An Analysis of Constraint-based Routing in MPLS

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Road Map

- MPLS Overview
- Constraint-based Routing (CBR)
- Simulation with MNS2.0 in NS-2
- Discussion
- Future work
- Reference
MPLS Overview

Multiple Protocol Label Switching (MPLS) Capabilities
- Traffic Engineering
- Connection-oriented QoS Support
- Multiprotocol Support
- Virtual Private Network (VPN)
MPLS Overview

Separation of Control and Forwarding Components
MPLS Overview

- Packet Forwarding

An MPLS Label Switched Path (LSP) set up between two Label Switched Routers (LSR) is similar to an ATM VC
MPLS Overview

- Packet Forwarding (cont.)
  One or more Forwarding Equivalence Class (FEC) may be mapped to a single LSP
MPLS Overview

Control component-Label distribution protocol (LDP)
Constraint-based Routing

CR-LDP consider not only network topology, but also other constraints-link bandwidth, delay, etc.
Simulation with MNS-2 in NS

- Install MNS-v2.0 (Written by Gaeil Ahn)
- Create a network topology
- Attach traffic agents of multiple service classes
- Measure performance of packet delay, packet loss and network utilization of the following two scenarios:
  - Scenarios 1
    - Set up CR-LSPs in the ascending order of importance
  - Scenarios 2
    - Set up CR-LSPs in the descending order of importance
Network topology
Traffic Type

• **Real-time2**
  – CBR traffic: Packet Size 200b, Bandwidth 1000k

• **Real-time1**
  – CBR traffic: Packet Size 200b, Bandwidth 800k

• **High priority Best Effort**
  – Exponential on/off traffic: Packet Size 200b, Burst time 500ms, Idle time 500ms, Bandwidth 300k

• **Simple Best Effort**
  – Exponential on/off traffic: Packet Size 200b, Burst time 200ms, Idle time 800ms, Bandwidth 100k
Scenario 1 (w/o OCPC)

- Simulation Schedule
  1. At 0.0, Set up CR_LSP (with lspid 1100) for SBT
  2. Right after CR_LSP 1100 is set up, SBT start
  3. At 0.2, Set up CR_LSP (with lspid 1200) for HBT
  4. Right after CR_LSP 1200 is set up, HBT start
  5. At 0.4, Set up CR_LSP (with lspid 1300) for RT1
  6. Right after CR_LSP 1300 is set up, RT1 start
  7. At 0.6, Set up CR_LSP (with lspid 1400) for RT2
  8. Right after CR_LSP 1400 is set up, RT2 start
  9. At 3.0, Stop traffic sources
  10. At 3.1, Stop simulation
Scenario 1 (w/o OCPC cont.)

- CR_LSP set-up diagram
Scenario 1 (w/o OCPC cont.)

- Network Performance Statistics

<table>
<thead>
<tr>
<th>Traffic Type</th>
<th>Bandwidth (kbps)</th>
<th>Packets Sent</th>
<th>Packet Dropped</th>
<th>Packet Lost Rate</th>
<th>Average Delay (ms)</th>
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<tbody>
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<td>82</td>
<td>0</td>
<td>0</td>
<td>54.3</td>
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<tr>
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<td>35</td>
<td>2.53%</td>
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</tbody>
</table>

Overall Delay : 96.89 ms
Scenario 1 (w/o OCPC cont.)

• Network Performance Statistics graph
Scenario 2 (with OCPC)

- Simulation Schedule
  1. At 0.0, Set up CR_LSP (with lspid 1100) for RT2
  2. Right after CR_LSP 1100 is set up, RT2 start
  3. At 0.2, Set up CR_LSP (with lspid 1200) for RT1
  4. Right after CR_LSP 1200 is set up, RT1 start
  5. At 0.4, Set up CR_LSP (with lspid 1300) for HBT
  6. Right after CR_LSP 1300 is set up, RT1 start
  7. At 0.6, Set up CR_LSP (with lspid 1400) for SBT
  8. Right after CR_LSP 1400 is set up, RT2 start
  9. At 3.0, Stop traffic sources
  10. At 3.1, Stop simulation
Scenario 2 (with OCPC cont.)

- CR_LSP set-up diagram
Scenario 2 (with OCPC cont.)

- Network Performance Statistics

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Overall Delay : 67.88 ms
Scenario 2 (with OCPC cont.)

- Network Performance Statistics graph
Discussion

• Constraint-based Routing in MNS2 succeeded in routing the traffic around the unsatisfied links
• LSPs set up order has great effect on the overall packet delay
  – From 96.89 ms to 67.88 ms
• The paths for the LSPs can be computed by some offline Constraint-based Routing algorithm[1].
Future Work

- Use some real traffic trace such as the Star War trace file
- Expend the Network topology and upgrade the link bandwidth
- Implement an Offline Constraint-based Routing Algorithm as a application on an offline server.
References 1


Reference 2

- [7] MNS-v2.0, christian.glomb@mchp.siemens.de
Thank You!