QoS and NGN

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These Slides are available at
http:/www.cse.wustl.edu/~jain/talks/itf05qs.htm

QoS - Past

- **IEEE 802.1D**: Strict priority, Massive bandwidth
- **ATM**: Classes of Service: CBR, VBR, ABR, UBR
  - Difficult to specify cell delay variation
  - Difficult to aggregate VBR
- **Integrated Services:** ATM like services
  - Best effort, controlled load, guaranteed service.
  - RSVP for signaling. Soft state.
  - Per-flow considered too complex for routers
- **Differentiated Services:** Marking in packets
  - Per hop behavior - Mechanisms and not services.
  - DiffServ is a misnomer.
- **MPLS:** End-to-end path setup.

QoS Debate

- Massive Bandwidth vs Managed Bandwidth
- Per-Flow vs Aggregate
- Quantitative vs Qualitative
- Absolute vs Relative
- End-to-end vs Per-hop
- Soft State vs Hard State
- Path based vs Access based
- Source-Controlled vs Receiver Controlled

Comparison of QoS Approaches

Issue	ATM	IntServ	DiffServ	MPLS	IEEE 802.1D
Massive Bandwidth vs Managed Bandwidth	Managed	Managed	Massive	Managed	Massive
Per-Flow vs Aggregate	Both	Per-flow	Aggregate	Both	Aggregate
Quantitative vs Qualitative	Quantitative	Quantitative+Qualitative	Mostly qualitative	Both	Qualitative
Absolute vs Relative	Absolute	Absolute	Mostly Relative	Absolute plus relative	Relative
End-to-end vs Per-hop	e-e	e-e	Per-hop	e-e	Per-hop
Soft State vs Hard State	Hard	Soft	None	Hard	Hard
Path based vs Access based	Path	Path	Access	Path	Access
Source-Controlled vs Receiver Controlled	Unicast Source, Multicast both	Receiver	Ingress	Both	Source

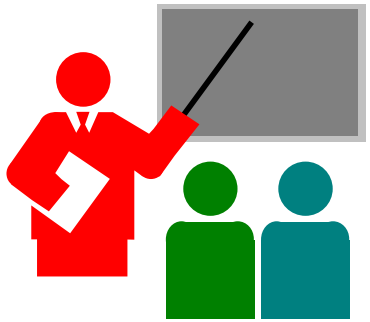
State of the Network: 2005

1. Security is most important:
   All packets go through deep inspections
   ⇒ Throughput limited by packet inspection, Firewalls, Spam filters
2. Wireless (WiFi) is spreading (Intel Centrino)
   Limited bandwidth ⇒Triple play over wireless needs QoS
3. More Cell phones than POTS.
   Smart Cell phones w PDA, email, video, images ⇒ Mobility
4. Voice over Internet Protocol (VOIP) is in the Mainstream
   ⇒ IP QoS vs Application specific QoS
5. Terabyte/Petabyte storage (Not VoD)
   ⇒ High-Speed Networking
6. Internet is less about communication and more for information retrieval

Upcoming Challenges of Networking

1. **Size**: 4 nodes ⇒ 100 M nodes ⇒ 4B people ⇒ 4T appliances
2. **Distance**: USA ⇒ Worldwide ⇒ Interplanetary ⇒ WAN ⇒ LAN ⇒ PAN
3. **Speed**: 128 kbps ⇒ 10Mbps ⇒ 10Gbps ⇒ 1.6 Tbps
4. **Criteria**: Least cost ⇒ Policy based (Traffic Mgmt), Power
5. **Traffic**: Delay-tolerant Data, real-time voice and video, storage and computing
6. **Trust**ed nodes ⇒ Secure, virus proof, spam proof, …
7. Stationary Nodes ⇒ **Mobile** Nodes ⇒ Mobile Networks
8. Stable Links ⇒ Continuous **disruption**, long outages, Varying quality
9. Single ownership ⇒ Multiple Domains ⇒ **Hierarchies** of ownership
10. **Heterogeneity**: Single technology ⇒ Multiple L1/L2/L3

Summary



1. QoS requirements different for Enterprise and carriers
2. Need to design services and not mechanisms
3. Application specific QoS mechanisms in addition to TCP/IP
4. Significant future challenges in QoS due to scale, mobility, …

Thank You!