Why is optical networking interesting?

[Website Link]

Cees de Laat

Faculty of Science
Why is optical networking interesting?

www.science.uva.nl/~delaat

Cees de Laat

EU

SURFnet

University of Amsterdam
The VLBI array scales with the square of the data-rate (S^2) and there is a strong push to increase the data rates. Rates of 8Gb/s or more are entirely feasible under development. It is expected that parallel decimation and correlator will remain the most efficient approach. However, distributed processing may have an application. Multi-gigabit data streams will aggregate into larger processing centers and the capacity of the final link to the data bank.

(Westerbork Synthesis Radio Telescope - Netherlands)
The International Virtual Laboratory

www.igrid2002.org

24-26 September 2002
Amsterdam Science and Technology Centre (WTCW)
The Netherlands

• A showcase of applications that are “early adopters” of very-high-bandwidth national and international networks
  – What can you do with a 10Gbps network?
  – What applications have insatiable bandwidth appetites?
• Scientists and technologists to optimally utilize 10Gbps experimental networks, with special emphasis on e-Science, Grid and Virtual Laboratory applications
• Registration is open (www.igrid2002.org)
• iGrid is not just a conference/demonstration event, it is also a testbed!!
• Contact
  – maxine@startap.net or deLaat@science.uva.nl
Know the user

A -> Lightweight users, browsing, mailing, home use
B -> Business applications, multicast, streaming, VPN’s, mostly LAN
C -> Special scientific applications, computing, data grids, virtual-presence
A -> Need full Internet routing, one to many
B -> Need VPN services on/and full Internet routing, several to several
C -> Need very fat pipes, limited multiple Virtual Organizations, few to few
So what are the problems

- Costs of fat pipes (fibers) are one/third of equipment to light them up
  - Is what Lambda salesmen tell me

- Costs of (semi) optical equipment one/fifth of full routing equipment (for same throughput)
  - 100 Byte packet @ 10 Gb/s -> 80 ns to look up in 100 Mbyte routing table (light speed from me to you on the back row!)

- Big sciences need fat pipes

- Bottom line: create a hybrid architecture which serves all users in one consistent cost effective way
• lambda for high bandwidth applications
  – Bypass of production network
  – Middleware may request (optical) pipe

• RATIONALE:
  – Lower the cost of transport per packet
CA*net 4 Architecture

Possible future CA*net 4 node
Bring plumbing to the users, not just create sinks in the middle of nowhere.
Transport in the corners

BW*RTT

Needs more App & Middleware interaction

Full optical future

For what current Internet was designed

# FLOWS
Layer - 2 requirements from 3/4

TCP is bursty due to sliding window protocol and slow start algorithm. So pick from menu:
- **Flow control**
- **Traffic Shaping**
- **RED (Random Early Discard)**
- **Self clocking in TCP**
- **Deep memory**

Window = BandWidth * RTT  &  BW == slow

Memory-at-bottleneck = _________ * slow * RTT

<table>
<thead>
<tr>
<th></th>
<th>fast</th>
<th>L2</th>
<th>high RTT</th>
<th>L2</th>
<th>fast</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS</td>
<td>fast</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WS</td>
<td></td>
<td>fast-&gt;slow</td>
<td></td>
<td></td>
<td>fast</td>
</tr>
<tr>
<td>WS</td>
<td></td>
<td>fast</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WS</td>
<td></td>
<td>slow-&gt;fast</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 2

- fast

- slow

- RTT

- BW

- slow

- fast
Daisy Chain control model of administrative domains

Selector Switch

Distributor Switch

AAA

Domain X

Domain Y

Faculty of Science
Problem Solving Environment
Applications and Supporting Tools
Application Development Support

Collective Grid Services
- Brokering
- Global Queuing
- Co-Scheduling
- Data Cataloging
- Auditing
- Authorization
- Monitoring
- Fault Management

Commo Grid Services (Resource)
- Grid Information Service
- Uniform Resource Access
- Global Event Services
- Uniform Data Access
- Communication Services

Grid Security Infrastructure (authentication, proxy, secure transport)

Communication

Grid access (proxy authentication, authorization, initiation)

Fabric
- Grid task initiation

Local Resource Services
- Resource Manager - CPUs
- Resource Manager - Monitors
- Resource Manager - On-Line Storage
- Resource Manager - Scientific Instruments
- Resource Manager - Tertiary Storage
- Resource Manager - Highspeed Data Transport
- Resource Manager - QoS

layers of increasing abstraction taxonomy
GRID-Layer

CE

SE

UE

ISP’s peering

L3

L2

L1

NE
Research needed

• Optical devices
• Internet Architecture
• Network Elements as Grid Resources
• Transport protocols get in other corners
• How dynamic must your optical underware be
• Don’t mix trucks and Ferrari’s
Revisiting the truck of tapes

Consider one fiber

• Current technology allows 320 λ in one of the frequency bands
• Each λ has a bandwidth of 40 Gbit/s
• Transport: \(320 \times 40 \times 10^9 / 8 = 1600\) GByte/sec

• Take a 10 metric ton truck
  • One tape contains 50 Gbyte, weights 100 gr
  • Truck contains (10000 / 0.1) * 50 Gbyte = 5 PByte

• Truck / fiber = 5 PByte / 1600 GByte/sec = 3125 s ≈ one hour

• For distances further away than a truck drives in one hour (50 km)
minus loading and handling 100000 tapes the fiber wins!!!
The END

Thanks to
TERENA: David Williams
SURFnet: Kees Neggers
UIC&iCAIR: Tom DeFanti, Joel Mambretti
CANARIE: Bill St. Arnaud
This work is supported by:
SURFnet
EU-IST project DATATAG