GLIF

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Dark Fiber based Networks

- **National Lambda Rail is operational in U.S.**
  - http://www.nlr.net/
  - Dark Fibers from Level3
  - LAX-SFO-SEA-DEN-ORD-PIT-NYC-WAS
  - Southern route is being installed
  - Cisco ONS-15808 DWDM
    - Upto 30 10GE LANPHYs
  - Light Paths can be configured statically
- **SURFnet operates a nation-wide DF based network**
  - http://www.surfnet.nl/
  - Light Paths can be configured statically

Non-DF based Networks

- **JGN2 in Japan**
  - OC-192 or 8*GbE for Long-Haul
  - Some links are 10GE LANPHY based on DF
  - Layer-2 service rather than Light Paths
- **CA*net4 in Canada**
  - Nation-wide Multiple OC-192
  - Only fraction of BW is used for commodity
  - Light Paths can be configured through a GUI
    - UCLP

OC-48/OC-192 class International links

- **Some are operated as a regular Layer-3 links**
  - TransPAC/APAN, SINET, etc
- **Others are operated as "lambda"**
  - some of the bandwith is reserved for a layer-3 link
  - SURFnet
    - OC-192 between Amsterdam and Chicago
  - IEEAF Atlantic
    - OC-192 between New York and Amsterdam
  - IEEAF Pacific
    - OC-192 between Seattle and Tokyo
  - JGN2
    - OC-192 between Tokyo and Chicago

A Light Path

- ☆ **There is no formal definition yet**
  - Generally point-to-point connection w/ QoS enforced
- ☆ **Many levels of definitions can be possible**
  - A MPLS tunnel/VPN w/ QoS
  - VLANs
  - ATM PVC w/ CBR or ABR
  - SONET/SDH
  - GbE/10GE encoded on SONET/SDH
- ☆ **Pure Light Path might have**
  - No jitter, No packet loss (there may be bit errors)
- ☆ **Layer-2 Light Path**
  - Bandwidth guaranteed, some jitter
  - Jumbo frame enabled
  - Transparent to Layer-3 Protocols

Scientific Data Transfer

☆ **Long-distance transmission**
- Source : Acceleerators, Telescopes, ...
- Destination : Universities, SuperComputer Centers, ...
- Transmission often across national borders
  - even several times

☆ **Amount of data is huge**
- Data sources generate lot of data
- Precision of analysis depends on the amount of data
- Semi-realtime transmission is required
  - For duration of "observation" or "experiment"
  - May not occupy the bandwidth in 24x7 basis

Scientific Data Transfer

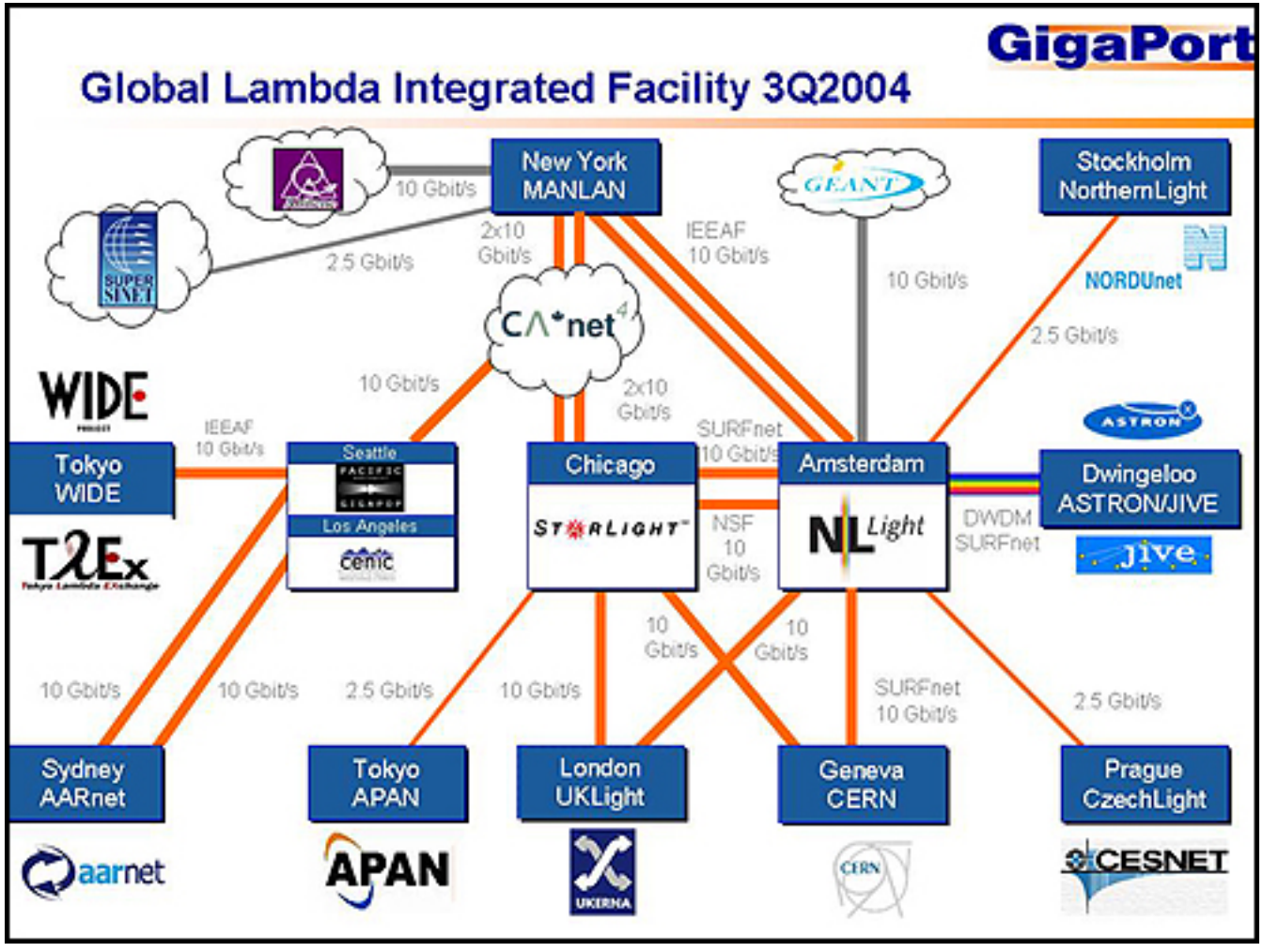
- ☆ **Number of hosts involved is small**
  - 10 hosts in each side, or even single host
- ☆ **Large bandwidth is requied**
  - GbE, OC-48, or 10GE/OC-192
  - 100ms or 200ms RTT delay
  - Bandwidth-Delay product is huge
    - Very difficult to control transmission
  - Most of them require reliable transmission
    - VLBI would be an exception
  - Regular TCP is difficult to accomodate it
    - "fairness" among other TCP sessions
    - Aggressive growth of window necessary
    - Even use of other transport protocol than TCP
- ☆ **Jumbo frames required To reduce the overhead**
  - header, interrupt, etc

Global Lambda Integrated Facility

- http://www.glif.is/
- A virtual organization
  - No formal by-law
- Annaul invitation-only meeings
  - Aug 2004 : Reykjavik, IS
  - Sep 2004 : Nottingham, UK
  - Sep 2005 : San Diego, US
  - Sep? 2006 : Tokyo?, JP
- Intermediate meeting for Tech WG
  - Feb 2005 : Salt Lake City, US

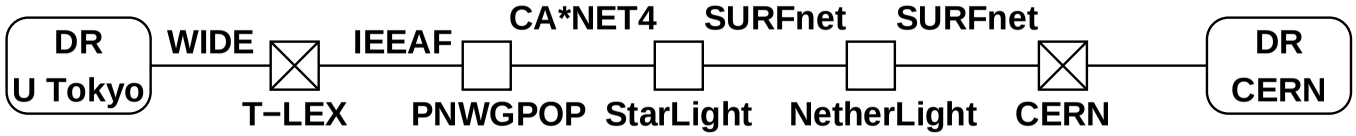
Global Lambda Integrated Facility

Global Lambda Integrated Facility



Sep 2004 : Tokyo -- Geneva OC-192

☆ Multi-national collaboration : JP, US, CA, NL, CH



- 11,000mi/18,000km long
- L2 device: NI40G in T-LEX and CERN
- First long-distance 10GE WANPHY
- The light path existed for two weeks

Sep 2004 : Tokyo -- Geneva OC-192

- ☆ **Data Reservoir tried to fill the pipe**
  - Prof. Hiraki from the Univ. of Tokyo
  - http://data-reservoir.adm.s.u-tokyo.ac.jp/
- ☆ **Each box is with a Chelsio T110 10GE NIC**
  - TCP was off-loaded to the NIC
  - 1500 byte standard frames used
- ☆ **Two different transfer modes tried**
  - A pair of Opteron boxes
    - Each with a Chelsio T110 10GE NIC
    - Single TCP
    - Memory to meory transfer
  - A pair of 9 Xeon boxes
    - Disk to disk tranfer
    - Many (36) TCP sessions
    - iSCSI over TCP

Sep 2004 : Tokyo -- Geneva OC-192

☆ **Circuit setup**
- Configuration has been done in a day

☆ **Packet loss**
- Divide-and-conquer loopback test
  - Time consuming process
  - SURFnet OC-192 card in Chicago was broken
  - Required another day to replace it
- Optical attenuator at ONS-15454 OC-192 LR card
  - Special SC connector (with a shutter)
  - Attenuator should be at the other end of patch
- Clock source issue
  - IEEAF OC-192 doesn’t provide clock
  - It provides just a clear channel
  - T-LEX ONS-15454 got a clock from OC-12

Sep 2004 : Tokyo -- Geneva OC-192

- **Email was used for communication**
  - Good
    - Asynchronous, Recorded
    - Photo, drawing, URL
  - Bad
    - Non-realtime, need a separate trigger
    - SPAM protection can delay the delivery
    - Difficult to tell "subtle" things
- **May need a sophisticated method**
  - International Trouble Ticketing System?

Sep 2004 : Tokyo -- Geneva OC-192

- ☆ **Providing access to boxes helped a lot**
  - Mutual R/O access provided
    - UW and T-LEX ONS15454's
  - DR got access on NI40G's in both ends
    - Realtime reading of error counters useful
- ☆ **Making it to public may involve a security issue**
  - May need to establish a "Trustworth" community
  - Access to every gear en-route should be provided
  - Abilene's Core Node Proxy is a wonderful example
  - Device independent access possible?
    - ONS-15454, OME6500, HDXc, Foundry, Cisco
    - Force10, Procket, Juniper, Hitachi/Alaxala, Fujitsu

Sep 2004 : Tokyo -- Geneva OC-192

☆ **Results**

- Circuit was configured w/o packet loss
  - 18,000km measured by "known" points
- Single TCP memory to memory
  - 7.57Gbps was marked
- Disk to disk transfer
  - 9Gbps was marked

SC2004

☆ DR tried Bandwidth Challenge

- AMS--CHI--TYO--CHI--PIT : 31,248km
- Marked 7.21Gbps Single-TCP memory to memory
- LSR was not fully approved
  - LSR measures by distance of L3 devices
  - AMS--TYO--CHI--PIT : 20,123km

☆ DR's retry in Chistmas

- TYO--CHI--AMS--NYC--CHI--TYO : 30,000km
  - Actual distance was 33,979km
  - But cropped to 30,000km due to a LSR rule
- 7.21Gbps was marked, yielding 216,300 Tbps m/sec
- Updated LSR
  - Single-TCP class
  - Multiple-TCP class

JGN2

☆ **JGN2 : Japan Gigabit Network version2**

- A Nation-wide testbed network
  - Funded by MPHPT
- Version 1 was ATM based
- 10GE/GbE based JGN2 launched in Apr 2004
- http://jgn2.jp/
  - Not all information available
  - Not information avalable in English
- (partially unprotected) OC-192 to Chicago

☆ **JGN Symposium held twice a year**

- Jan 17-18, 2005 in Osaka

JGN Symposium

☆ Background

- Prof. Smarr from UCSD invited to give a keynote
- He was not make a trip to Japan
- He happened to be in Seattle
- Research Channel at UW get involved
- Trial for remote talk with HDTV
  - Using JGN's OC-192 circuit to Chicago
- Plan was not discussed in detail by Nov 04

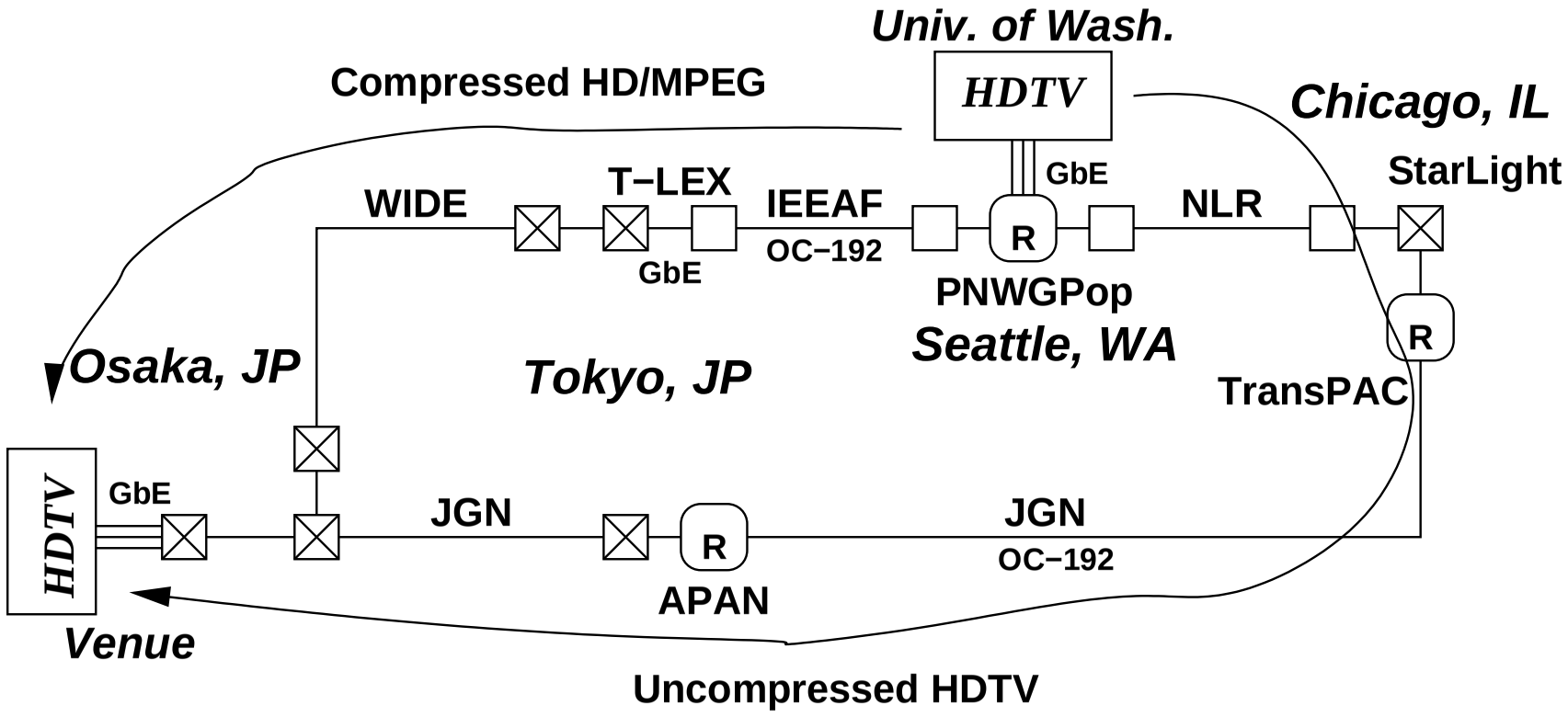
☆ Uncompressed HDTV

- Requires 1.5Gbps bandwidth
- UW's implementation can stripe it over two GbEs
  - No OC-48 or 10GE is necessary

JGN Symposium

☆ Intial Plan

- Two independent path for redundancy
  - Chicago route for main uncompressed stream
  - IEEAF route for backup HD/MPEG



JGN Symposium

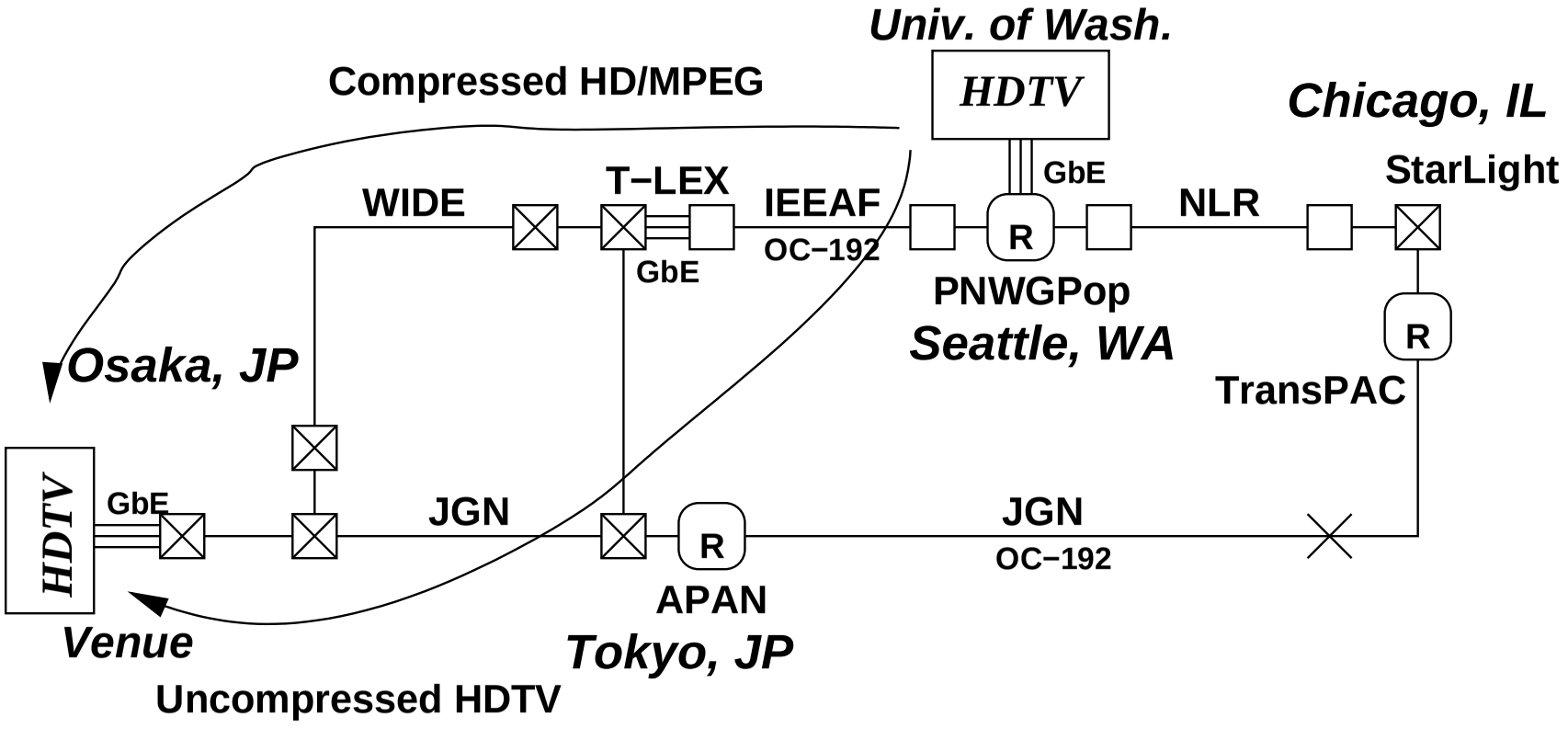
☆ **A fiber cut happened in Jan10 1742JST**

- Due to flooding in Nevada
- LA--Chicago JGN2 OC-192 was unprotected
- The carrier was not able to get there until Jan11

JGN Symposium

☆ Contingency plan was being discussed

- Use IEEAF circuit for two streams
- Even after fiber restored at Jan13 1420JST
  - To avoid confusion
  - UW was busy for three demonstrations



JGN Symposium

JGN Symposium

☆ **Prof. Smarr gave presentation in almost perfect**

- Audio demux broken in the last minutes in Osaka
- Use the combination of
  - Video from the Uncompressed stream
  - Audio from HD/MPEG
- Lip-Sync was lost, unfortunately

☆ **For those who involved to make this successful**

- UW, Pacific-Interface, PNWGpop, NLW, StarLight
- TransPAC, APAN, IEEAF, T-LEX, WIDE, JGN2
- NTT Communications, NTT Lab, NTT West
- and more

Control Plane of GLIF

- ☆ **Most of the gear in the middle**
  - Configured manually
  - Coodination by meeting required
  - Actual configuration is done in a day or two
  - "wiring" a fiber may required
  - The configuration lasts for a few days or more
- ☆ **CANARIE developed UCLP**
  - User-Controlled Light Path
  - Configuration through a GUI w/ authentication
  - Generate TL1 commands to be uploaded to gear
  - "time-share" in order of an hour possible
  - one app for daytime, another for nighttime

Control Plane of GLIF

- ☆ **GMPLS is not easy to introduce**
- ☆ **A Light Path may spawn**
  - Multiple administration domains
    - Authentication and Authorisation required
    - May skip accounting in this case
  - Multiple vendors gear in multiple layers
    - DWDM, TDM, OXC
    - Encoding interface : GbE into STS-24
    - Layer-2 devices, VLANs

Summary of GLIF

☆ **It is working**
- Very static, or PVC-like in other words
- A light path lasts for hours, days, or even weeks
- Reconfiguration may need a day or two
- Control Plane Protocol
  - Email, Phone, or buy a glass of beer
- JP, US, CA, UK, NL, CH, CZ, KR, TW
- End-to-end light path was proved useful

☆ **Single Lambda was GbE/STS-24**
- Current trends of single lambda is 10GE/STS-192
- More bandwidth required
  - 3--4 10G between Japan to Seattle in SC2005
  - DR may fill the pipe w/ PCI-X 2.0