Advanced Networking For Projects

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Traditional Networking

- **Tape Technology nearing EOL**
  - One supplier left
  - $1200 per tape
  - Drives no longer available
- **Expensive logistics**
- **Effectively limits bit rates**
  - Hence limits resolution
- **Slow turn around time**
  - Real-time measurement not possible
  - Inflexible duty cycles
<table>
<thead>
<tr>
<th>Period</th>
<th>Most performant Data Link technology available</th>
<th>Technology available in pan-European network</th>
<th>Technology available in United States network</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991 - 1995</td>
<td>34/45 Mbps PDH</td>
<td>2 Mbps PDH</td>
<td>45 Mbps PDH</td>
</tr>
<tr>
<td>1996 - 1997</td>
<td>155 Mbps SDH</td>
<td>45 Mbps PDH</td>
<td>155 Mbps SDH</td>
</tr>
<tr>
<td>1997 - 2000</td>
<td>622 Mbps SDH</td>
<td>155 Mbps SDH</td>
<td>622 Mbps SDH</td>
</tr>
<tr>
<td>2000 +</td>
<td>10 Gbps DWDM</td>
<td>10 Gbps DWDM</td>
<td>2.5 Gbps DWDM</td>
</tr>
</tbody>
</table>
Evolution of Market Competitiveness: International Intra-European Connectivity

- **Average Offer Price**
  - 200,000 in 1996
  - 150,000 in 1997
  - 30,000 in 1998-99
  - 12,500 in 1999-2000
  - 5,000 in 2000-2001

- **Lowest Offer Price**
  - 36 in 2000-2001

**Period Covered**
- 1996
- 1997
- 1998-99
- 1999-2000
- 2000-2001

**Metrics**
- Euro / Mbps / Year
Relative Cost of Connectivity Compared with Number of Suppliers
Intercontinental Connectivity Price Evolution
Europe-USA Route

Intercontinental Connectivity in Euros/MBps/year

The Network of Light
GÉANT Facts and Figures

• European Capacity 146 Gbps
• Global Connectivity 7.5 Gbps
• Europe Capacity 2003
  – 140 Gbps Wavelength
  – 6 Gbps SDH
• European Cost
  – 14 M Euro Wavelength
  – 16 M Euro SDH
Are Projects Different?

• Very Large Bandwidth
• Limited Set of Locations
• Specific (well articulated?) Needs
Support for European VLBI

Diagram showing radio telescopes connected to correlators with data flows indicated as (RT or non-RT).
EVN Traffic Flows over GÉANT

Diagram showing network connections and traffic capacities between countries:
- JANET to UK
- SURFnet connecting between UK, NL, and SE
- NORDUnet connecting between SE and PL
- DFN connecting between NL and CZ
- JIVE as a central hub
- DE1, DE2, NL, SE, CZ, AT, FR, CH, BE, IT, PSNC, JANET, SURFnet, NORDUnet, DFN, JIVE, DE1, DE2, NL, SE, CZ, AT, FR, CH, BE, IT, PSNC

Traffic capacities:
- 2.5G
- 10G
- 256M
- 512M
- 1G
Project Issues

- Local Access
- Economics
- Technology
- Security
Le Fils de GÉANT

• Switching versus Routing
• Transmission Trends
  – Speed
  – Technology
  – D.I.Y.
• Control and Resource Management
Is Speed Everything?

• 40 Gbps Technology Cost
• Multiple 2.5 Gbps
• Interfacing Costs
  – Routers
  – Switches