TransLight
A Global LambdaGrid for e-Science

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STAR TAP was created in 1997 to provide a persistent infrastructure for the long-term interconnection and interoperability of advanced international networking in support of applications, performance measuring, and technology evaluations. By 2000, STAR TAP successfully became a model for Next-Generation Internet eXchanges (NGIXs).
StarLight: Global Optical Internet Exchange

StarLight is an experimental optical infrastructure and proving ground for network services optimized for high-performance applications.

Operational since summer 2001, StarLight is perhaps the world’s largest 1GigE and 10GigE switch/router exchange for high-performance access to participating networks and is becoming a true optical switching facility for wavelengths.

Abbott Hall, Northwestern University’s Chicago downtown campus
NSF Network Types

• NSF describes three classes of Research & Education networks beyond the commodity Internet:
  – Production Networks
  – Research Networks
  – Experimental Networks
Production Networks

• High-performance networks, which are always available and dependable.
• These networks reach all researchers.
Research Networks

• Smaller-scale networks for basic scientific and engineering network research.

• Research Networks are not expected to be reliable, nor are they expected to support applications.
Experimental Networks

- High-performance trials of new technologies that support *application-dictated* development of software toolkits, middleware, computing and networking.
- Provide *known and knowable characteristics* with deterministic and repeatable behavior on a persistent basis, while encouraging experimentation with innovative concepts.
- Experimental Networks are seen as the *missing link* between Research and Production Networks.

http://www.evl.uic.edu/activity/NSF/index.html
http://www.calit2.net/events/2002/nsf/index.html
The Next S-Curves of Exponential Technology Growth

- Technology S-Curve:
  - Research
  - Experimental/Early Adopters
  - Production/Mass Market

- Networking Technology S-Curves:
  - Gigabit Testbeds
  - Internet2 Abilene
  - Experimental Networks
  - Lambda Grids

Timeline:
- ~1990s
- 2000
- 2010
StarLight is Home for all Types of Networks

• A Production Network 1GigE and 10GigE exchange
• An Experimental Network optical (lambda) exchange and proving ground for network services optimized for high-performance computing applications
• A Research Network 1GigE and 10GigE MEMS-switched exchange
• A co-location space with 66 racks for networking and computing and data-management equipment
• An OIX with fiber and/or circuits from SBC/Ameritech, Qwest, AT&T, Global Crossing, Looking Glass Networks, Level 3, RCN, T-Systems, I-WIRE
• A lambda-switching facility, with links coming from USA, NetherLight, DataTAG, CA*net4, and proposed from UK-Light and APAN forming TransLight
Who Needs Experimental Networks?

- 28 demonstrations from 16 countries: Australia, Canada, CERN, France, Finland, Germany, Greece, Italy, Japan, The Netherlands, Singapore, Spain, Sweden, Taiwan, United Kingdom, United States
- Applications demonstrated: art, bioinformatics, chemistry, cosmology, cultural heritage, education, high-definition media streaming, manufacturing, medicine, neuroscience, physics, tele-science

- Grid technologies demonstrated: Major emphasis on grid middleware, data management grids, data replication grids, visualization grids, data/visualization grids, computational grids, access grids, grid portals
- 25Gb transatlantic bandwidth (100Mb/attendee, 250x iGrid2000!)

www.startap.net/igrid2002
A worldwide community of e-scientists, application programmers, networking engineers, electrical/computer engineers, artists and computer scientists working together
Who Needs Experimental Networks?
NSF Major Research Equipment (MRE) and Information Technology Research (ITR) projects

ALMA: Atacama Large Millimeter Array
www.alma.nrao.edu

GriPhyN: Grid Physics Network
www.griphyn.org

TeraGrid
www.teragrid.org

International Virtual Data Grid Laboratory
www.ivdgl.org

The OptIPuter

Network for Earthquake Engineering Simulation
www.neesgrid.org

Large Hadron Collider (LHC)
http://lhc-new-homepage.web.cern.ch

Particle Physics Data Grid
www.ppdg.net

GEON: Geosciences Network
www.geongrid.org

NEON: National Ecological Observatory Network
www.sdsc.edu/NEON

EarthScope
www.earthscope.org
What is a Lambda?

- A *lambda*, in networking, is a fully dedicated wavelength of light in an optical network, typically used today for 1-10Gbps.
- Lambdas are circuit-based technology, but can carry packet-based information.
- We are now mostly working with 1Gb dedicated layer2 circuits that act like lambdas.
- For this discussion, *lambda* means large and desirable units of networking, which is how the applications see them, conceptually offering the promise of end-to-end custom connectivity or allowing sufficiently massive over-provisioning of bandwidth so that the connection is effectively uncongested.
What is a LambdaGrid?

- A **grid** is a set of networked, middleware-enabled computing resources.
- A **LambdaGrid** is a grid in which the lambda networks themselves are resources that can be scheduled, like all other computing resources. The ability to schedule and provision lambdas provides **deterministic** end-to-end network performance for real-time or time-critical applications, which cannot be achieved on today’s grids.
TransLight is a Global-Scale Experimental Network (Coming Summer 2003)

- Supports prototypes of the most aggressive e-science applications coming this decade
- Consists of many GigE lambdas among North America, Europe and Asia via StarLight available for scheduling
- Enables researchers to experiment with deterministic provisioning of dedicated circuits, and then compare results with standard production networks
- Experiments include moving large amounts of data, real-time collaboration and visualization, and distributed computing
TransLight Activities

• A TransLight Governance Board to create policy for scheduling circuits; initial members are SURFnet, CANARIE, DataTAG/CERN, StarLight/Euro-Link, with others to be invited soon
• Provide global lambdas for scheduling
• Build more hubs with switches, co-location space and fiber access like StarLight and NetherLight
TransLight Fabric

Red Lines: TransLight Lambda 10Gb Links, Funded

Blue Lines: TransLight Lambda 10Gb Links, Donated
The TransLight Project
~54 Int’l GigE Lambdas in 2003/2004

• 16 Canadian Lambdas from StarLight
  – 8 GigEs Chicago to Eastern Canada and NYC
  – 8 GigEs Chicago to Western Canada and Seattle

• 22 European Lambdas to StarLight
  – 10 GigEs Amsterdam to Chicago
  – 4 GigEs CERN to Chicago
  – 8 GigEs London to Chicago

• 12 European Lambdas to NetherLight
  – 4 GigEs CERN to Amsterdam
  – 2 GigEs Prague to Amsterdam
  – 2 GigEs Stockholm to Amsterdam
  – 8 GigEs London to Amsterdam

And many Metro/Regional/National Lambdas
TransLight Persistent Experiments

- New network protocols – TCP is not usable for long fat applications
- Optical point-to-point connects for instruments
- Circuits are not scalable, but neither are routers
- Application-centric intelligent signaling and management plane middleware – putting intelligence on the edges (not the core)
- Tuning compute, data, visualization, networking using clusters to get orders of magnitude improvement
- Security at 10Gb line speed
Extremely High-Resolution Digital Montage Visualization

- Large digital montage viewer for tiled LCD displays view high-resolution montages from NCMIR, Scripps, USGS.

- Example: In a Homeland Security / Emergency Response Application, USGS has aerial photos of 133 urban areas:
  - 5643 tiles each 5000x5000 pixel resolution ~ 375,600x375,600 pixels for each urban area (394GB per area)
  - Total data ~ 51 TB

www.evl.uic.edu/cavern
StarLight as a Research Network
Using Optical Switching

• No need to look at every packet when transferring a terabyte of information
  – 1% the cost of routing
  – 10% the cost of switching
  – 64x64 10Gb:
    • $100,000 O-O-O switched
    • $1,000,000 O-E-O switched
    • $10,000,000 O-E-O Routed

• Spend the savings on computing and collaboration systems instead!

• Replaces patch panels; allows rapid reconfiguration of 1 and 10Gb experiments
StarLight as a Research Network
Optical Micro-Mirror Switching

Innovation or impossible? This is the core of a Glimmer-glass optical switch.
A “groomer” is a box that accepts multiple circuits of varying types (e.g., 1GigE, 10GigE) and aggregates and/or disseminates over the 10Gbps transoceanic link. As the amount of transoceanic connectivity increases, we aim to “bandwidth match” the amount of data being sent and/or received by clusters across continents.
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