

Quality of Service in Data Networks

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These slides are available on-line at:

<http://www.cis.ohio-state.edu/~jain/talks/qos9910.htm>

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- ❑ Ten Networking Trends
- ❑ Traffic > Capacity vs Capacity > Traffic
- ❑ QoS Design Approaches
- ❑ Comparison of QoS Approaches
- ❑ Customer Perspective of QoS
- ❑ QoS Debates
- ❑ Voice and Data: Back to the Future
- ❑ ATM QoS: What we learnt?
- ❑ QoS Components

Ten Networking Trends

1. Faster Media
2. More Traffic
3. Traffic > Capacity
4. Data > Voice
5. ATM in Backbone
6. Everything over IP
7. Differentiation Not Integration
8. Back to Routing From Switching
9. Traffic Engineering
10. Other Trends

Future

Year

1980



In 1990, the memory will be so cheap that you will not have to worry about paging, swapping, virtual memory, memory hierarchy, and....

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Trend 3: Traffic > Capacity



Expensive Bandwidth

- Sharing
- Multicast
- Virtual Private Networks
- More efficient use (L3)
- Need QoS
- Likely in WANs

Cheap Bandwidth

- No sharing
- Unicast
- Private Networks
- Less efficient use
- QoS less of an issue
- Possible in LANs

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QoS Design Approaches

- ❑ Massive Bandwidth vs Managed Bandwidth
- ❑ Per-Flow vs Aggregate
- ❑ Source-Controlled vs Receiver Controlled
- ❑ Soft State vs Hard State
- ❑ Path based vs Access based
- ❑ Quantitative vs Qualitative
- ❑ Absolute vs Relative
- ❑ End-to-end vs Per-hop
- ❑ Static vs Feedback-based
- ❑ Homogeneous multicast vs heterogeneous multicast
- ❑ 1-to-n multicast vs n-to-1 multicast

Comparison of QoS Approaches

Issue	ATM	IntServ	DiffServ	MPLS	IEEE 802.3D
Massive Bandwidth vs Managed Bandwidth	Managed	Managed	Massive	Managed	Massive
Per-Flow vs Aggregate	Both	Per-flow	Aggregate	Both	Aggregate
Source-Controlled vs Receiver Controlled	Unicast Source, Multicast both	Receiver	Ingress	Both	Source
Soft State vs Hard State	Hard	Soft	None	Hard	Hard
Path based vs Access based	Path	Path	Access	Path	Access
Quantitative vs Qualitative	Quantitative	Quantitative + Qualitative	Mostly qualitative	Both	Qualitative
Absolute vs Relative	Absolute	Absolute	Mostly Relative	Absolute + relative	Relative

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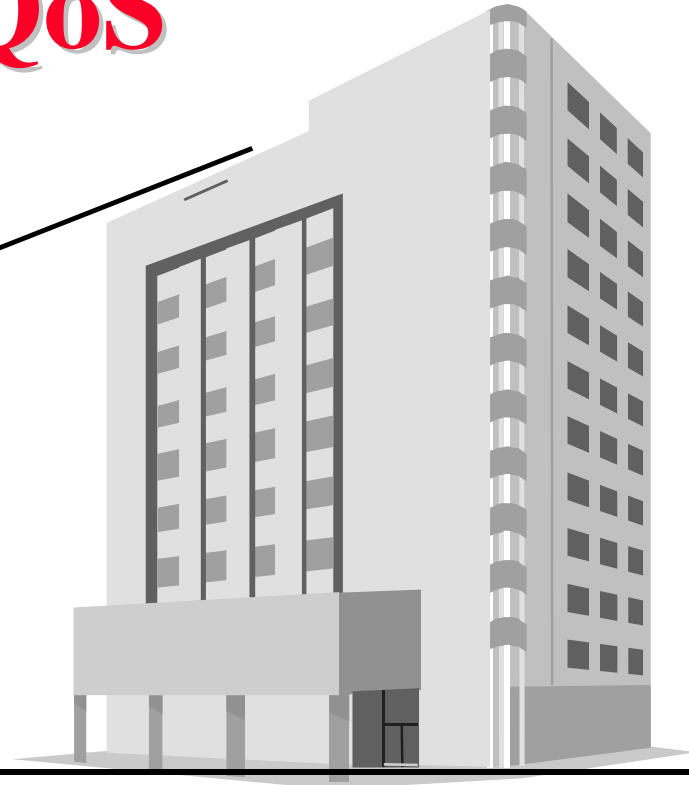
Comparison (Cont)

Issue	ATM	IntServ	DiffServ	MPLS	IEEE 802.3D
End-to-end vs Per-hop	end-end	end-end	Per-hop	end-end	Per-hop
Static vs Feedback-based	Both	Static	Static	Static	Static
Homogeneous multicast vs heterogeneous multicast	Homo-geneous	Hetero-geneous	N/A	Homo-geneous	N/A
1-to-n vs n-to-1 multicast	1-to-n	1-to-n	N/A	Both	Both

ATM QoS



Today

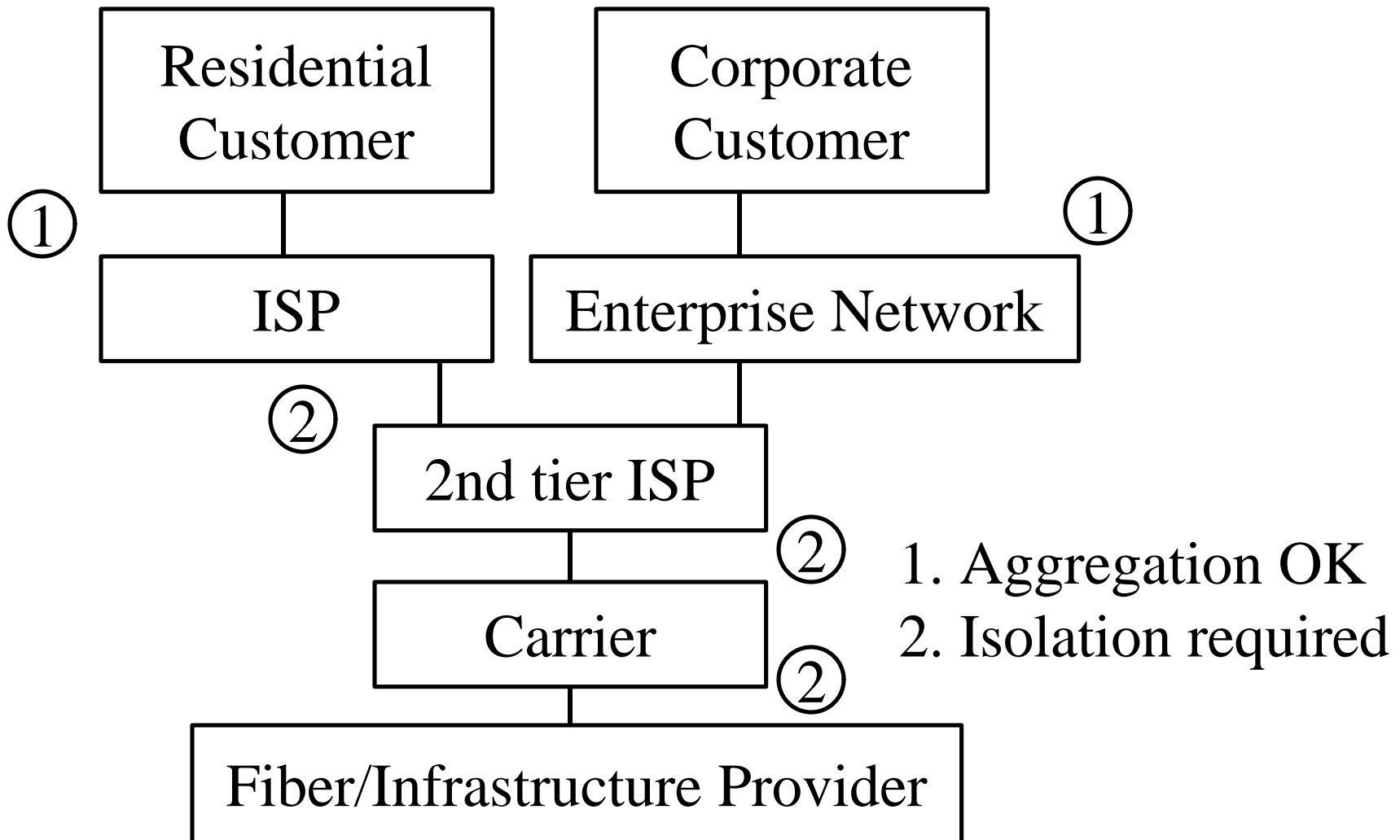


ATM

Too much too soon

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Customer Perspective of QoS



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QoS Debates

- ❑ Diffserv may be ok for enterprise backbone but not for carriers.
- ❑ Need a fundamental change in QoS metrics
Customer specifiable, measurable, aggregateable, realizable, and thorough (voice+data)
- ❑ Can not rely on end-to-end TCP controls

Voice and Data: Back to the Future

People

- ❑ Lots of Money
- ❑ Little space
- ❑ Time critical
- ❑ Solutions: Cars, Planes

Cargo

- ❑ Little Money
- ❑ Need lots of space
- ❑ Time Not critical
- ❑ Solutions: Trucks, Rail, Ships, Cargo Plane

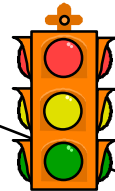
- ❑ Share the media but not transport
- ❑ In less developed countries, people may be treated like cargo.

QoS Components

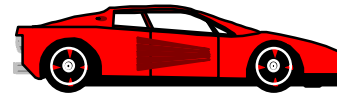
① Signaling and Admission control



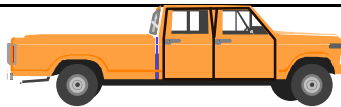
② Shaping



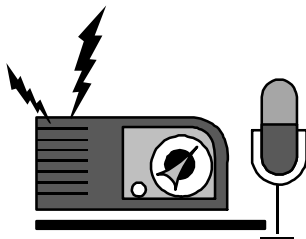
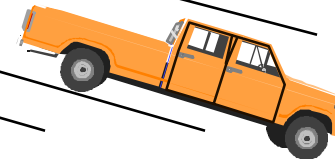
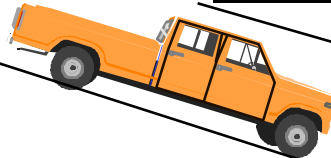
③ Policing



Scheduling ⑤



④ Routing



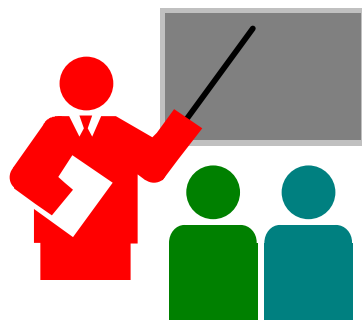
⑦ Traffic Monitoring and feedback

⑥ Buffer Mgmt

QoS Components

- ❑ Shaping, Policing, Marking/classification
- ❑ Policies
- ❑ Scheduling and drop policies
- ❑ Routing: QoS based, Explicit, Parallel, Local
- ❑ Traffic aggregation: Virtual leased line
Not Microflow/flows or aggregates with common headers

Summary



- ❑ Either extreme (per-flow or aggregate) is not sufficient. Need intermediate aggregates.
- ❑ Aggregation based on IP addresses and TCP port numbers is ok for enterprise but not for carrier backbone.
- ❑ Need virtual leased lines in the backbone.
- ❑ MPLS provides the aggregation, parallel explicit paths. Must avoid becoming too complex and too late.

Thank You!



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