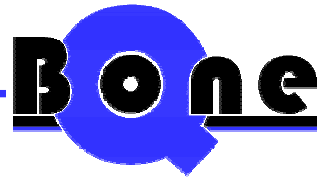
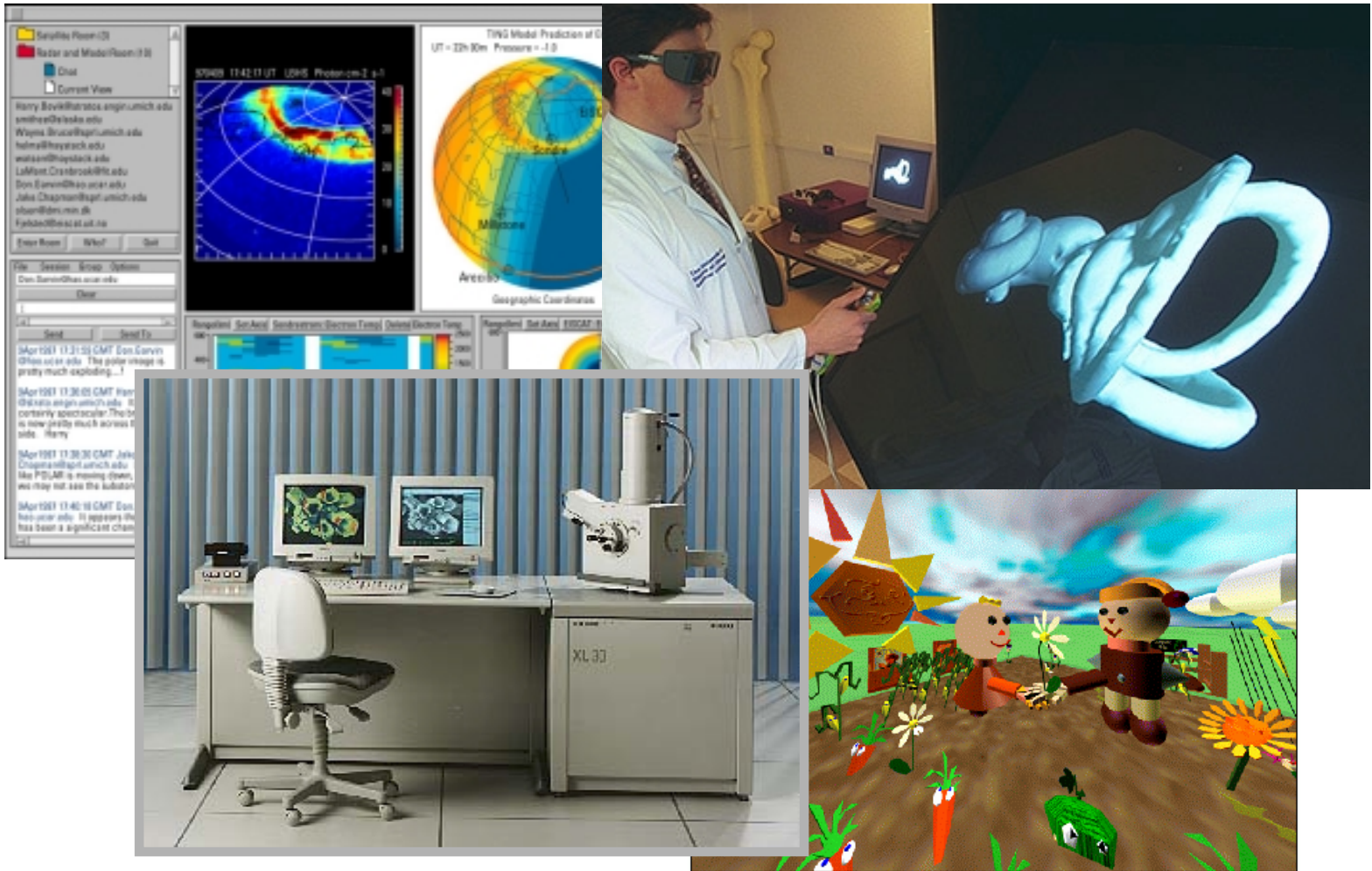


Internet2 QoS Past, Present, and Future

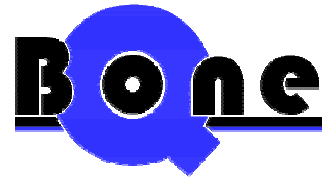
First Joint Internet2/DOE QoS Workshop
February 9-10, 2000
Houston, Texas



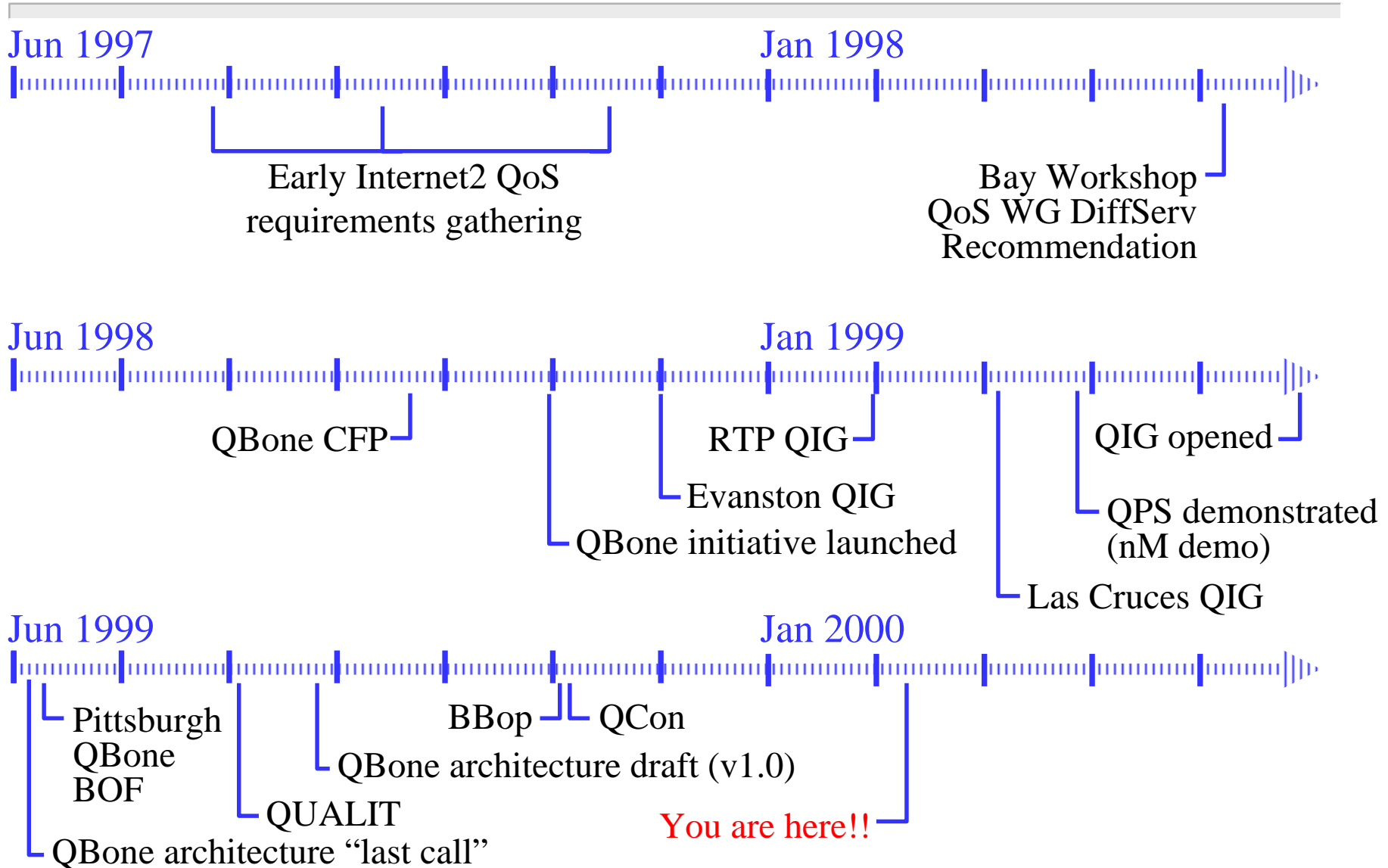
Applications, Applications, ...



Internet2 is all about enabling **new** networked applications!



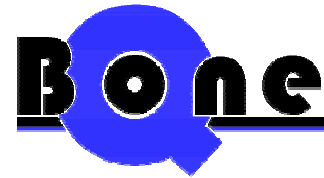
Timeline



QBone Architecture

- A Service: QBone Premium Service (QPS)
 - Built on Expedited Forwarding (EF) (RFC 2598)
 - Contract: leased line emulation at a specified peak rate
 - Near-zero loss
 - Low, bounded jitter
- Reservation Setup Protocol
 - Phase0: long-lived, manual setup, campus-to-campus extent
 - Phase1: more dynamic, automatic setup, flexible extent
- QBone Measurement Architecture
 - Uniform collection of QoS metrics
 - Uniform dissemination interface

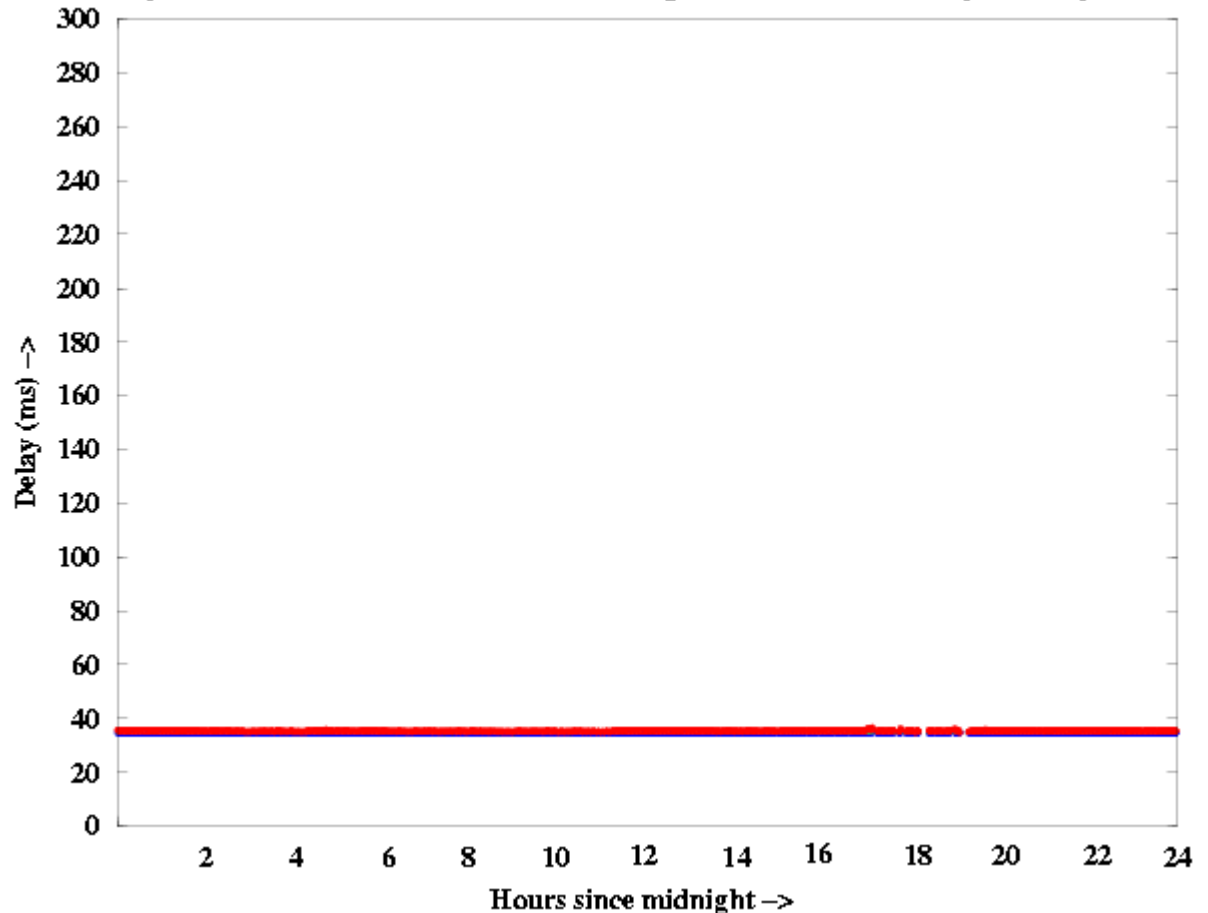
Typical ESNet/vBNS Performance



SLAC → CMU

Delay statistics over 1-minute intervals starting 00:00 UTC, Wednesday, January 12, 2000

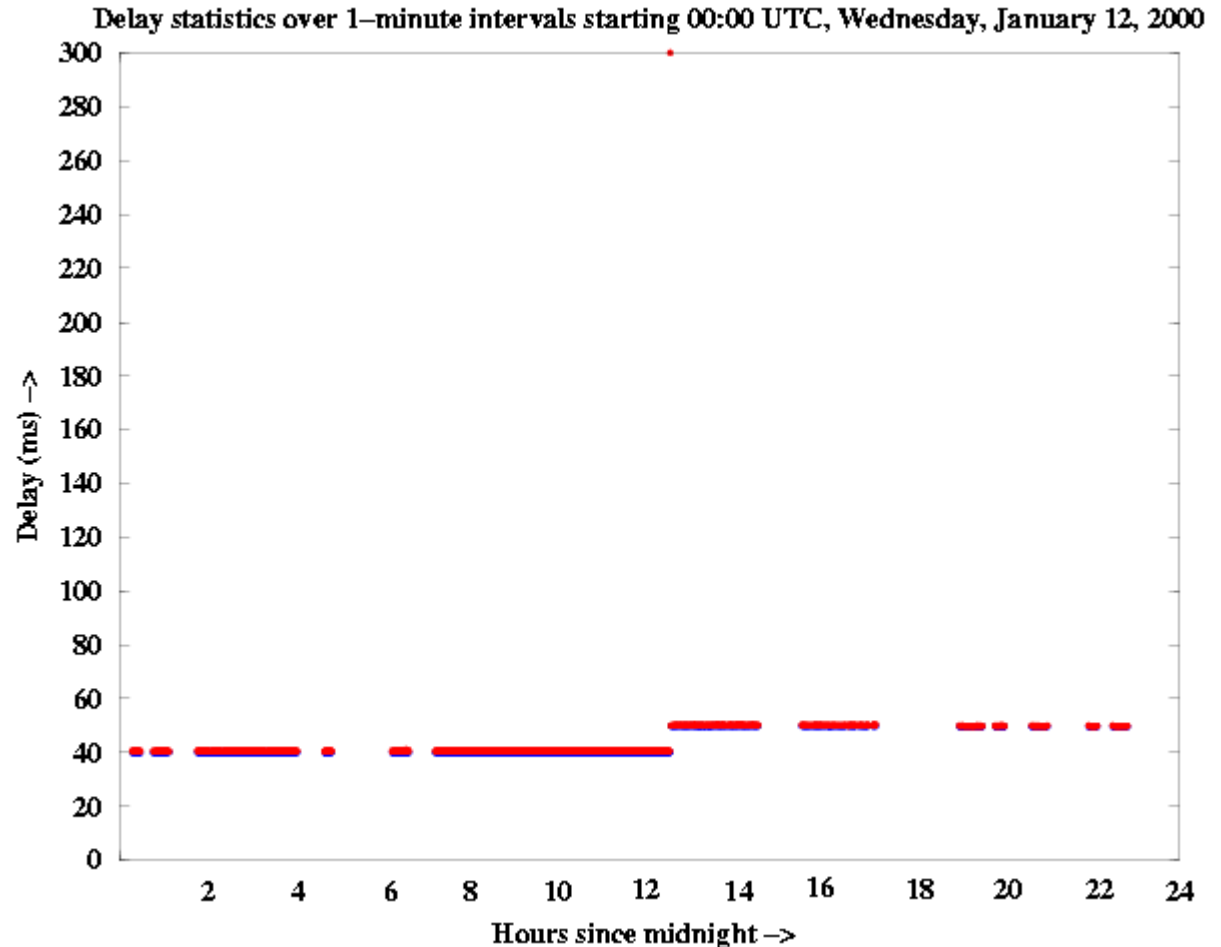
- Minimum Delay
- 50th Percentile Delay
- 90th Percentile Delay



Typical ESNet/Abilene Performance

ORNL → Washington

- Minimum Delay
- 50th Percentile Delay
- 90th Percentile Delay



So, Why Are We Doing QoS?!

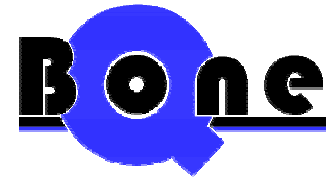
■ True...

- Edge-to-edge measurements show that Internet2/NGI utilization is **very low** (~%5)
- Delay/jitter sensitive apps **will work** when placed close to core

■ But...

- Significant anecdotal evidence suggests that the **e2e story is much less pretty** \Rightarrow *it's the campus stupid!*
- **Other congestion points exist** (*e.g.* inter-continental links)
- Internet2 (and our beloved students) **working hard at ramping up utilization** \Rightarrow *when utilization reaches commodity Internet levels (~%40), delay/jitter sensitive apps will not work regardless of where they are placed!*

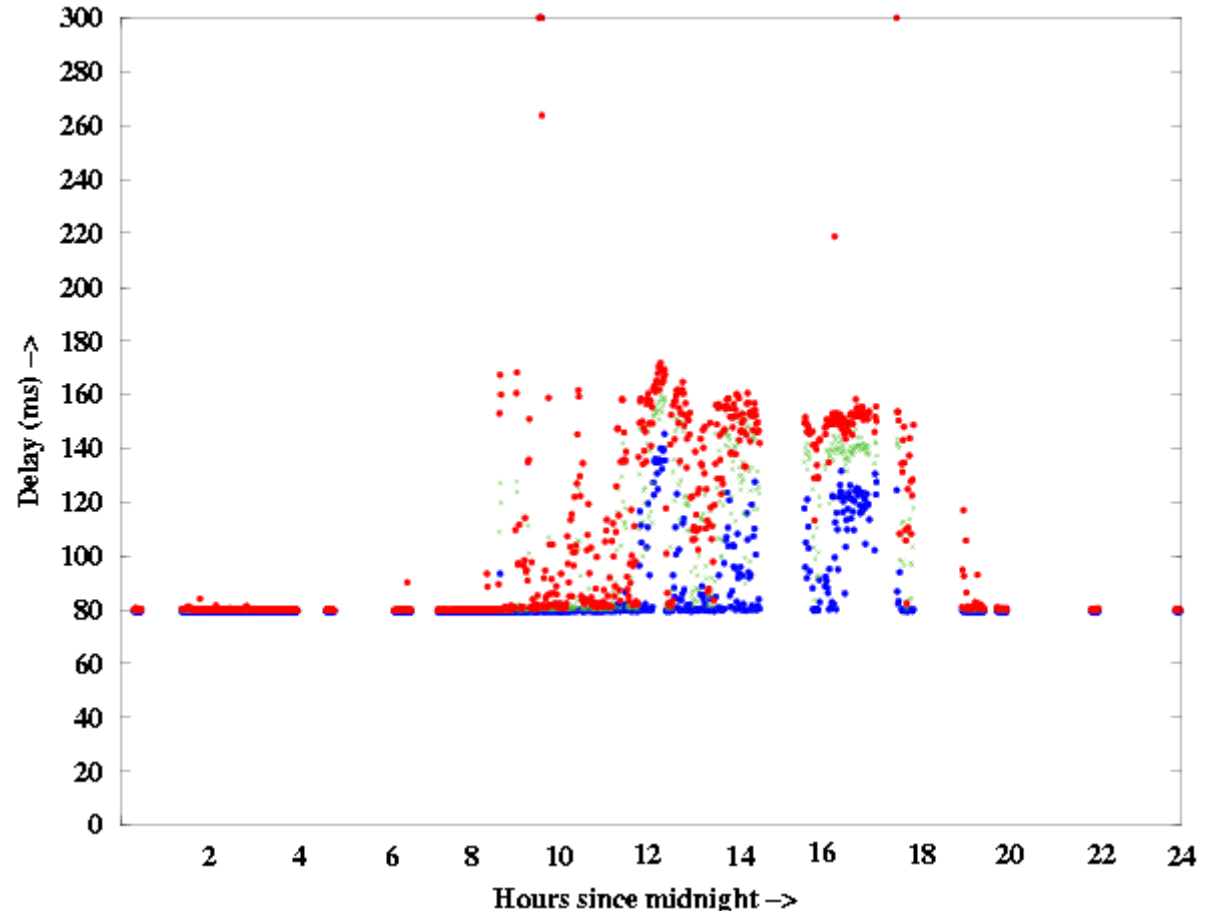
Inter-Continental Link Congestion



Washington → UKERNA

Delay statistics over 1-minute intervals starting 00:00 UTC, Wednesday, January 12, 2000

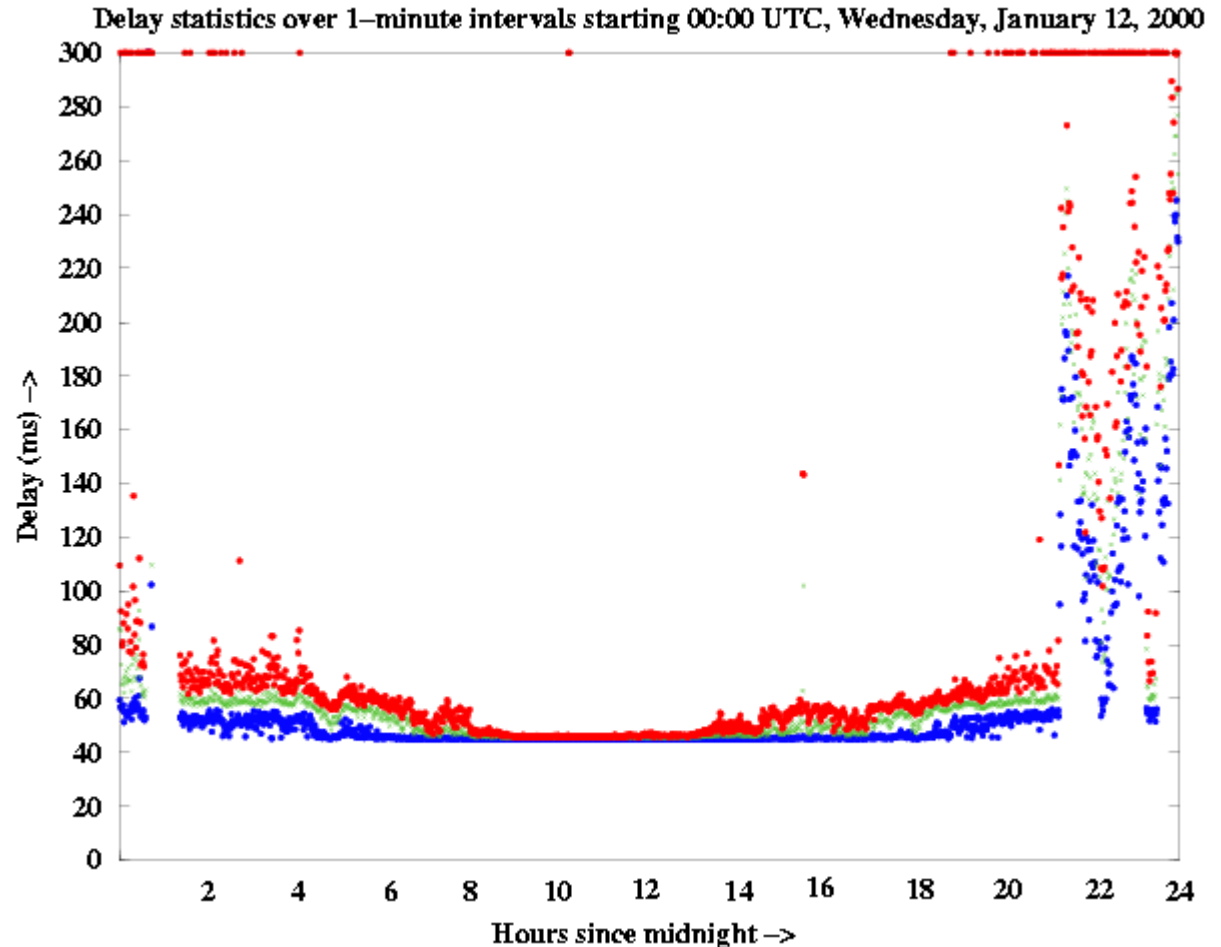
- Minimum Delay
- 50th Percentile Delay
- 90th Percentile Delay

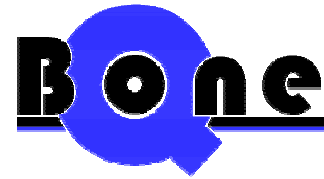


The Future?

University-DOE Performance Through the Commodity Net...

- Minimum Delay
- 50th Percentile Delay
- 90th Percentile Delay





Abilene QBone Plans

■ The Plan:

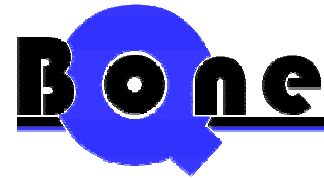
- To make Abilene a **reference implementation** of the QBone architecture

■ Why?



- Not because we need it now, but because it's the **right thing** to do
- Also, connectors may actually start congesting their access links

■ The Team:

- | | |
|----------------------|--------------|
| – UCAID | – NLANR/NCNE |
| – Indiana University | – Cisco |
| – I-TEC | – Qwest |
| ■ North Carolina | – Nortel |
| ■ Ohio | |



Abilene QoS Service Phasing

<i>Sweetwater</i>	<i>Midland</i>	<i>Odessa</i>	<i>Pecos</i>
			
Measurement Infrastructure (Surveyor + SNMP + HTTP Dissemination)			
Edge Policing (CAR)			
Manual Setup (Whiteboard + CLI)			
	EF Core Forwarding (MDRR)		
		EF Edge Forwarding (MDRR)	
		Automated Setup (BB or ?)	
			Shaping (GTS)

Abilene QoS Status

- Beta-testing “Sweetwater” service
- OC48 POS E2 “perf” cards deployed throughout core
⇒ *will be ready to do “Midland” EF forwarding soon*
- Peering with “DOE Science Grid Testbed” underway
⇒ *we are **very interested** in other working on other peerings*
- Better measurement dissemination coming soon
⇒ *care of OSU*
- Looking at Cisco “Guaranteed Bandwidth” MPLS work

Challenges

- Redouble efforts to bring QoS/QBone functionality to the gigaPoPs and campuses
- Focus on the choke points:
 - Inter-provider links
 - Inter-continental links
 - Weakly-connected end-systems (*i.e.* wireless)
- Leverage new DiffServ **forwarding** primitives to create useful new end-to-end **services**
- Keep the

{	services
	peerings
	signaling

 simple!

Signaling

■ Problem:

- Hosts must be able to ask the network for service
⇒ *but all stakeholders in path must be able to exert control!*
- Signaling is by its nature **difficult** (lots of failure cases and need for extensibility)

■ Open Issues:

- How much complexity is inevitable? / How much simplicity can be achieved?
- How will reservations be parameterized in time & space?
- Adapt existing protocols or start anew?

■ Options:

- RSVP
- SIBBS
- YESSIR, ...

So, Why Here? Why now?

■ Q: *Why Is Internet2 the Right Place?*

- **We need QoS:** Many Internet2 applications **require** QoS; distance learning, remote instrument control, remote collaboration
- **We are all friends:** Openness of the R&E community gives us an enormous advantage in figuring out inter-domain, e2e problems like QoS
- **We've done it before:** The very premise of Internet2 is that we can recreate the “Internet1” development model

■ Q: *Why now?*

- Most of the underlying building blocks we need are now in the routers and hosts; we just need to roll up our sleeves and put it all together

So, What's in the Cards?

