

A Comparison of ATM Service Categories

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- Comparison of CBR, VBR, ABR, UBR, GFR
 - Complexity
 - Buffering
 - Efficiency for TCP Traffic
 - Fairness for TCP Traffic
 - UDP Traffic
 - Differentiated Services

Issues

- ❑ Services: CBR, VBR, ABR (with MCR), UBR (no MCR), GFR (with MCR)
- ❑ UBR with MCR has characteristics in-between UBR and GFR
- ❑ VBR \Rightarrow nrt-VBR (except in voice discussion)
- ❑ Metrics: Cost/Complexity, Performance (throughput, buffering, fairness)
- ❑ Applications: Data (TCP or UDP), Voice, Differentiated Services
- ❑ Configurations: Backbone ATM, end-to-end ATM
- ❑ Note: No absolute answers. Only points for a debate.

Complexity

- ❑ Note: Service categories are listed best first.
- ❑ CAC (Provisioning): UBR, CBR, ABR, GFR, VBR
- ❑ Policing: UBR, CBR, VBR, GFR, ABR
- ❑ Meeting Service Guarantees in Switches (Resource Allocation algorithm):
CBR, nrt-VBR, rt-VBR, UBR (need frame boundaries), GFR, ABR
- ❑ VC Aggregation: CBR, UBR, ABR, GFR (different frame sizes), VBR
- ❑ Queueing (# of queues for n VCs): UBR (1),
CBR/VBR/ABR/GFR (n)

Complexity (Cont)

- Complexity of Implementation
(Switch cost, NIC cost):
CBR, UBR, VBR, ABR, GFR

Switch Buffering

- ❑ CBR: Almost no buffering
- ❑ ABR: Low buffering
- ❑ VBR/GFR/UBR: High buffering

Router or End-system Buffering

- ❑ Depends on the type of traffic
- ❑ UBR, GFR, VBR: Traffic immediately enters the ATM network \Rightarrow Low buffering
- ❑ CBR: Queues depend upon peak traffic rate and PCR
- ❑ ABR:
 - Queues in the end systems or routers
 - Ack regulation schemes can control required buffering for TCP

Use of Extra Router Buffering

- ❑ ABR/CBR: Routers can buffer when the backbone network is congested.
Waiting is generally better than loss.
- ❑ GFR/VBR/UBR: Router does not know about network congestion. Extra memory does not help.

Bursty TCP Traffic: Bandwidth Utilization

- ❑ High Utilization \Rightarrow Less idle time
- ❑ ABR: Any available bandwidth is immediately allocated
- ❑ GFR/UBR/VBR: Higher burstiness
 \Rightarrow More queues/loss and More idle times
- ❑ CBR: Not suited for bursty traffic

Bursty TCP Traffic - Fairness

Configuration I:

ATM backbone \Rightarrow VCs between Routers

\Rightarrow Each VC carries multiple TCP flows

- ❑ ABR: Most losses in the router not in switches
 \Rightarrow Key factor is the fairness in the router
 \Rightarrow Proper RED can make it fair
- ❑ CBR: Queues in routers (as in ABR)
- ❑ VBR/GFR/UBR:
Not fair since most losses in ATM switches.
Fair buffer allocation (FBA) can ensure fairness among VCs but not among flows in the same VC.

Bursty TCP Traffic - Fairness

Configuration II:

ATM end-to-end \Rightarrow 1 VC per TCP flow

- ❑ ABR: No losses
- ❑ CBR: No losses
- ❑ GFR: Switches can fairly distribute losses using per-VC queueing or FBA
- ❑ UBR: Switches probably will not have separate UBR queues \Rightarrow Low Fairness unless FBA

Bursty UDP Data Traffic

- ❑ Metric: Throughput or Efficiency
- ❑ Several Client-Server transaction applications use UDP.
- ❑ Data \Rightarrow Loss Sensitive \Rightarrow Retransmission
- ❑ UDP \Rightarrow No Slow Start \Rightarrow Losses can continue \Rightarrow Losses are more expensive than in TCP
- ❑ Other conclusions are similar to TCP

Loss-tolerant UDP Traffic

- ❑ Example: Voice over IP
- ❑ Loss-tolerant generally implies delay sensitive
- ❑ ATM backbone \Rightarrow Aggregated flows
- ❑ ABR: Queues in the router. If hierarchically coded and drop preference indication in packets
 \Rightarrow Routers can drop the low priority packets
- ❑ CBR: Low efficiency due to traffic variability.
But Routers can drop the low priority packets.
- ❑ GFR/VBR/UBR: Packets may enter ATM network and dropped there. CLP bit coded by drop preference.

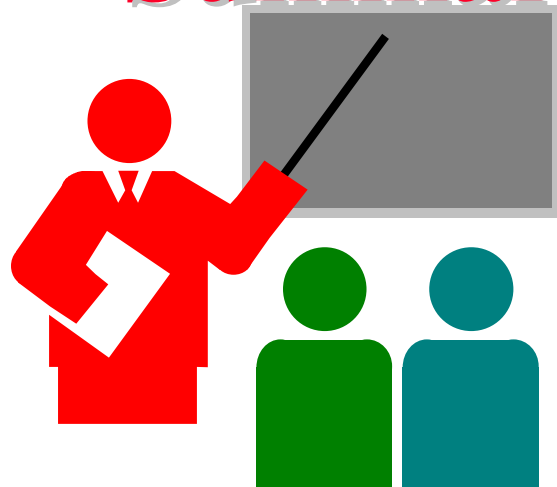
Differentiated Services

- ❑ Details of DS are yet to be finalized.
- ❑ Currently 4 queues and 3 drop preferences (July IETF Meeting)
- ❑ ATM has only two drop preferences: $CLP = 0$ or 1
- ❑ ABR: Queues in the Router \Rightarrow Routers can set different thresholds for different drop preferences
- ❑ CBR: Queues in the router.
But not as efficient as ABR for Bursty traffic.
- ❑ GFR/VBR/UBR: Queues in side the network
 \Rightarrow Can't handle more than 2 drop preferences

Differentiated Services - Priorities

- ❑ Four Queues: With Priority and weights
- ❑ Weights \Rightarrow Guaranteed bandwidth
- ❑ ABR/CBR: All queues in the routers
 \Rightarrow Edge routers can keep multiple priority queues feeding to a single ABR VC
- ❑ GFR/VBR/UBR: No queues in the routers
 \Rightarrow Can't enforce priorities in the router
- ❑ GFR: Higher MCR \neq Higher Priority
 \neq Higher share of extra bandwidth
- ❑ VBR: Higher SCR/PCR \neq Higher Priority

Summary



- ❑ ABR: Key Distinction is feedback
⇒ Network is congestion free and maximally utilized
- ❑ ABR gives more control to edge-routers.
Routers have more control over drop policies
- ❑ Other services depend more upon ATM switches
⇒ Fairness difficult to achieve if one VC contains
multiple TCP flows

Summary (Cont)

- ❑ With ABR it is possible to make use of added buffering in the routers
- ❑ For Bursty Data: $ABR > GFR > VBR > UBR > CBR$
- ❑ Because of implementation complexity GFR may dominate in the short term
- ❑ With ABR, it is possible to implement multiple hierarchical levels of coding
⇒ Possible to allow multiple drop preferences
- ❑ All other classes can't handle more than two levels of drop preferences ⇒ ABR may rebound if multiple drop preferences in Differentiated Services

Summary (Cont)

- ❑ Large careers need ABR to keep queues manageable in the network