Inter-domain progress between US and Japan

Tomohiro Otani

NICT Tsukuba RC, Japan

KDDI R&D Laboratories, Inc.

enλIGHTened computing

KDDI R&D LABS NiCT National Institute of Information and Communications Technology

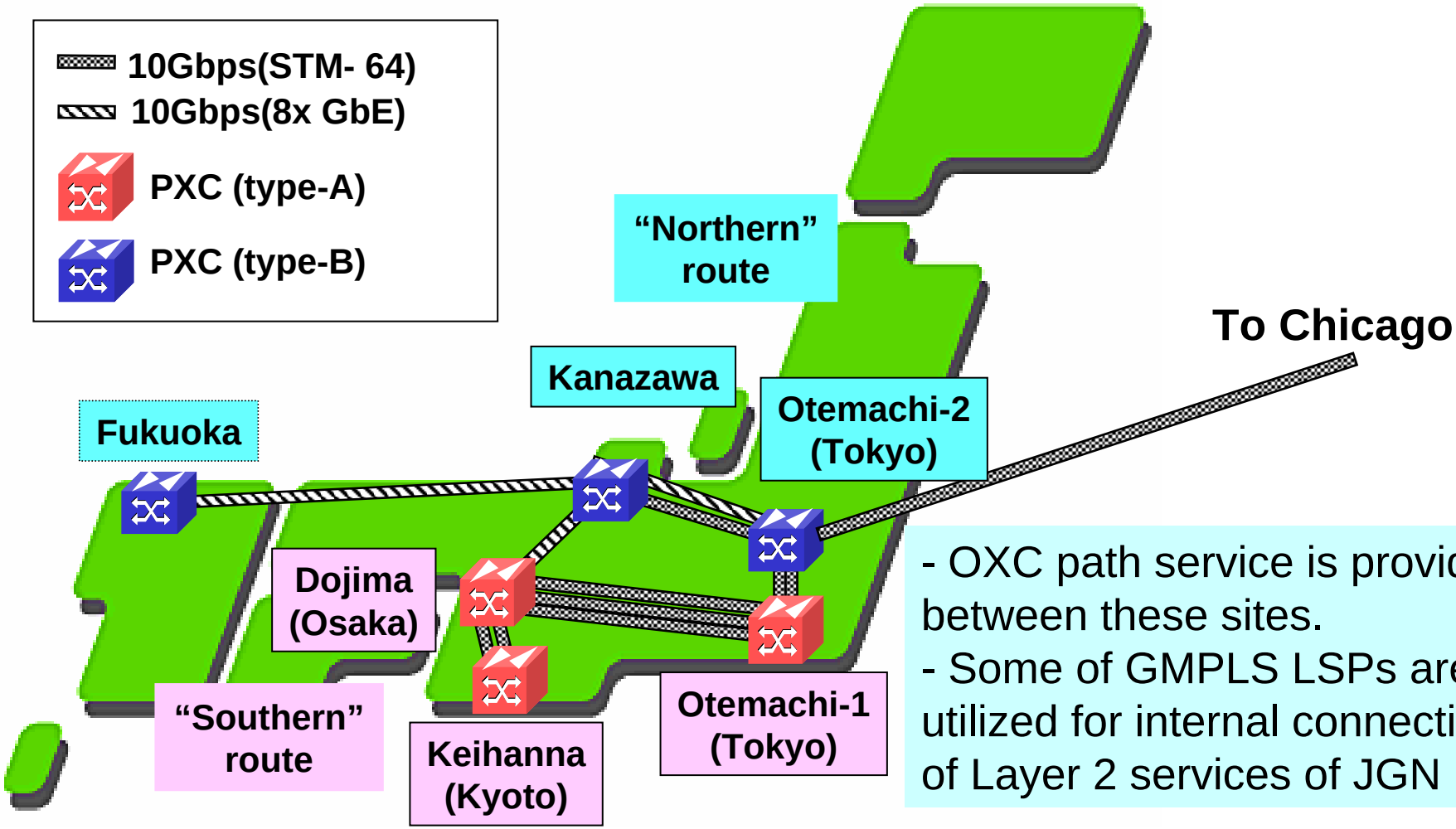
Agenda

- Introduction of JGN II project
- GMPLS E-NNI
- Experiment between US and Japan
- Standardizing activity in IEFT

What's JGN II ?

- R&D network testbed for universities, research institutions, and companies
- Non-commercial use only
- 64 access-points on every prefecture
- JGN II has been operated by NICT, since April 2004.
- Some international lines (Japan-US, etc)
- An introduction of GMPLS and photonic cross connects (PXCs) technologies to a backbone network.
- JGNII provides optical path service by using GMPLS and PXC technologies as well as L2 or L3 service on top of the GMPLS network.

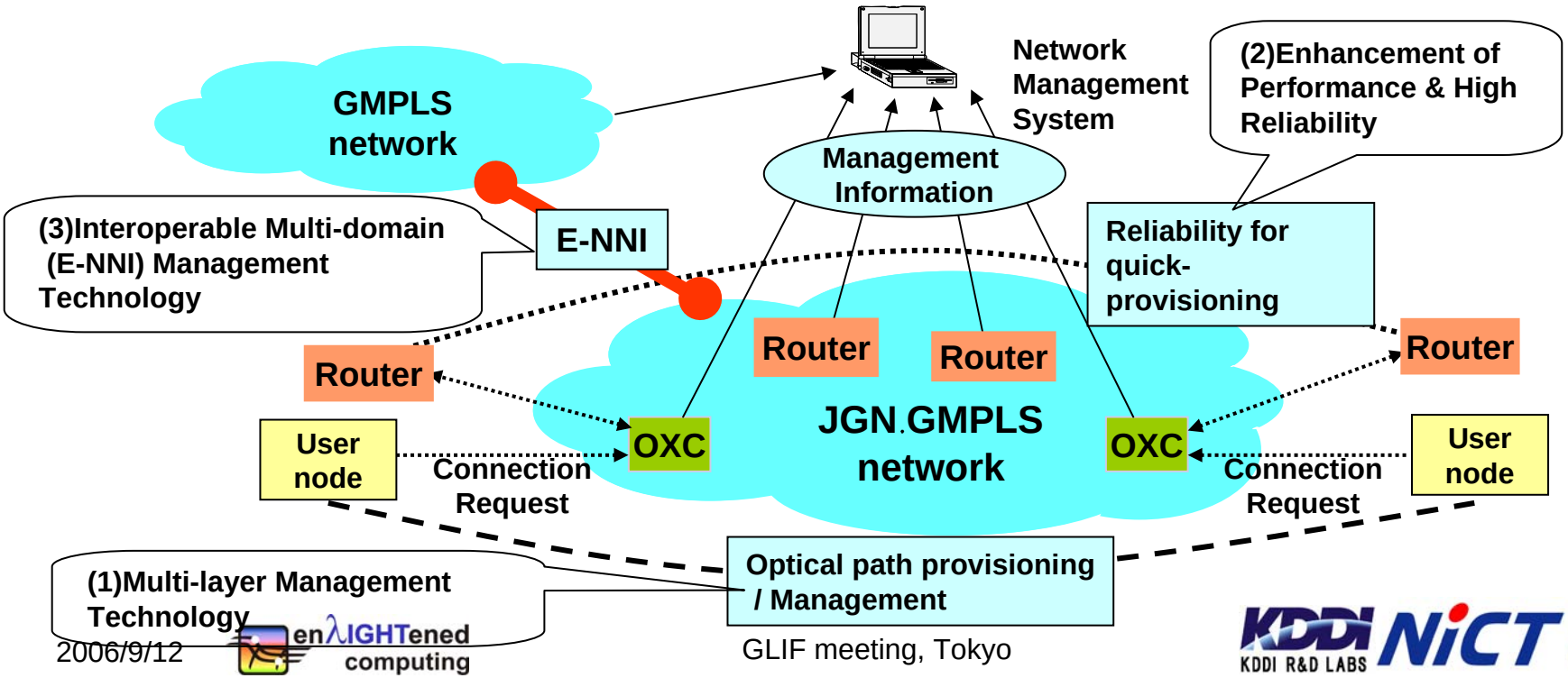
Overview of JGN II GMPLS network



- OXC path service is provided between these sites.
- Some of GMPLS LSPs are utilized for internal connectivity of Layer 2 services of JGN II.

GMPLS related research activities

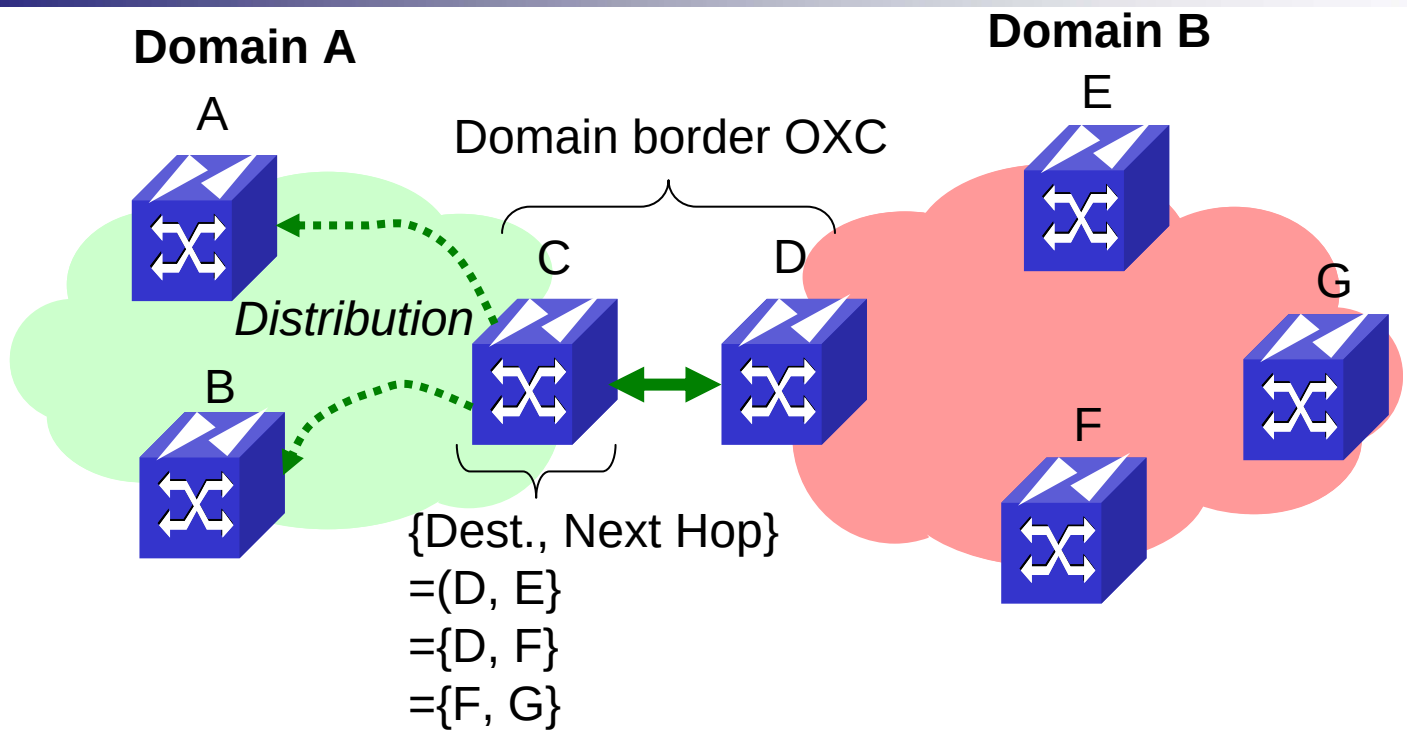
- Multi-layer management technology
  - Lambda-LSP provisioning network management and control mechanism
  - Application driven network control and management technology
- Enhancement of performance and reliability of GMPLS Network
  - Reliability of control plane as well as data-plane, including line monitoring
- Interoperable multi-domain (E-NNI) management technology
  - GMPLS Interworking between multiple domains



GMPLS E-NNI

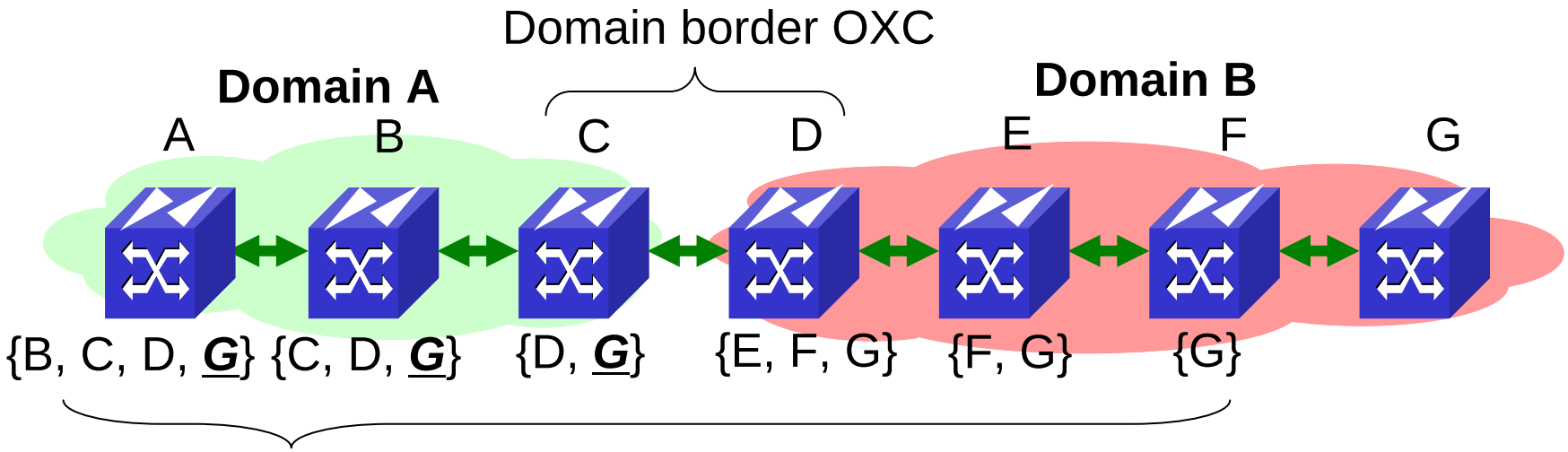
- GMPLS External Network - Network Interface
  - GMPLS routing & signaling mechanisms over multiple GMPLS domains.
- This new protocol is designed to allow GMPLS end-to-end LSPs (Label Switched Paths) that traverse the domain boundary to be setup and torn down without exposing internal routing information of the individual networks.

Routing mechanism



- Static route information is configured.
  - No IGP is running between domains to conceal the detail topology.
  - Dynamic routing mechanism is under investigation.

Signaling mechanism

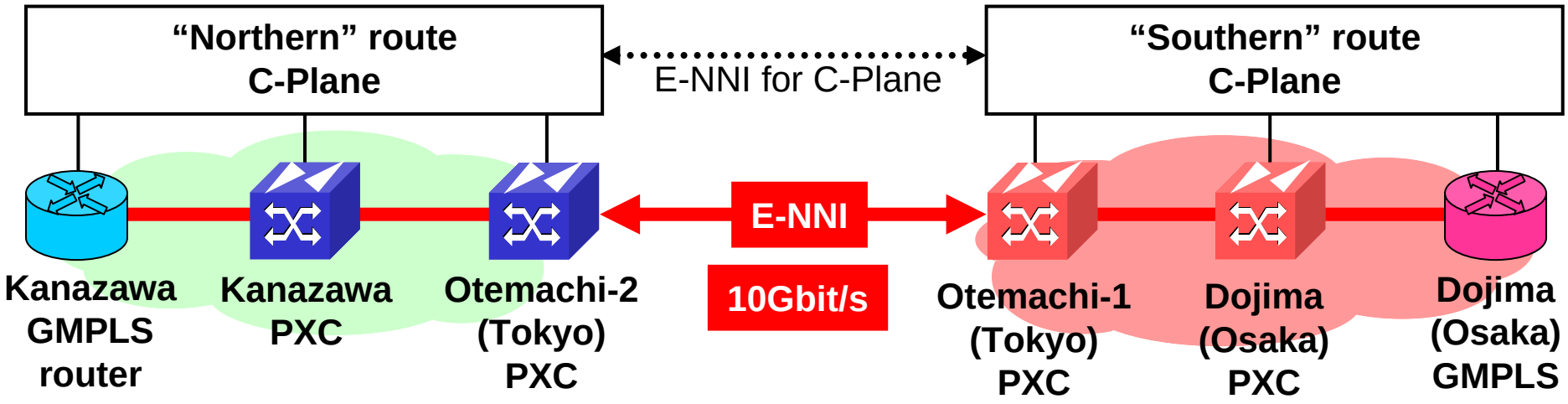


**Underlined and bold characters indicate the loose hop destination*

- Per-domain based path computation is applied
  - RSVP-TE loosely hopped signaling
  - Path computation at the domain border node

Evaluation of E-NNI

- GMPLS RSVP-TE signaling
  - Lambda LSPs could be successfully created over multiple domain.
- GMPLS OSPF-TE routing
  - Static routes were configured on domain-border nodes.
  - Dynamic routing exchange is under investigation
    - IETF standardizing activities
    - BGP-4, PCE, etc.



GMPLS E-NNI between Japan and U.S.

- Collaboration of

and

- Both testbeds support high-end scientific and network research in their respective countries by using Generalized Multi-Protocol Label Switching (GMPLS) to setup and control end-to-end optical circuit paths.

E-NNI experimental overview (1)

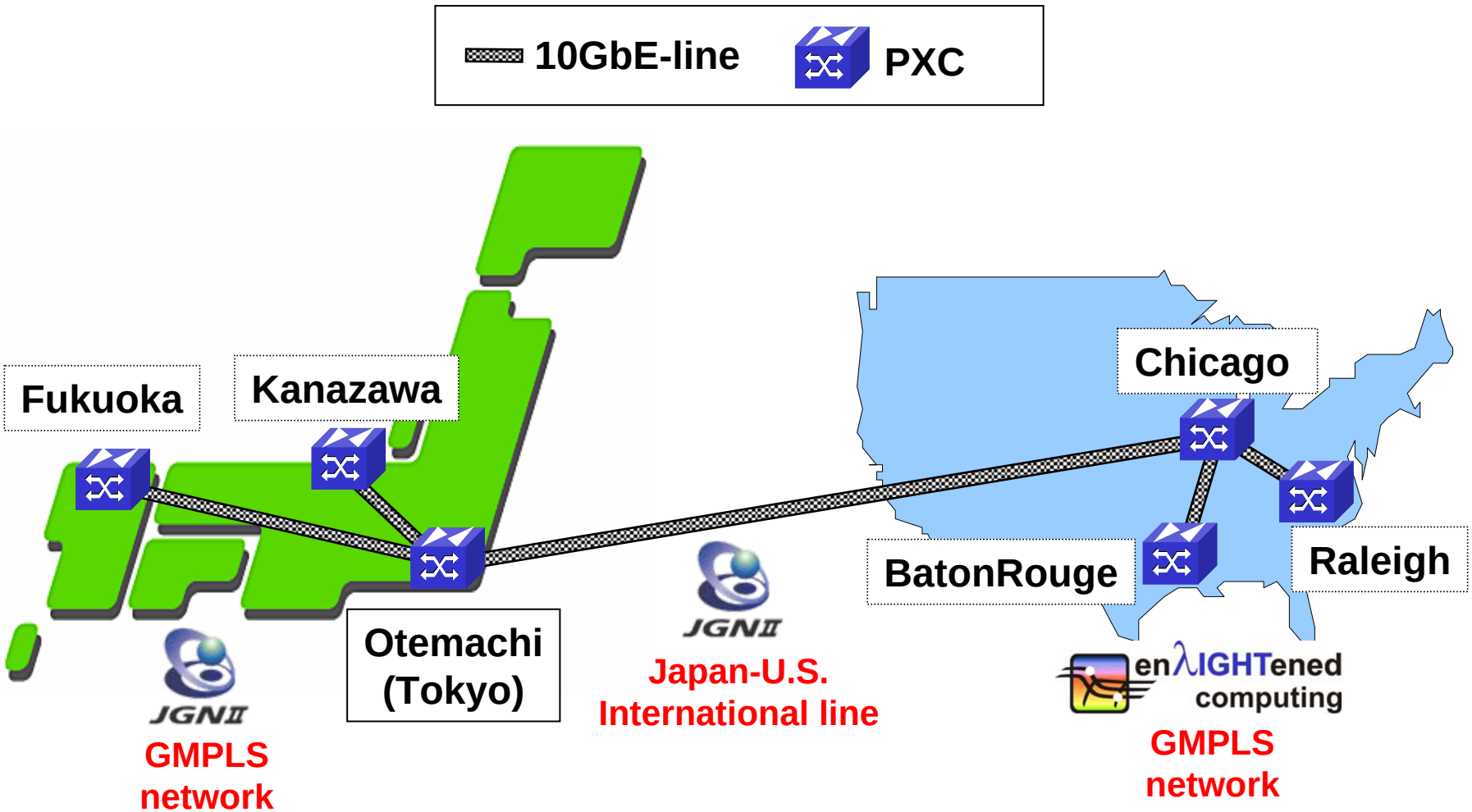
- Protocols
  - LMP (Link Management Protocol)
  - RSVP-TE
  - No routing information (ex. OSPF-TE) between border PXCs
- Control plane setup
  - Direct L2 connectivity between Tokyo PXC and Chicago PXC
  - Addressing: Local IP address
- Configuration of border PXCs
  - Next hop to peer in the external domain

E-NNI experimental overview (2)

- TE-link information
  - Unnumbered
  - Lambda Switch Capable
  - 10GbE
- Data plane network
  - Japan domain: JGN II GMPLS network
  - U.S. domain: Enlightened Computing GMPLS network
  - International circuit: JGN II international line (10GbE) between Tokyo and Chicago

Time-zone difference between Japan and U.S. made configuration coordination challenging!

Test configuration

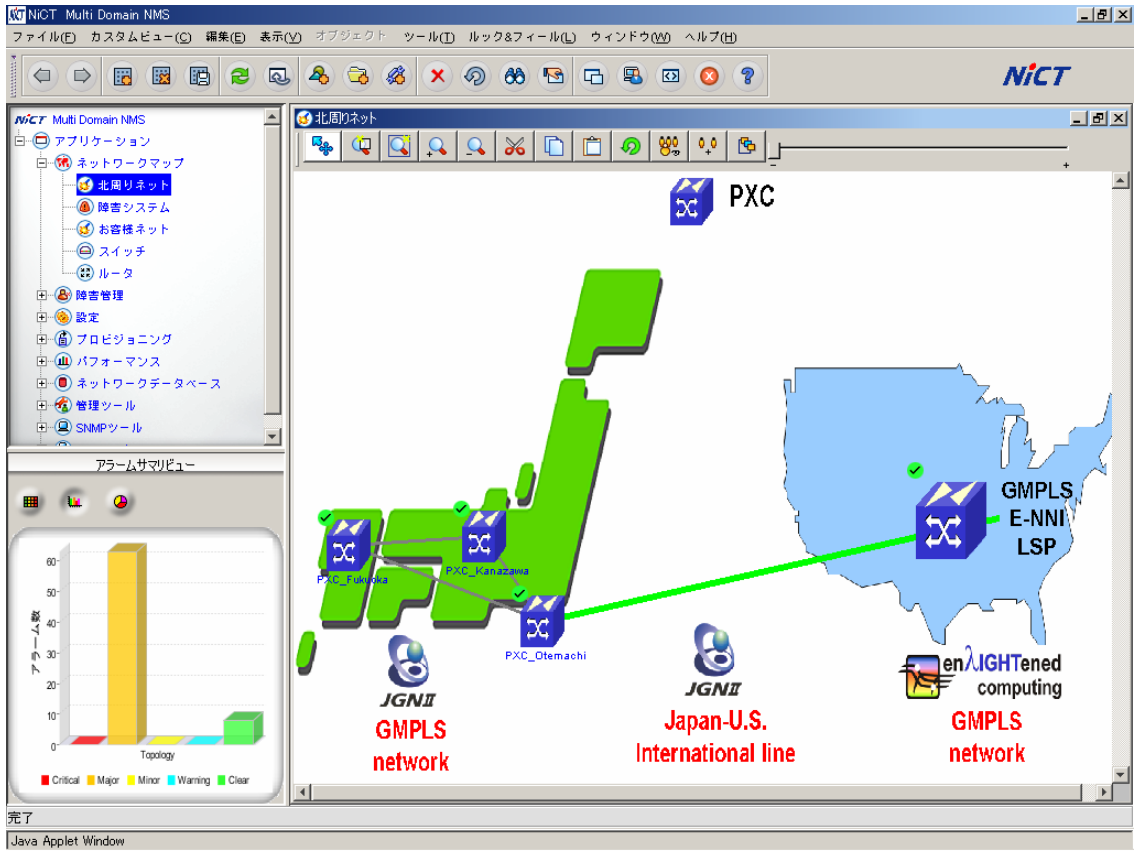


Experimental results

- LSPs could be successfully demonstrated between different pairs of sites in the US and Japan without exposing the topology information.
- The GMPLS signaling was completed within about 600 ms, although the data plane connectivity was established with the order of 30 second including layer 2 and 3 connectivity establishment.
- Future action items
  - Transit functionality evaluation
  - Multi-layer operation (Currently lambda) considering layer 2
  - Etc.

E-NNI Network management system

- Network management tools for the internal purpose.
  - Managing the E-NNI connection
  - Managing the GMPLS-based BoD service



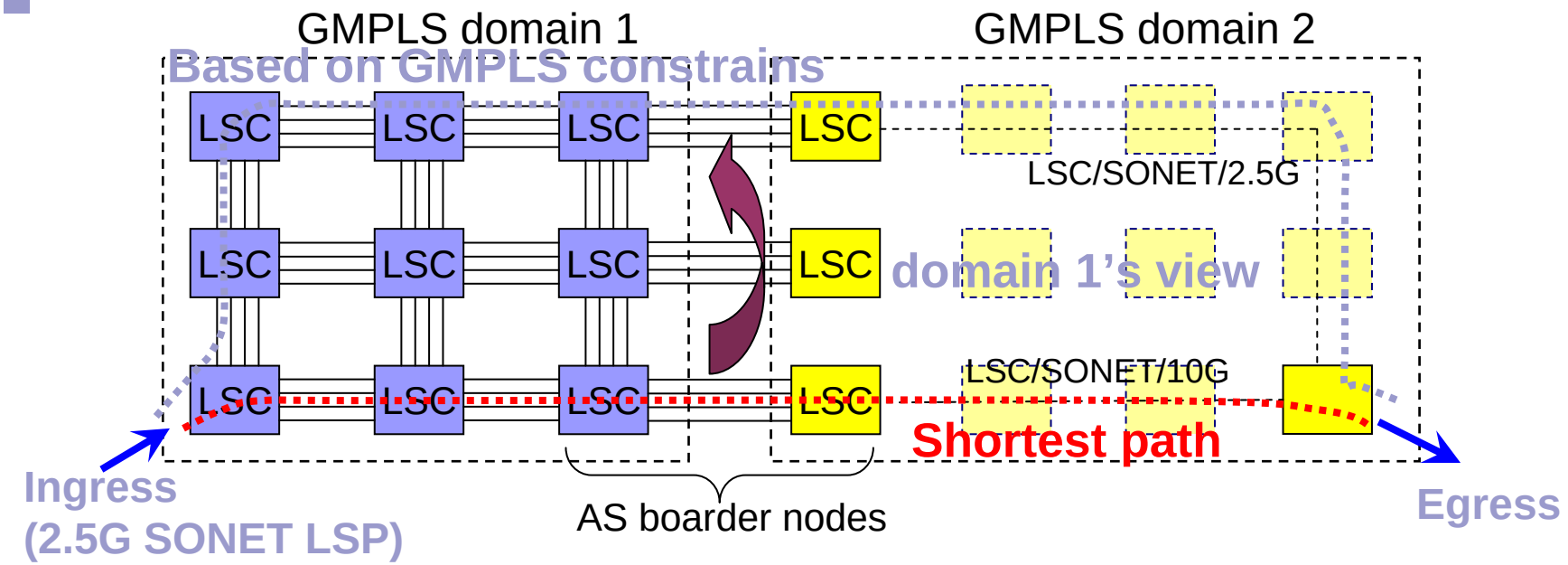
GMPLS Inter-domain Traffic Engineering Requirements

draft-otani-ccamp-interas-gmpls-te-04.txt

Tomohiro Otani otani@kddilabs.jp
Kenji Kumaki ke-kumaki@kddi.com
Satoru Okamoto okamoto.satoru@lab.ntt.co.jp
Wataru Imajuku imajuku.wataru@lab.ntt.co.jp

KDDI R&D LABS
National Institute of Information and Communications Technology

GMPLS inter-domain TE requirement overview



- Comparing from the MPLS inter-domain network model, the GMPLS inter-domain network model should consider below constrains:
  - Switching capability of nodes: TDM-SC, LSC, FSC
  - Encoding type of TE links: Ethernet, SONET, Lambda, etc.
  - Bandwidth of TE links: 1G, 2.4G, 10G, 40G, etc.
  - SRLG of TE links as well as nodes

  ⇐ determined by SPs' business strategy

  so as to appropriately establish a GMPLS LSP across multiple domains, while keeping the topology information concealing.

GMPLS inter-domain requirements

- EGP extensions for GMPLS
  - Requirements for TE parameters in EGP and EGP redistribution
  - GMPLS boarder nodes are required to announce the profile or an end-point (reachability) list consisting node IDs, interface addresses and interface IDs per below parameters;
    - Interface Switching capability
    - Bandwidth Encoding
    - SRLG (global view)
    - Protection type
- GMPLS inter-domain signaling for the support of TE
  - GMPLS per-domain basis/end-to-end path calculation support
  - Fast Recovery support
- GMPLS inter-domain TE Management
  - Requirements for fault management and TE MIB

Extensions to the OSPF Management Information Base in support of GMPLS

draft-ietf-ccamp-gmpls-ospf-mib-00.txt

Masanori Miyazawa	ma-miyazawa@kddilabs.jp
Tomohiro Otani	otani@kddilabs.jp
Thomas D. Nadeau	tnadeau@cisco.com
Kenji Kumaki	ke-kumaki@kddi.com

KDDI R&D LABS

National Institute of Information and Communications Technology

OSPF-TE MIB

- OSPF-TE MIB
  - Topology information retrieving
    - Topology display
    - LSP calculation (off-line)
  - TE-LSA information for managing MPLS/GMPLS TE attributes
  - MIB proposal
    - *draft-ietf-gmpls-ospf-mib-00.txt*

```
+--ospfTeMIB(50)
   |
   +--ospfTeObjects(1)
   | |
   | +--ospfTeLsdbTable(1)
   | | |
   | | +--ospfTeLsdbEntry(1)
   | |    |  Index: ospfLsdbLsid, ospfTeLinkId
   | |    |
   | |    +-- CR-- EnumVal   ospfTeLinkType(1)
   | |    |       Values: Point-to-point(1), Multi-access(2)
   | |    +-- CR-- IpAddr    ospfTeLinkId(2)
   | |    +-- CR-- Integer32 ospfTeMetric(3)
   | |    +-- CR-- Unsigned  ospfTeMaxBandwidth(4)
   | |    |       Textual Convention: ospfTeLinkBandwidth
   | |    |       Range: 1..2147483647
   | |    +-- -R-- Unsigned  ospfTeMaxReservableBandwidth(5)
   | |    |       Textual Convention: ospfTeLinkBandwidth
   | |    |       Range: 1..2147483647
   | |    +-- CR-- Unsigned  ospfTeUnreservedBandwidthPri0(6)
   | |    |       Textual Convention: ospfTeLinkBandwidth
   | |    |       Range: 1..2147483647
   | |    +-- CR-- Unsigned  ospfTeUnreservedBandwidthPri1(7)
   | |    |       Textual Convention: ospfTeLinkBandwidth
   | |    |       Range: 1..2147483647
   | |    +-- CR-- Unsigned  ospfTeUnreservedBandwidthPri2(8)
   | |    |       Textual Convention: ospfTeLinkBandwidth
   | |    |       Range: 1..2147483647
```

Conclusions

- Inter-domain progress between US and Japan was introduced
  - GMPLS E-NNI (RSVP-TE signaling & static routing)
  - More advanced functionalities is under investigation
    - Dynamic routing exchange
    - GMPLS TE extension
    - L2SW capable support
- Related standardizing activities in IETF
- JGNII GMPLS network is ready for providing OXC path service for inter-domain connectivity

Thank you !!