Traffic Management for Satellite-ATM Networks

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Goals

- Traffic management issues for TCP/IP based data services over satellite-ATM networks
  - Discuss design issues for TCP/IP over ATM
  - Optimize the performance of TCP/IP over ATM for long delay networks
  - Evaluate ATM service categories for TCP/IP traffic

ATM Service Categories for Data

- **Unspecified Bit Rate (UBR):** User sends whenever it wants. No guarantees made by network
- **Guaranteed Frame Rate (GFR):** User sends whenever it wants. Network guarantees a minimum frame rate, and fair usage of excess capacity. Needs frame delineation info
- **Available Bit Rate (ABR):** User follows network feedback. Network guarantees a minimum cell rate, and fair usage of excess capacity. Network guarantees cell loss ratio
- **Non-Real Time Variable Bit Rate (nrt-VBR):** User declares peak and average rates. Network guarantees cell loss ratio

Designed for best effort and non-real time traffic
ATM Service Categories (contd.)

- **Real Time Variable Bit Rate (VBR):** User declares peak and average rates. Network guarantees cell delay, cell delay variation and cell loss ratio.
- **Constant Bit Rate (CBR):** User declares peak rate. Network guarantees cell delay, cell delay variation and cell loss ratio.

Designed for real time traffic
Satellite-ATM Deployment (Backbone Networks)

TCP over ATM

End System Policies
Buffer Management
Feedback Control
Queuing
Unspecified Bit Rate (UBR)

- Queuing: Single UBR queue
- Buffer Management
  - Tail Drop: Low efficiency, low fairness
  - Early Packet Discard: Low fairness
  - Per-VC accounting: High efficiency, high fairness
- End-system Policies
  - Vanilla TCP: Poor performance
  - Fast Retrans. & Recov.: Bad for long latency
  - Selective Ack: Good performance for long latency
- No control over sources ⇒ Potentially Large queues in network

UBR with Guaranteed Rate (GR)

- Queuing:
  - Single queue with guaranteed minimum service rate
- Buffer management: Same as UBR
- End system policies: Same as UBR
- Improved performance of TCP due to guaranteed rate
- Cannot isolate traffic from different organizations
  - Will not work for backbone networks
  - May be OK for access networks
 Guaranteed Frame Rate (GFR)

- Minimum rate guarantee for frames
- Complete frames are accepted or discarded in the switch
- Traffic policing is frame based
- Traffic conforming to MCR is served with low cell loss
- Traffic above MCR is served as best effort
- CLP=0 frames given higher priority than CLP=1 frames
- Network can optionally tag frames exceeding MCR (GFR.2)
- Good for backbone as well as access networks

GFR (contd.)

<table>
<thead>
<tr>
<th>Queuing</th>
<th>Per-VC</th>
<th>FIFO</th>
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<tbody>
<tr>
<td>Buffer Management</td>
<td>Per-VC</td>
<td>Global Threshold</td>
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<tr>
<td></td>
<td>Thresholds</td>
<td>Threshold</td>
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<tr>
<td>Tag-sensitive Buffer Mgmt</td>
<td>2 Thresholds</td>
<td>1 Threshold</td>
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</tbody>
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- Equal MCR allocation
  - Can do with FIFO and per-VC thresholds
- Unequal MCR allocation
  - Difficult to provide per-VC MCR with FIFO for TCP/IP traffic with high MCR allocation
  - Easy to provide per-VC MCR with per-VC queuing
Available Bit Rate (ABR)

- Queuing: Single ABR queue or per-VC queues
- Feedback Control:
  - *Bit Based*: Slow control, bad for long latency networks
  - *Explicit Rate*: Fast control, bounded buffer requirements
  - *Virtual Source/Virtual Destination*: Allows hop-by-hop control & isolates terrestrial switches from effects of satellite latency
- Buffer Management:
  - Less important with a good explicit rate scheme like ERICA+
  - Bounded buffer requirements (Constant × round trip delay × bandwidth) for zero loss for TCP/IP over ABR
  - UBR-like buffer requirements at the edges of the ABR network

<table>
<thead>
<tr>
<th>UBR</th>
<th>GFR</th>
<th>ABR</th>
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<tbody>
<tr>
<td>No guarantee, Unfair</td>
<td>Minimum rate + fair excess, Fair</td>
<td></td>
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<tr>
<td>Queue in network</td>
<td>Queue at network edges</td>
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<tr>
<td>Simple for user</td>
<td>Good for provider</td>
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<tr>
<td>Same end-to-end or backbone</td>
<td>Good if end-to-end ATM</td>
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Summary

- Design issues for TCP over ATM
  - *End system policies*: Vanilla TCP, Fast Retr. Recov., *SACK*
  - *Feedback control*: Explicit rate, binary, end-to-end, VS/VD
  - *Buffer management*: tail drop, EPD, per-VC acc., tag sensitive
  - *Queueing*: Per-Class, per-VC
- **UBR**: No guarantees, poor performance
- **UBR w/ per-VC accounting**: Good efficiency + fairness
- **GR**: Cannot isolate different VCs
- **GFR**: Per-VC minimum rate guarantees
- **ABR**: Congestion shifted to edge of network
- **VS/VD**: Isolate terrestrial segments from satellite

Thank You