MPLS and QoS/CoS

Hiroshi ESAKI, Ph.D
<hiroshi@wide.ad.jp>
The University of Tokyo

Presentation Summary
-Mainly talk about MPLS-

• MPLS
  – Integrating Diff-Serv/RSVP/BB/COPS over IPv4/IPv6
  – Current R&D items;
    • Open source MPLS stack for BSD, including QoS/CoS; AYAME
    • MPLS-based wide-area distributed IX

• QoS/CoS
  – Integrating ALT-Q/BB/COPS/MPLS
    • AYAME (http://www.ayame.org/)
    • Moon-bear Project (http://www.moon-bear.net)
  – Measurement (AGURI)… presented by kjc
What is MPLS technology?

- Map a label to the data flow defined by FEC (Forward Equivalent Class), and forward the data using the allocated label over layer 3 infrastructure.
- The data flow, defined by FEC can be any level (e.g., MP-S uses optical wave (layer 1)) and any granularity.
- Route of MPLS pipe (called as LSP) can be defined by some routing protocol (e.g., source route or standard IGP).
- Policy for the data flow routing can be defined by the edge, not only by the network, i.e., policy networking defined by the edge.
- You could realize that MPLS provides a general pipe for any layer using a layer 3 infrastructure.
  ➔ there are many applications, e.g., VPN, traffic engineering, using the MPLS technology
**Shim layer between IP and Data-link**

**i.e., called as Sub-IP at IETF**

<table>
<thead>
<tr>
<th>Layer</th>
<th>Address</th>
<th>Semantics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>URL</td>
<td>A. Global logical service address of node in the Internet</td>
</tr>
<tr>
<td></td>
<td>(e.g., <a href="http://www.whitehouse.gov">http://www.whitehouse.gov</a>)</td>
<td></td>
</tr>
<tr>
<td>TCP</td>
<td>Port number</td>
<td>B. End-to-end identifier for application multiplexing</td>
</tr>
<tr>
<td></td>
<td>(e.g., 8080)</td>
<td></td>
</tr>
<tr>
<td>IP</td>
<td>IP address</td>
<td>C. Global node identifier in the Internet (identifier and routing)</td>
</tr>
<tr>
<td></td>
<td>(e.g., 133.196.16.10)</td>
<td></td>
</tr>
<tr>
<td>LSR</td>
<td>Label for FEC</td>
<td>D. Link unique identifier for label switching</td>
</tr>
<tr>
<td>DataLink</td>
<td>MAC address / VC-ID</td>
<td>E. Link unique identifier for label switching</td>
</tr>
<tr>
<td></td>
<td>(e.g., 44-45-53-54-00-00)</td>
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</tr>
</tbody>
</table>

Introduction of another (i) forwarding label, and (ii) multiplexing label between IP and datalink

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We realize that:

MPLS can define any protocol layer over IP infrastructure,

and can define any data flow type signaled by IP infrastructure.

Introduction of another (i) forwarding label, and (ii) multiplexing label
<< Requirements in mid of 90’s >>
1. Diff-Serv / Int-Serv for QoS/CoS
2. High Speed Large Capacity IP Router
3. VPN (Virtual Private Network)
4. Traffic Engineering

MPLS tried to solve No.2 Objective, at the beginning

MPLS tries to solve No.3 & No.4
MPLS integrates Diff-Serv / Int-Serv

MPLS for layer 1/2/3

ALT-Q Integration
BB/COPS Implementation
MPLS, What’s next?

We may think MPLS would solve the routing issue, that could not be solved by routing protocol, via the layer co-operation

History of MPLS Activity @ WIDE

- 1994 March : CSR Internet-Draft to IETF
- 1995 April : CSR BOF at IETF
- 1996 March : IP Switch by Ipsilon
  March : LAST-WG @ WIDE
  July : Tag Switch by Cisco
  Nov. : Collaboration Cisco and Toshiba
  Dec. : Tag Switch BoF at IETF
- 1997 March : MPLS WG for LSR at IETF
- 1999 : Distributed IX using MPLS

(*) CSR: Cell Switch Router
LAST: Label Switch Technology
What’s next on MPLS at WIDE?

- Currently running:
  - AYAME Project (MPLS open source by WIDE)
    http://www.ayame.org/
    (*) integrating BB/COPS for intra-domain
  - MPLS-based Wide-area Distributed IX
    (Nation-wide testbed operation)

- Next R&D (?): 
  - Layer Collaboration, i.e., Multi-Layer Switching and Routing
  - Wireless Ad-Hoc Networking (private consideration....)

MPLS-based Distributed IX

We propose a next generation IX (Internet eXchange) architecture using MPLS technology. That is, we are trying to apply MPLS for interconnection (or peering) between ISPs.

We have been tested the MPLS based IX (MPLS-IX) architecture and functionality since 1999. We also started an experimental testbed using commercial products in Oct, 2001.

Optical switching technology, such as GMPLS or other protocols, and IPv6 would be future research items.
Design & Features of MPLS-IX

- Independent on data-link medium
  - POS, ATM, GbE, FDDI, PPP, and any media
    - OC-192 or OC-768 POS also works fine
    - No need to negotiate about interface type with peering node
    - No more either “only with Ethernet” or “only with ATM”

- Widely distributing model
  - Widely distributing interconnection network
    - Any WAN link would be available for peering interface
  - Participants can connect with any interface or circuit
    - No more additional routers or space required
MPLS-IX model

- Transmit through MPLS network
  - LSP between user networks
  - Transmit packets over LSP
  - IX does NOT make routing decision (except label switching)

Interconnection with existing IXes

- Interconnect multiple L2 IXes
- Hierarchical IX architecture
Possibilities of MPLS-IX

- Many useful MPLS features
  - Traffic Engineering
  - QoS/CoS - DiffServ features
  - Interconnection between MPLS Domains
  - Source address routing by RSVP
  - Solution to multi-home sites
  - etc...

MPLS-IX Testbed Operation

- 6 Core routers for experimental MPLS-IX
- Using JGN as the MPLS-IX backbone
- Many (over 40) networks will join/connect
- Participants can connect to the “distix” via
  - JGN – paths between participants and Core routers
  - Direct connect – to the one of Core routers
- Year 2002 agenda
  - IP version 6
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Anycast CDN with MPLS

- Well-known Unicast Address
- Host route
- Issues (would be) resolved by MPLS;
  - Route Fluctuation
  - Load balancing/distribution
    - among anycast servers
    - among links to the anycast servers
  - Only valid with IGP
QoS/CoS R&D Items

• Past researches
  – ALT-Q, packet scheduler for BSD
  – Diff-Serv Integration to MPLS Node (i.e., CSR)
  – FEC (Forward Error Correction) for BSD

• Current researches
  – Collaborating open source project
    • AYAME Project (http://www.ayame.org/)
    • Moon-bear Project (http://www.moon-bear.net)
      – BB/COPS for intra-domain
  – Measurement (AGURI)
Summary

• MPLS
  – Integration of Diff-Serv/RSVP/BB/COPS over IPv4/IPv6
  – Current R&D items;
    • Open source MPLS stack for BSD, including QoS/CoS
    • MPLS-based wide-area distributed IX
  – A lot of applications, using the provision of layer independent pipe over layer 3 infrastructure

• QoS/CoS
  – Integrating ALT-Q/BB/COPS/MPLS
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