Management of Vectored DSL

Globecom 2009
Access Business Forum

George Ginis
Adaptive Spectrum and Signal Alignment, Inc
Limited resources for vectoring operations

Performance trade-offs among customers

Management system needed to realize full benefits
Dynamic Spectrum Management (DSM)

Collect
- management data from all lines;
- store for long period.

Analyze
- recent data and history;
- detect problems;
- project performance.

Act
- reconfigure lines to improve speed/stability;
- report faults.

Backbone Network
Vectored DSL Access Nodes
DSL lines
Modems

DSL management

Adaptive Spectrum and Signal Alignment, Inc
New Management Challenges (DSM Level 3)

Manage trade-offs among vectored lines

Achieve co-existence of non-vectored lines and vectored lines

Manage for noise sources that become dominant after eliminating the crosstalk
Data Parameters

Crosstalk coupling (XLOG)
- Received crosstalk PSD divided by received signal PSD

Noise correlation
- Correlation of error samples of different receivers
Crosstalk Diagnosis

Identify source pair for high crosstalk (“rogue” pair).

Noise correlation can indicate common outside source.

Pair likely causing disruption/degradation on non-vectored lines as well.
Performance Prediction

Use data parameters (XLOG, noise correlation) to estimate data rates

Understand performance trade-offs and make decisions on priorities

<table>
<thead>
<tr>
<th>Line</th>
<th>Current Service</th>
<th>Service with vectoring – low priority</th>
<th>Service with vectoring – high priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>123-456-7890</td>
<td>50 Mbps</td>
<td>60 Mbps</td>
<td>65 Mbps</td>
</tr>
<tr>
<td>650-654-3400</td>
<td>30 Mbps</td>
<td>35 Mbps</td>
<td>42 Mbps</td>
</tr>
<tr>
<td>…</td>
<td>…</td>
<td>…</td>
<td>…</td>
</tr>
</tbody>
</table>
Control Parameters (1)

- **Vectoring enable/disable**
  - Choose on which lines to allocate vectoring resources

- **Frequency controls**
  - Choose on which frequencies to allocate vectoring resources
Control Parameters (2)

- **Max Data Rate**
  - Not allowed

- **Target Data Rate**
  - Allocate vectoring resources according to *Line Priority (HIGH/LOW)*.
  - Do not exceed *Max Data Rate*.
  - Allocate vectoring resources to achieve *Target Data Rate*.
  - If resources are insufficient, sacrifice data rate up to *Min Data Rate*.

- **Min Data Rate**
  - Not allowed
Controlling the Lines

Enable vectoring for lines that benefit the most

Enable vectoring for customer with high-end services

Disable vectoring for malfunctioning equipment

### DSL management

<table>
<thead>
<tr>
<th>Line</th>
<th>Current Service</th>
<th>Benefit from vectoring</th>
<th>Purchased service</th>
<th>Enable vectoring?</th>
</tr>
</thead>
<tbody>
<tr>
<td>123-456-7890</td>
<td>50 Mbps</td>
<td>15 Mbps</td>
<td>Premium</td>
<td>YES</td>
</tr>
<tr>
<td>650-654-3400</td>
<td>30 Mbps</td>
<td>2 Mbps</td>
<td>Basic</td>
<td>NO</td>
</tr>
</tbody>
</table>
Controlling the Frequencies

Disable vectoring in frequencies dominated by RFI, AM, or other time-varying interference.

Disable vectoring in frequencies where crosstalk from non-vectored systems dominates.

[Graph showing RFI PSD and Rx PSD crosstalk]
Achievable data rates depend on the allocation of vectoring resources. Must choose rate controls and line priorities based on achievable data rates and customer’s purchased service.
Co-existence of Vectored and Non-vectored lines (DSM Level 2+3)

Cable cross-section

- Vectored lines
- Non-vectored line

Non-vectored lines in the same binder increase the crosstalk level

Reducing power for non-vectored lines restores the rates of the vectored lines
Managing for External Noise (DSM Level 1+3)

Crosstalk often hides other noise sources.

With crosstalk eliminated, lines are more sensitive to noise effects.

Management for impulse and other time-varying noise becomes even more important.
Conclusions

**Vectored DSL brings copper pairs to the 100 Mbps performance region**

**Proper management brings out the full benefits of the technology**