Impact of Grid Computing on Network Operators and HW Vendors

Hot Interconnect @ Stanford

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Optical Networks Change the Current Pyramid

George Stix,
Scientific American,
January 2001

DWDM- fundamental miss-balance between computation and communication
5 Years – x10 gap, 10 years- x100 gap
Waste Bandwidth

“A global economy designed to waste transistors, power, and silicon area - and conserve bandwidth above all - is breaking apart and reorganizing itself to waste bandwidth and conserve power, silicon area, and transistors.”

George Gilder Telecosm
The “Network” is a **Prime Resource for Large-Scale Distributed System**

Integrated SW System Provide the **“Glue”**

Dynamic optical network as a fundamental Grid service in data-intensive Grid application, to be scheduled, to be managed and coordinated to support collaborative operations.
From Super-computer to Super-network

> In the past, computer processors were the fastest part
  • peripheral bottlenecks

> In the future optical networks will be the fastest part
  • Computer, processor, storage, visualization, and instrumentation - slower "peripherals"

> eScience Cyber-infrastructure focuses on computation, storage, data, analysis, Work Flow.
  • The network is vital for better eScience
Grid Network Limitations in L3

> Radical mismatch between the optical transmission world and the electrical forwarding/routing world.
  * Currently, a single strand of optical fiber can transmit more bandwidth than the entire Internet core.

> Transmit 1.5TB over 1.5KB packet size
  ❳→ 1 Billion identical lookups

> Mismatch between L3 core capabilities and disk cost
  * With $2M disks (6PB) can fill the entire core internet for a year

> L3 networks can’t handle these amounts effectively, predictably, in a short time window
  * L3 network provides full connectivity -- major bottleneck
  * Apps optimized to conserve bandwidth and waste storage
  * Network does not fit the “e-Science Workflow” architecture

Prevents true Grid Virtual Organization (VO) research collaborations
Lambda Grid Service

Need for Lambda Grid Service architecture that interacts with Cyber-infrastructure, and overcome data limitations efficiently & effectively by:

• treating the “network” as a primary resource just like “storage” and “computation”
• treat the “network” as a “scheduled resource”
• rely upon a massive, dynamic transport infrastructure: Dynamic Optical Network
Generalization and Future Direction for Research

> Need to develop and build services on top of the base encapsulation

> Lambda Grid concept can be generalized to other eScience apps which will enable new way of doing scientific research where bandwidth is “infinite”

> The new concept of network as a scheduled grid service presents new and exciting problems for investigation:
  • New software systems that is optimized to waste bandwidth
    • Network, protocols, algorithms, software, architectures, systems
  • Lambda Distributed File System
  • The network as a Large Scale Distributed Computing
  • Resource co/allocation and optimization with storage and computation
  • Grid system architecture
  • enables new horizon for network optimization and lambda scheduling
  • The network as a white box, Optimal scheduling and algorithms
Enabling new degrees of App/Net coupling

> Optical Packet Hybrid
  • Steer the herd of elephants to ephemeral optical circuits (few to few)
  • Mice or individual elephants go through packet technologies (many to many)
  • Either application-driven or network-sensed; hands-free in either case
  • Other impedance mismatches being explored (e.g., wireless)

> Application-engaged networks
  • The application makes itself known to the network
  • The network recognizes its footprints (via tokens, deep packet inspection)
  • E.g., storage management applications

> Workflow-engaged networks
  • Through workflow languages, the network is privy to the overall “flight-plan”
  • Failure-handling is cognizant of the same
  • Network services can anticipate the next step, or what-if’s
  • E.g., healthcare workflows over a distributed hospital enterprise
finesse the control of bandwidth across multiple domains
while exploiting scalability and intra-, inter-domain fault recovery
thru layering of a novel SOA upon legacy control planes and NEs
Grid Network Services
www.nortel.com/drac

Internet (Slow)
Fiber (FA$T)

Multi-Resource Orchestration

DRAC
Grid Network Services
www.nortel.com/drac

OM3500
OM3500

Make the Network part of the GT4 - WSRF - SOA Equation
Some key folks checking us out at our booth, GlobusWORLD ‘04, Jan ‘04