Binder: A System to Aggregate Multiple Internet Gateways in Community Networks

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How to solve our research issues?

Start your own ISP!
HUBS: Rural Broadband ‘Co-op’ ISP

• No real technical obstacles BUT

• Plenty of technical opportunities

• Data, data, data.

with Peter Buneman, Michael Fourman, Richard Simmons, William Waites
Gateway Aggregation (Today)

- Packet re-ordering
- Flow-to-pipe assignment
- Assume co-location
- Research-oriented
(Our) Constraints

• Simple

• Deployable

• Resilient

• Managed by Tom, or Diana, or Harry, etc
Binder Architecture

- Packet capture & redirection
- Multipathing
- Aggregation
Binder Implementation

- Tunneling via OpenVPN
- MP-TCP
- IP Source Routing Implementation
Emulation Testbed

<table>
<thead>
<tr>
<th>Src - Det</th>
<th>min</th>
<th>avg</th>
<th>max</th>
<th>mdev</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) default</td>
<td>2.32</td>
<td>3.69</td>
<td>8.43</td>
<td>1.08</td>
</tr>
<tr>
<td>(ii) alternate</td>
<td>6.93</td>
<td>15.88</td>
<td>71.17</td>
<td>11.22</td>
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<tr>
<td>(iii) remote host</td>
<td>23.28</td>
<td>25.35</td>
<td>37.96</td>
<td>2.88</td>
</tr>
</tbody>
</table>
Initial Results - loss

- Goodput (Mbps)
  - Binder x 1 Flow
  - Binder x 10 Flows (Total)
  - Baseline x 1 Flow

- Loss Probability
  - 1e-08
  - 1e-07
  - 1e-06
  - 1e-05
  - 0.0001
  - 0.001
  - 0.01
Initial Results - latency

Graph showing the Goodput (Mbps) against the Latency of slower subpath (ms) for different scenarios:
- Binder x 1 Flow
- Binder x 10 Flows (Total)
- Baseline x 1 Flow
Table 1: Time varying changes in path characteristics to evaluate Binder

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>High RTT path (ms)</th>
<th>Loss Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>85</td>
<td>1e-07</td>
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<tr>
<td>3</td>
<td>90</td>
<td>1e-06</td>
</tr>
<tr>
<td>6</td>
<td>95</td>
<td>1e-05</td>
</tr>
<tr>
<td>9</td>
<td>100</td>
<td>1e-04</td>
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<tr>
<td>12</td>
<td>105</td>
<td>1e-03</td>
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<tr>
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<td>1e-07</td>
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<tr>
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<td>1e-06</td>
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<td>110</td>
<td>1e-02</td>
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<tr>
<td>36</td>
<td>110</td>
<td>1</td>
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Questions