Purpose of Delay Agent

• Control Link Properties
  – Bandwidth
  – Delay
  – Packet Loss
Goals of New Implementation

- Support link up/down, bandwidth limits, delay
- Support Linux for end node shaping
- Support Linux as a delay node
- Clean API between OS-independent front-end and OS-specific back-ends
New Delay Agent Capabilities

- Bring links up and down using OS loss implementation
- Modify bandwidth limits
- Change packet delay
OS Support

• FreeBSD
  – End node shaping
  – Delay Nodes

• Linux
  – End node shaping
Design (Front-End)

• From Events
  – Receives events from Emulab event system
  – Events modify link parameters or bring them up/down

• To Back-ends
  – Demuxes events to appropriate pipe(s)
  – Parses parameters to make a Parameter object
  – Save parameter object and sends it to back-end.
  – Link up/link down are a special case.
Multiple Pipes

- Each link has two pipes
- Events to 'link' apply to both
- Events to 'link-end' apply to one
- An agent may handle multiple links
Design (Back-End)

- Receives parameters from front-end
- Parameters handled based on type
  - BANDWIDTH, DELAY, LINK_UP
- Call OS-dependent routines to modify desired property
# Experimental Results

<table>
<thead>
<tr>
<th></th>
<th>Old Agent</th>
<th>FreeBSD</th>
<th>Linux</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bandwidth (kbps)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>968</td>
<td>968</td>
<td>996</td>
</tr>
<tr>
<td>Incremental</td>
<td>489</td>
<td>490</td>
<td>488</td>
</tr>
<tr>
<td>Link Down</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Link Up</td>
<td>5170</td>
<td>5170</td>
<td>5169</td>
</tr>
<tr>
<td><strong>Delay (ms)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>41</td>
<td>41</td>
<td>42</td>
</tr>
<tr>
<td>Incremental</td>
<td>43</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>Link Down</td>
<td>100% Loss</td>
<td>100% Loss</td>
<td>100% Loss</td>
</tr>
</tbody>
</table>
Experimental Analysis

- FreeBSD performed almost identically
  - No underlying OS change
- Linux differences due to different OS environment
Conclusion

- Within project requirements, the new agent is a drop-in replacement for the old one
  - Remaining requirements (packet loss, RED, etc.) will be added later
- All project goals were met, except supporting Linux as a delay node
  - This requires modification of Emulab infrastructure outside of the delay agent, but the agent code supports this configuration