX, Speech/IVR) and network (DNS, DHCP) servers

Call Setup Performance

- Initial perception of the calling services
- Dial tone response time: 2-3 seconds maximum
- Call setup: 2.5 seconds maximum – same as PSTN

Voice Quality

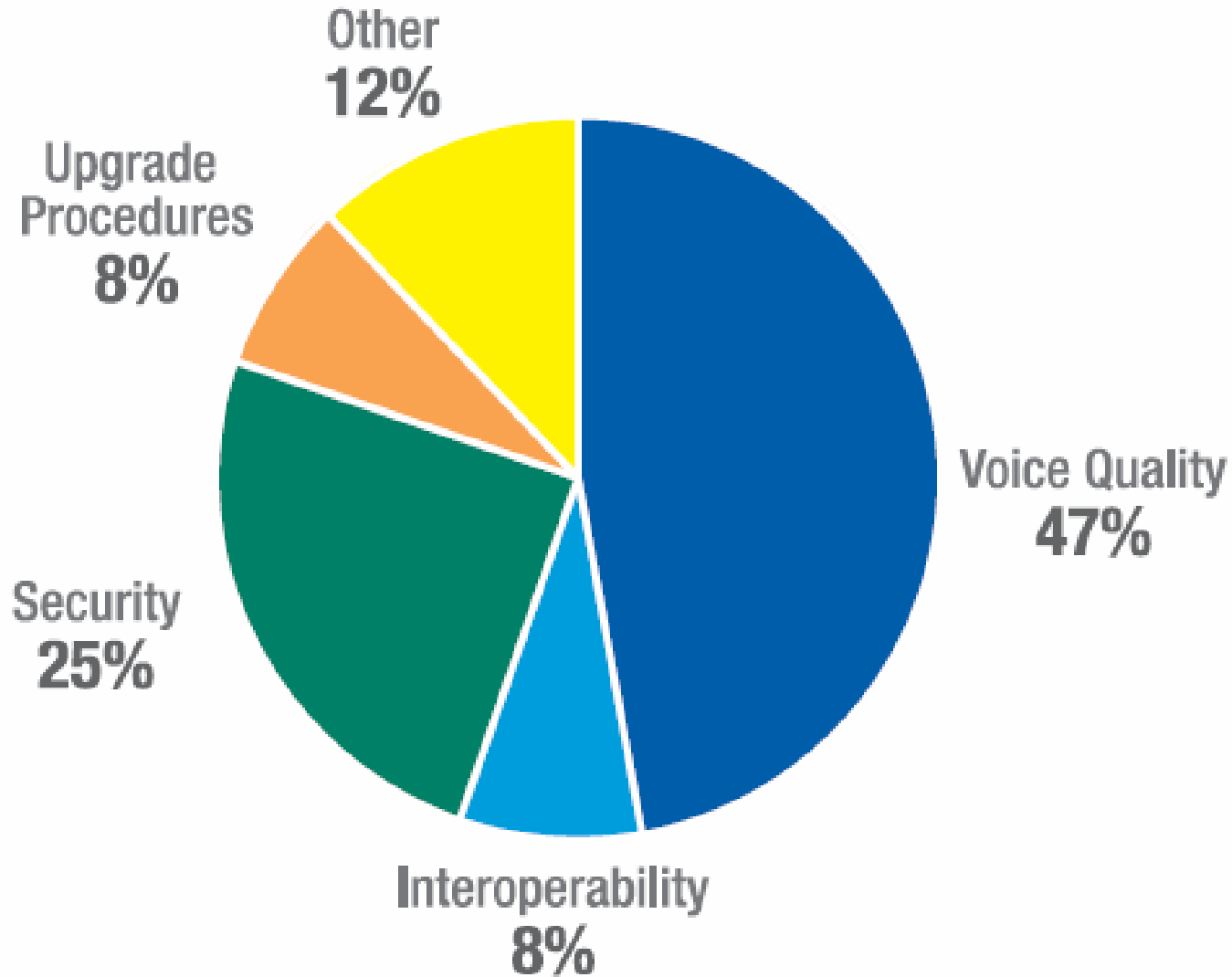
- Volume vs. Compression vs. Score
- Network Delays (150ms), Jitter (40ms), Packet Loss (0.5%)

Voice Application Performance

- Quality of Experience for key transactions
- IP Servers processing RTP voice streams
- Impact on data network services (and vice versa)

- Signaling latency (speed of dial tone, speed of call transfer, etc.),
- Reliability of application information delivery (screen pops, information elements use for routing, etc.),
- Application performance (IVR responsiveness, Application performance under load, etc.)
- Impact of VoIP on applications (speech recognition accuracy with packet loss, conference bridge loudest-speaker detection, etc.)
- All-paths testing (correct configuration of all forwarding, hunting, routing, voicemail and messaging configuration, etc.)

Top Quality Concerns about VoIP Implementations



Source: Empirix, Inc.

Inter-Office Link Testing

- Voice Quality versus bandwidth, QoS, Codecs,
- Ongoing testing to proactively combat “network atrophy”

Interoperability and Migration

- TDM-to-VoIP, multivendor (QSIG over VoIP, etc...)

Business Resilience

- Failover testing (SRST), Load Balancing, PSTN backup tests

Be ready for these activities

- Determine how much VoIP traffic the network can handle without degrading voice quality
- Find configuration and interoperability errors in networks and VoIP equipment
- Detect and troubleshoot interoperability issues
- Find performance bottlenecks and resource problems
- Trap and troubleshoot difficult and intermittent problems impacting application functionality and voice quality
- Tune speech applications for best performance
- Ensure that service provided by offshore or outsourced facilities is as good or better as locally provided service

What is different about Peer-to-Peer VoIP w.r.t. Enterprise VoIP Rollouts?

- Many factors for enterprise rollouts are exactly the same
- The “consumer groundswell” means that p2p VoIP will be there in addition to traditional VoIP
- Versions + configurations are very fluid
- In many ways, akin to the way sticky personal desktop applications impact enterprise IT groups

SurfControl's Global Threat Center Guidelines

- Create and enforce an Acceptable Use Policy (AUP) for Desktop VoIP.
- Standardize on Desktop VoIP applications that will be supported on the corporate network.
- Create security policies governing the downloading of any application onto corporate desktops, including Desktop VoIP clients.
- Establish a layered security model that operates at the gateway, on the network, and on the desktop.
- Use security technologies to ensure the optimum threat protection including the ability to prevent unwanted desktop VoIP applications from installing on the desktop, the ability to create customizable threat signatures and the proactive monitoring and reporting of Desktop VoIP usage on the network.
- Provide ongoing education to users regarding the potential dangers of desktop VoIP systems.

 Previous generations of peer-to-peer systems did not in fact create major security issues

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What's the effect of P2P VoIP systems on network performance?

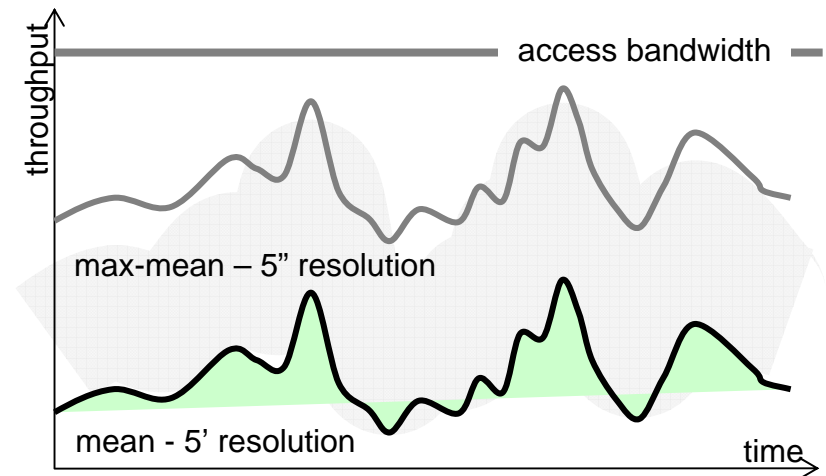
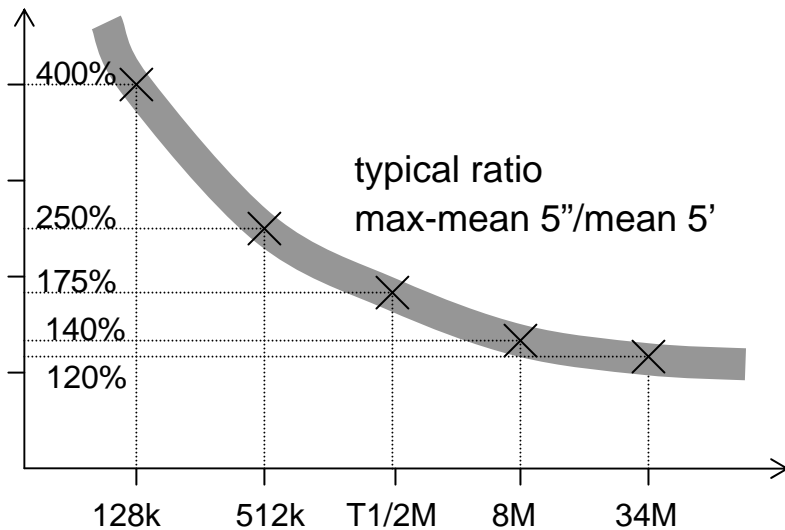
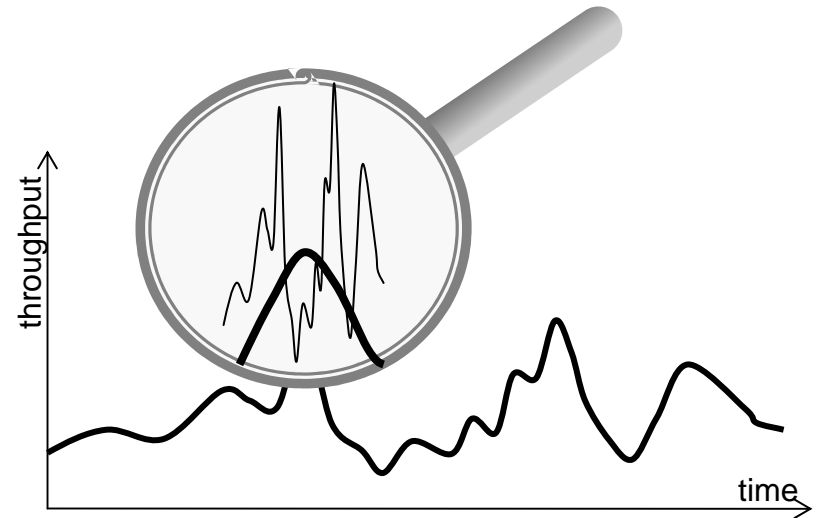
- Early generation P2P systems used “broadcast” (multicast) communications between peers which *did* affect network performance adversely

- Newer P2P systems use better techniques to reduce detrimental effects of P2P telephony
 - Distributed Hash Tables
 - More efficient peer identification systems

- We're not out of the woods yet!

Networks exhibit micro-congestion

- Traffic pattern is fractal (self replicating) over all time scales, including micro scale - see <http://portal.acm.org/citation.cfm?doid=178221.178222>
- Micro-congestions due to packet and session multiplexing are unpredictable
- Extra-bandwidth must be provisioned to protect critical application



Network Activity Analysis

Hammer XMS - Analysis - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

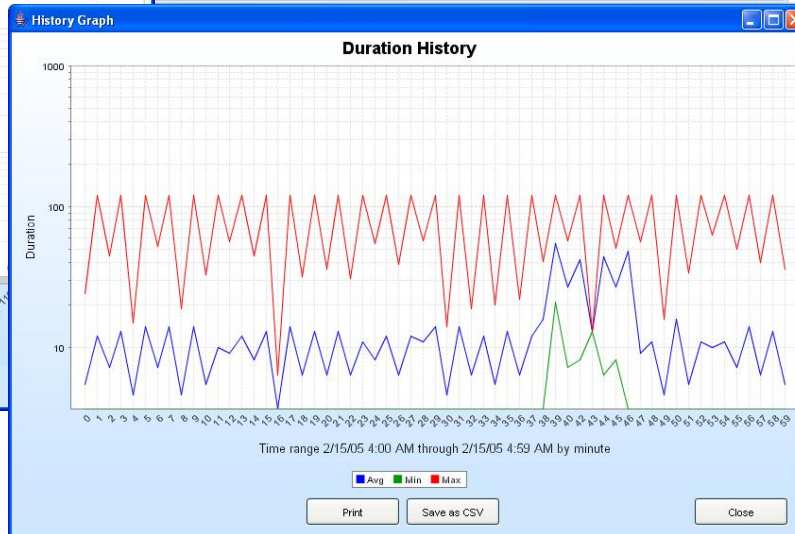
http://10.16.82.19/Monitor/CallQAnalysis.jsp

My Yahoo! Weather Ebay 1.2 XMS Yahoo! Mail HMO Drill Down

Home
Diagnostics
Reports
Administration
Help
Logout

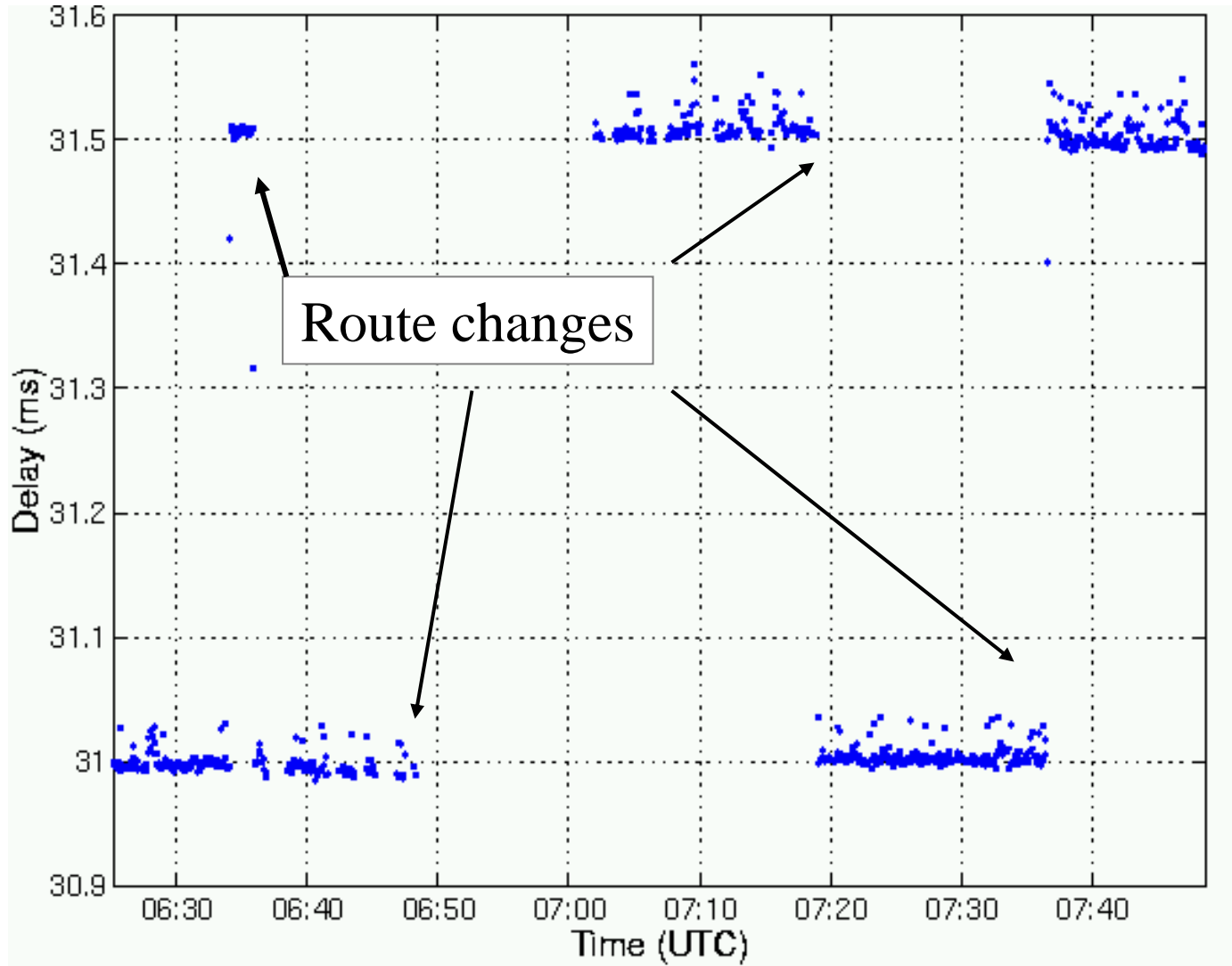
Call Detail Summary- Analysis for Feb 15, 2005

| Hour | Atmpt Calls | Seize Ratio | Comp Calls | Failed | % Failed | Calls/Sec | Dur-Avg | Dur-Min | Dur-Max | PPD-Avg | PPD-Min | PPD-Max | Con-Avg | Con-Min |
|------------------------------|-------------|-------------|------------|--------|----------|-----------|---------|---------|---------|---------|---------|---------|---------|---------|
| Tue Feb 15 00:00:00 EST 2005 | 931 | 99 | 930 | 11 | 1 | 0 | 11 | 3 | 120 | 9 | 7 | 90 | 12 | 7 |
| Tue Feb 15 01:00:00 EST 2005 | 800 | 98 | 801 | 12 | 2 | 0 | 12 | 3 | 120 | 9 | 7 | 107 | 12 | 8 |
| Tue Feb 15 02:00:00 EST 2005 | 930 | 98 | 931 | 14 | 2 | 0 | 11 | 3 | 120 | 9 | 7 | 90 | 11 | 7 |
| Tue Feb 15 03:00:00 EST 2005 | 898 | 99 | 896 | 9 | 1 | 0 | 10 | 3 | 120 | 9 | 7 | 71 | 10 | 8 |
| Tue Feb 15 04:00:00 EST 2005 | 874 | 99 | 875 | 5 | 1 | 0 | 10 | 3 | 120 | 10 | 7 | 111 | 11 | 8 |
| Tue Feb 15 05:00:00 EST 2005 | 813 | 99 | 813 | 8 | 1 | 0 | 11 | 3 | 120 | 9 | 7 | 54 | 11 | 8 |
| Tue Feb 15 06:00:00 EST 2005 | 772 | 99 | 772 | 6 | 1 | 0 | 12 | 3 | 120 | 8 | 7 | 32 | 10 | 7 |
| Tue Feb 15 07:00:00 EST 2005 | 1049 | 98 | 1047 | 23 | 2 | 0 | 12 | 3 | 120 | 9 | 7 | 113 | 12 | 2 |
| Tue Feb 15 08:00:00 EST 2005 | 1276 | 98 | 1276 | 22 | 2 | 0 | 9 | 3 | 63 | 9 | 7 | 104 | 12 | 6 |
| Tue Feb 15 09:00:00 EST 2005 | 1143 | 98 | 1113 | 23 | 2 | 0 | 10 | 3 | 63 | 9 | 7 | 64 | 12 | 7 |
| Tue Feb 15 10:00:00 EST 2005 | 1057 | 22 | 2 | 0 | 11 | 3 | 63 | 9 | 7 | 81 | 12 | 8 | | |
| Tue Feb 15 11:00:00 EST 2005 | 1310 | 26 | 2 | 0 | 12 | 3 | 120 | 9 | 7 | 84 | 12 | 7 | | |
| Tue Feb 15 12:00:00 EST 2005 | 1261 | 40 | 3 | 0 | 13 | 3 | 120 | 9 | 7 | 93 | 12 | 6 | | |
| Tue Feb 15 13:00:00 EST 2005 | 1351 | 43 | 3 | 0 | 12 | 3 | 120 | 9 | 7 | 112 | 12 | 7 | | |
| Tue Feb 15 14:00:00 EST 2005 | 1024 | 37 | 4 | 0 | 12 | 3 | 62 | 9 | 7 | 103 | 13 | 8 | | |
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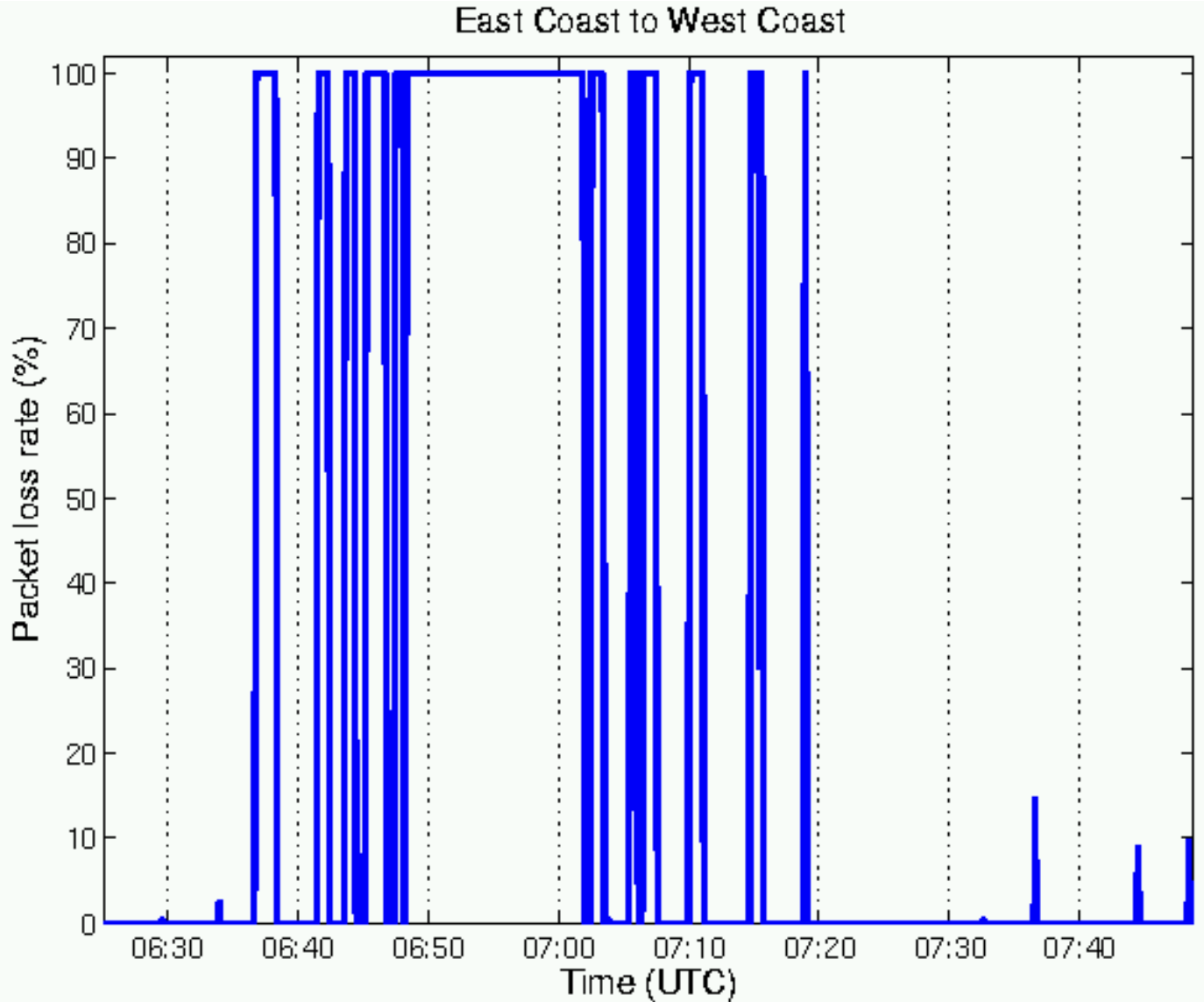


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Delay from Route Changes



Loss from Route Changes



- Not “ready for prime time”, but coming anyway
- Many quality implications
 - “Unknowns” are to be expected & managed (can’t be avoided)
 - Security threats are real, so consider them now
- Does not change many of the challenges for Enterprise VoIP deployment
 - Still need to plan, test, troubleshoot, manage,
- Combination of peer-to-peer characteristics and low latency needs of VoIP will make network management tricky with significant p2p VoIP traffic

Thank you!

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Thank You!