97-0615: Feedback
Consolidation Algorithms for
ABR Point-to-Multipoint
Connections

Sonia Fahmy, Raj Jain, Rohit Goyal,
Bobby Vandalore, Shivkumar Kalyanaraman
Department of CIS, The Ohio State University

Sastri Kota, Lockheed Martin Telecommunications

Pradeep Samudra, Samsung Telecom America, Inc.

Contact: jain@cis.ohio-state.edu

http://www.cis.ohio-state.edu/~jain/
Consolidation algorithm design

Previous 4 algorithms

Proposed 3 algorithms

Simulation results

Performance comparison
The Consolidation Operation

- Necessary to prevent feedback implosion: too many BRMs per FRM at the root

Root  ➔ Branch Point  ➔ Leaf 1  ➔ Leaf 2

| = FRM  | = data  | = BRM

The Ohio State University

Raj Jain
Design Issues

- Who generates BRMs: branch points or leaves?
- Wait for feedback from all branches?
- Control of ratio of BRMs to FRMs at the root?
- Ratio of BRMs to FRMs inside the network?
- Interaction of branch point and switch operations if branch point is a switch?
- Which values are stored per VC and which per branch?
- Handling non-responsive branches and timeouts? Algorithm should not halt nor cause overload/underload
- Consolidation delay and scalability?
Scalability

- Overhead (# BRMs at root and inside network) and feedback delay should not increase with the number of leaves, branches or levels
Previous Algorithms

- **Algorithm 1**: Simply turn around RM cells with the current minimum and reset minimum

- **Algorithm 2**: Turn around FRM only if at least one BRM has been received since last BRM was sent

- **Algorithm 3**: Do not turn around RM cells. Simply flag the receipt of the FRM, and return the first BRM (with modified fields) to arrive after that

- **Algorithm 4**: Wait till BRMs are received from all branches after last BRM was sent, and return the last one (with modified fields)
New Algorithms

- **Goals:**
  - Eliminate consolidation noise, but not at the expense of a very slow transient response
  - Transient response must be fast in the case of overload

- **Algorithm 5:** If the ER in the BRM is much less than the last ER sent (or CCR), do not wait ⇒ send the BRM, but do not reset the values: reset when feedback from all leaves is received

- **Problem:** BRM to FRM ratio at the root may exceed one
New Algorithms (Cont)

- **Solution** ⇒ **Algorithm 6**: For every premature RM cell, increment a counter. Decrement the counter the next time an RM giving a higher rate than the last sent is to be returned, but do not return the RM.

- **Another Problem**: What if the branch point is a switch, and it is overloaded?

- **Solution** ⇒ **Algorithm 7**: When a BRM is received at the branch point, invoke the switch algorithm for the branches before checking if there is overload or not.
Simulation Parameters

- Links: WAN, 155.52 Mbps (149.76 Mbps after SONET)
- Traffic: unidirectional; bursty, persistent and with and without (on/off) VBR background
- Source: Parameters selected to maximize ACR
  Initial Cell Rate = PCR
  Rate Increase Factor = 1 \Rightarrow ACR is not limited
  TBE = very large
- Switch: ERICA algorithm
  Target utilization = 90%
  Averaging interval = \min\{100 \text{ cells}, 1 \text{ ms}\}
Persistent S1 sends to dS1, dS2, dS3. S4 sends to dS4.

Chain configuration: Bottleneck link only on route to distant leaf leaves $\Rightarrow$ all branches except longest branch (to dS1) give PCR as ER.
Simulation Results 2

- Algorithms 1, 2, 3: noise, unfair, unstable
- Algorithms 4, 5, 6: no noise, but slow response
- Algorithm 7: no noise and fast response
Modified chain configuration: Bottleneck feedback is closer than other leaves. Non-bottlenecked feedback comes from far away.
Simulation Results 3

- Algorithm 4: slow transient response
- Algorithms 5, 6: much faster response
- Algorithm 7: fastest
- Similar results with configurations with 10 leaves at different switches
<table>
<thead>
<tr>
<th>Algorithm</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complexity</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Med</td>
<td>&gt;Med</td>
<td>&gt;Med</td>
<td>&gt;&gt;Med</td>
</tr>
<tr>
<td>Transient</td>
<td>Fast</td>
<td>Med</td>
<td>Med</td>
<td>Slow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fast for overload</td>
<td>Very fast for overload</td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td>High</td>
<td>Med</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>BRM:FRM</td>
<td>1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>may&gt;1</td>
<td>lim=1</td>
<td>lim=1</td>
</tr>
<tr>
<td>Sensitivity to branch points and levels</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Med</td>
<td>&gt;Med</td>
<td>Med</td>
<td>Med</td>
</tr>
</tbody>
</table>
Performance Comparison (Cont)

- Algorithms 1 and 2 do not perform well and are complex
- Algorithm 3 suffers from consolidation noise
- Algorithm 4 has a slow transient response
- Algorithms 5, 6, and especially 7 overcome this problem
Conclusions

- Consolidation algorithms offer tradeoffs between complexity, transient response, noise, overhead and scalability.

- The new algorithms 6 and 7 speed up the transient response, while eliminating consolidation noise and controlling overhead.