Parameter Values for Satellite Links

Raj Jain, Shiv Kalyanaraman, Sonia Fahmy, Fang Lu
The Ohio State University

Saragur M. Srinidhi
Sterling Software and NASA Lewis Research Center

Raj Jain is now at Washington University in Saint Louis,
jain@cse.wustl.edu http://www.cse.wustl.edu/~jain/
Effect of XRM, XDF in long delay paths

- Simulation Results
- Analytical explanation
- Problem: Low throughput even when no congestion
- Proposed solution
Effect of Xrm

- XRM limits the number of cells lost if the link is broken
- Source Rule (6): If you not received feedback from the network after $Xrm \times Nrm$ cells, reduce your ACR:
  \[ ACR = \max\{MCR, ACR - ACR \times XDF\} \]
Effect of XDF

- After $X_{rm} \times N_{rm}$ cells:
  \[ ACR = ACR(1 - XDF) \]

- After $X_{rm}(1 + N_{rm})$ cells:
  \[ ACR = ACR(1 - XDF)^2 \]

- After $X_{rm}(k + N_{rm})$ cells:
  \[ ACR = ACR(1 - XDF)^k \]
Effect of XDF

- There is an almost vertical drop after XRM:

- The value of XDF has very little effect
- The source becomes a “Low Rate Source”
Design Principles

- Abnormal operations should not be handled at extreme cost to normal operation

⇒ While we don’t want to lose too many cells if the link breaks, we do not want to get 50% throughput if the link is operating.

- If the network is operating optimally, the control scheme should not move it to suboptimal

⇒ If VCs is at the optimal rate, leave it alone or minimize oscillations.
Simulation Parameters

- **Source**: Parameters selected to maximize ACR
  - \( N_{rm} = 32 \)
  - \( ICR = \text{Optimal} = 0.9 \times PCR/\text{Number of VCs} \)
  - \( AIR = PCR/N_{rm} \Rightarrow \text{ACR is not limited by AIR} \)
  - \( RDF = 256 \text{ cells} \)
  - \( X_{rm} = 32, 256, \ldots \)  \( X_{DF} = 1/16 \)
  - \( TDFF = 0 \Rightarrow \text{ACR does not go down due to TOF} \)

- **Traffic**: Bidirectional, Infinite sources

- **Switch**:
  - Target Utilization = 90%
  - Averaging interval = min\{30 cells, 200 \( \mu \text{s} \}\)
Single-Source Configuration

- All links 155 Mbps, ICR = 0.9 × PCR
- Goal: If the scheme has problem with single-source, it will have problems with more complex configurations
Simulation Results

- The queue lengths are small (no bottleneck)
- The rates oscillate between very low and very high even though the network feedback is consistently at ACR = 139 Mbps.
- Average throughput:
  - 0 for $t=(0,275\text{ms})$,
  - 32 Mbps for $t=(275\text{ms}, 825\text{ms})$,
  - 45 Mbps for $t=(825\text{ms}, 1200\text{ms})$
Simulation Results (Cont)

- The results do not change much with XDF
- Percent throughput even lower for higher speed (622 Mbps) links
Satellite Links

- One-way delay = Up-down = 275 ms
- Round-trip delay = 550 ms
- Xrm = 32

⇒ Maximum $32 \times 32 = 1024$ cells in flight before ACR starts coming down
- $X_{rm} = 256$ (maximum allowed) 
  $\Rightarrow$ 8 times more cells in flight
- Increasing $N_{rm}$ is not recommended as it reduces sensitivity at lower rates
Response time $= \max \{ \text{feedback delay, Inter-RM cell time} \}$
Required Xrm

- For full throughput
  \[ Xrm \geq \frac{RTTQ}{(Nrm \times ACR)} \]
  Where RTTQ = Round Trip Time including Queueing

- For 155 Mbps, \( Xrm \geq 6,144 \)
- For 622 Mbps, \( Xrm \geq 24,576 \)
- For two satellite hops: \( Xrm \geq 49,152 \)
- For \( n \) satellite hops: \( Xrm \geq 24,576n \)
  \( \Rightarrow \) Need 32 bits for Xrm
Two-Source Configuration

- All links 155 Mbps
- ICR = 0.9 \times PCR/2
- Goal: To verify optimal Xrm formula
In section 5.10.3.1 Parameter definitions and usage, replace “XRM is a 8 bit integer” with “XRM is a 32-bit integer”