"Inter-Carrier ASON/GMPLS Network Domains Interworking Trial in Kei-han-na Open Lab"

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JGN II: National Testbed Network in Japan

Motivation
- Why interworking of inter-carrier ASON/GMPLS network domains is required?
  - ITU-TASON overlay architecture vs. IETF GMPLS peer/overlay architecture

Field Trial of Interworking of ASON/GMPLS domains
- Nationwide scale
  - 4 operators 7 ASON/GMPLS domains.
- Signaling interworking with ASON E-NNI
  - Reachability information exchange among domains.
  - RSVP signaling over multiple domains.
    - ASON to ASON
    - ASON to GMPLS
    - GMPLS to ASON
    - GMPLS to GMPLS

Conclusions
Kei-han-na Info-Communication Open Laboratory Overview

- **Established at 2003**
  - To establish a global-standard info-communication sectors in Japan “Kansai” region through industry, academia, and government collaboration.
  - National Institute of Communication Technology (NICT) provides rental lab space and rental research facilities.
    - IP routers, TDM-XC
    - Access point to the JGN II network

- No financial support from National Agency to the Interoperability Working Group.

Creating new industries and services

Human resource development
JGN II Network

- **National Testbed Network in Japan**
  - Provided by NICT
    - GMPLS controlled
    - Multi-layer (IP + Optical) NMS
    - 64 access point on every prefecture in Japan
    - Some international lines (US to Chicago, Asia to Thailand and Singapore)

- **New Trial Services**
  - IPv6
  - Wide area Ethernet (FE, GbE, 10GE)
    - No QoS guarantee
  - OXC
    - 1G (GbE) Lambda / 10G (SDH) Lambda
  - Optical Testbed
    - Dark Fibers and Optical Amps.
  - **Customer Controlled Call/Connection Setup (planned)**
    - Web based. Not public control plane service.
JGN II Network Topology

Outline of JGN2 Network

[Legends]
- 20Gbps
- 10Gbps
- 1Gbps/100Mbps
- Optical testbed

Access points
Core network nodes
(Available as access points)

http://www.jgn.nict.go.jp/e/02-about/02-2/data/02-2a.pdf
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Creating new industries and services

Human resource development
Organization of the Open Laboratory

General Assembly of the Council

Board of Directors

Secretariat

Operation and Research Committee

Sub Committees

Planning and Publication

High Performance Network

Human Communications

Network Robot

Working Groups (WGs)

Interoperability

PJ1: GMPLS interoperability
PJ2: Inter-Carrier Interface (Physical)
PJ3: Inter-Carrier Interface (Logical)
PJ4: Nation-wide Inter-Carrier Trial

Photonic

Grid and Application

- Verification for inter-connectivity of new inter-Carrier or inter-AS interface (E-NNI).
    - Demonstrated at MPLS 2005.
    - Reported in OFC2006 PDP47, iPOP2006 1-2
  - PJ 2: 10GbE over OTN technologies.
- Cooperative development from Japan, proposal for international standardization.
  - ITU-T, IETF, and OIF.
- Extended GMPLS connectivity experiment and construction of the open site.
  - PJ 1/4: Multi-vendor GMPLS interoperability field demonstration reported in OFC2005 PDP40.
Team Members of “Interoperability WG PJ3”

http://www.khn-openlab.jp/bunkakai-gw/kokino-net/sousetsu/index-e.html

- NTT
- KDDI R&D Labs.
- NEC
- Fujitsu Lab.
- Mitsubishi Electric
- Keio Univ.
- NICT

OIF Workshop, 31 July 2006, Vancouver, BC Canada
Motivation of Inter-Carrier E-NNI development

- Photonic Network Technologies are the key to solve the IP traffic demand explosion.
  - IP + Optical network architecture
  - Control Plane Technologies
    - Inter-Carrier E-NNI will be defined not only the IP layer, but also the photonic network layer.
- The architectural choice of GMPLS networks (ITU-TASON or IETF GMPLS) differs among carriers.
  - Depend on operation policy, vendor selection, market trends, technology trend, ...
- A seamless end-to-end call setup service over multi-carrier should be provided.

- Short Term Milestone
  - Interworking among ASON network domains and GMPLS network domains.
What should we solve? (1/2)

- **Signaling Session interconversion**
  - ASON - Multi-session signaling
  - GMPLS - Single session signaling

![Diagram showing ASON and GMPLS overlays with signaling sessions and RSVP sessions](image)
Inter-Carrier Routing
- OIF E-NNI routing may not be used.
- EGP routing protocol is preferable.
  - Reachability information exchange
    - Address, Node capabilities (switching, termination, adaptation, encoding, ... )
Interworking of ASON and GMPLS

- **Signaling Interworking**
  - Single session should be emulated for GMPLS peer/overlay network domains.
    - *Pseudo single session mechanism* was implemented to border nodes (Inter-Carrier E-NNI nodes).

- **Routing Interworking**
  - TNAs and endpoint IP addresses should be uniquely assigned.
    - Numbered and Unnumbered assignment may be aligned within the domain.

- **Call set up Interworking**
  - Between ASON UNI and GMPLS UNI
    - Encoding (adaptation) should be aligned
    - Switching Capability may be aligned
      - If not aligned, multi-layer signaling is required.
Inter-Carrier E-NNI Implementation

- ASON E-NNI signaling protocol (RSVP-TE)
  - TDM: OIF E-NNI 1.0
  - LSC: modified from OIF E-NNI 1.0
  - Pseudo single session was supported

- Routing protocol (BGP-4)
  - Reachability information (addresses and adaptation) exchange among BGP peers.
    - Proprietary BGP-4 extension
    - Local reachability information (within the domain) extract from I-NNI IGP: e.g. GMPLS OSPF.
      - Proprietary OSPF/BGP-4 extension
        - If not supported, manually configured.
    - Summarized reachability information (from other domains) redistribute to I-NNI IGP: e.g. GMPLS OSPF.
      - Proprietary OSPF extension
      - OSPF AS-external-LSA is also used for advertising reachable addresses.
Features of the field trial

- 4 operators’ total 6 ASON and GMPLS network domains
  - GbE is used for data plane Links for LSC domains.
  - STM-16 is used for TDM domains.
    - JGN II and Carrier’s R&D Networks
- Interworking between
  - ASON UNI and GMPLS I-NNI
  - GMPLS I-NNI and Inter-carrier E-NNI
  - GMPLS domains via Inter-carrier E-NNI
- Call set up between
  - ASON UNI and GMPLS UNI
    - UNI1.0R2 (TDM) and GMPLS UNI (TDM)
    - UNI1.0R2 extension for LSC and GMPLS UNI (LSC)
  - ASON UNI and GMPLS peer

OIF Workshop, 31 July 2006, Vancouver, BC Canada
7 sites were connected by GbE Links

- NTT
- KDDI
- NiCT
- JGNII

GbE Link(s)

500km

Kanazawa
Fukuoka
Fujimino
Musashino
Otemachi
Kei-han-na
Yokosuka
Detailed trial network configuration
(Jan. – Feb. 2006)
The inter-carrier E-NNI point was constructed at Kei-han-na site.
Ex.1 KDDI GMPLS – NTT ASON (LSC)

- KDDI GMPLS peer to NTT ASON UNI: OK
- NTT ASON UNI to KDDI GMPLS peer: OK
  - D-Plane (GbE Link) was established between Fujimino site and Musashino site
  - Numbered vs. Unnumbered
    - Pseudo Single Session Mechanism (manual configuration) absorbed the difference.

Musashino site: NTT

NTT ASON

E-NNI

Fujimino site: KDDI

KDDI GMPLS

GbE Link
Ex. 2 NICT ASON – NTT GMPLS (LSC)

- **NICT ASON UNI to NTT GMPLS UNI**: OK
  - Multiple E-NNI spans were traversed.
- **GMPLS UNI to ASON UNI**: did not examine
  - No enough time.
  - **NTT GMPLS UNI to NTT ASON UNI**: OK
Ex.3 JGN II GMPLS – NTT GMPLS (LSC)

- JGN II GMPLS peer to NTT GMPLS UNI: OK
- NTT GMPLS UNI to JGN II GMPLS peer: NG
  - CSPF on the E-NNI could not calculate the route
  - Implemented CSPF did not support numbered links.
### All Results (LSC)

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<th>NICT ASON</th>
<th>NTT ASON</th>
<th>NICT GMPLS</th>
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<th>KDDI GMPLS</th>
<th>JGN II GMPLS</th>
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**D-P:** Data-Plane

**Overlay:**
- From NICT ASON to NTT ASON: OK
- From NICT ASON to NICT GMPLS: OK
- From NICT GMPLS to NTT ASON: OK
- From NTT ASON to NTT GMPLS: OK
- From KDDI GMPLS to JGN II GMPLS: OK

**Peer:**
- From NICT ASON to NTT ASON: OK
- From NICT ASON to NICT GMPLS: OK
- From NICT GMPLS to NTT ASON: OK
- From NTT GMPLS to NTT ASON: OK
- From KDDI GMPLS to JGN II GMPLS: OK
- From JGN II GMPLS to KDDI GMPLS: OK

- **NG:** Not supported
### Potential Results (LSC)

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Findings from the experiments (1/2)

- **Numbered vs. unnumbered**
  - ASON UNI devices preferred the numbered addressing.
  - Several types of non-IP router equipment were in favor of the unnumbered addressing.
    - A node-id was utilized as a destination address.
      - To distinguish the destination port/link, an interface index (IF-ID) should be specified.
  - CSPF should support coexistence of numbered domains and unnumbered domains.
- More work is required to complete interworking.
Findings from the experiments (2/2)

- Troubles were mainly occurred in the CSPF
- Standardization (or agreement) is required
  - Intra-domain
    - Reachability information should be advertised to E-NNI (border) nodes.
  - Inter-domain
    - Reachability information should be exchanged among E-NNI nodes.
  - From other domains
    - Reachability information should be recognized by CSPF.
Conclusions

- A field trial of ASON and GMPLS interworking was conducted on a nationwide scale.

- Seamless call set up over multi-carrier domains over the distance of 1,000 km or more was successfully achieved.

- Demonstrated interworking operation is expected to relax the choice of the adopted GMPLS network model for carriers.

- We can accelerate deployment of ASON and GMPLS networks.
  
  - But more work is required ……
Acknowledgement

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- The author is grateful to all members of the interoperability working group for their cooperation.

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Thank you !!