MPLS: MultiProtocol Label Switching

R. Scott Peabody, PE
s.peabody@adcomm911.com
425 766-6314
MPLS Topics

Brief History
Drivers
Case Study
Manufacturers

Technical Overview:
Terminology
Basic Operations
Quality of Service

Services:
Cpipe
Epide
VPLS
VPRN

Is MPLS Right for You?
1997 – Formation of the IETF MPLS working group
1999 – First MPLS Deployments (L3VPN)
Drivers of MPLS Development

- 1997: Routers can’t cope with 10 Gbit/sec
- High Growth in Packet services
  - Internet
  - Cellular Access
  - Private Networks

- Slow Growth in Circuit-based Services
  - Peaked in 2000 in the developed world
Service Provider Demands

- Greater Efficiency in Packet Services
- Convergent Solution
  - Too many technologies already: Frame Relay, ATM, SONET, DSL
- Operational Considerations:
  - Billing
  - Traffic Management
  - Out of Band Network Management
MPLS Services

VPN Services
- L2 VPN Services
  - Point-to-Point Services
    - VPWS, VLL, Pipe Services
      - Apipe, Epipe, Ipipe, Cpipe
  - Point-to-Multipoint Services
- L3 VPN Services
  - L3 Services. VPRN
  - VPLS Services
    - L2 Services. VPLS

Non-VPN Services
- Routed IES Services
  - VPRN: Virtual Private Routed Network (virtual layer 3 network)
  - VPLS: Virtual Private LAN Service (virtual layer 2 switch network)

VPN: Virtual Private Network
IES: Internet Enhanced Service
Old Backhaul Network

12T Spurs (MHSB)

WSDOT T1

DS3 Loop

Fiber
New Backhaul Network

- Hybrid Mesh
- Loop Protection
- One Spur Site (MHSB)
- Bandwidth: Gigabit Fiber
  277 Mbps Microwave
MPLS – How Does It Work?
Building Blocks:
Routers and Circuits

Aviat

Cisco

Juniper

Nokia

+ MPLS Licenses

+ Circuits:
  • Fiber
  • Microwave
  • Copper
  • Other

+ Interfaces
MPLS Terminology

Customer Edge Device (CE):
Source (or destination) of data for transport through MPLS network

Provider Edge Device (PE):
Router adds (or removes) MPLS label to customer data

Provider Device (P):
Router switches MPLS label to move data through provider core

Host 1

R2

R3

R1

R4

Host 2
More Terminology

iLER
Ingress Label Edge Router:
Device adds MPLS label to customer data packet
MPLS Operation = PUSH

eLER
Egress Label Edge Router:
Device removes MPLS label from customer data packet
MPLS Operation = POP

LSR
Label Switch Router:
Device switches MPLS label to move customer data through core network
MPLS Operation = SWAP
Basic Operation

IP Forwarding  Label Switching  IP Forwarding

PUSH  iLER  SWAP  LSR  SWAP  LSR  eLER  POP

Label Switched Path

data  label  data  label  data  label  data  data

IP Forwarding  Label Switching  IP Forwarding
Basic Operation

Label – 20 bits (0-15 reserved)
EXP – 3 bits (Class of Service)
S – 1 bit (Bottom of Stack)
TTL – 8 bits (Time To Live)
Path Protection and Routing Options

Path Protections:
1. Primary with up to 7 Secondary
2. Primary with Hot Standby Secondary (signaled in advance)
   Fast Re-route predetermines the backup for each link or node

Routing through the Network:
1. Static
2. Dynamic
   a. Best Effort (LDP)
   b. Resource Reserved (RSVP-TE)
      Traffic Engineered
Services - Epipe

Epipe provides point-to-point connection with no MAC learning
Virtual Private LAN Service

VPLS provides a point-to-multipoint Layer 2 Virtual Private Network. All sites appear connected to a single switched VLAN.
Virtual Private Routed Network

VPRN provides a virtual Layer 3 Routed Network. IP routing information available between customer routers.
# Forwarding Classes - QOS

<table>
<thead>
<tr>
<th>FC</th>
<th>Name</th>
<th>Class Type</th>
<th>Notes</th>
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<tbody>
<tr>
<td>NC</td>
<td>Network Control</td>
<td>Real-time</td>
<td>For network control traffic</td>
</tr>
<tr>
<td>H1</td>
<td>High 1</td>
<td>Real-time</td>
<td>For delay/jitter sensitive data</td>
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<tr>
<td>EF</td>
<td>Expedited Forwarding</td>
<td>Real-time</td>
<td>For delay/jitter sensitive data</td>
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<tr>
<td>H2</td>
<td>High 2</td>
<td>Real-time</td>
<td>For delay/jitter sensitive data</td>
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<tr>
<td>L1</td>
<td>Low 1</td>
<td>Non real-time - Assured</td>
<td>For assured traffic</td>
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<tr>
<td>AF</td>
<td>Assured Forwarding</td>
<td>Non real-time - Assured</td>
<td>For assured traffic</td>
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<tr>
<td>L2</td>
<td>Low 2</td>
<td>Non real-time - Best Effort</td>
<td>For best effort traffic</td>
</tr>
<tr>
<td>BE</td>
<td>Best Effort</td>
<td>Non real-time - Best Effort</td>
<td>For best effort traffic</td>
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## Applying Quality of Service

<table>
<thead>
<tr>
<th>#</th>
<th>Service name</th>
<th>FC</th>
<th>Service</th>
<th>CIR (Mbps)</th>
<th>PIR (Mbps)</th>
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<td></td>
<td>AF</td>
<td>VPLS</td>
<td>1/10*</td>
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<td></td>
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<td>VPLS</td>
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<td>VRFN</td>
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<td></td>
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<td>VRFN</td>
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</tbody>
</table>

*Note: 1/10 means that 1Mbps at Remote sites while 10Mbps at both trunking controller sites*
MPLS: Not for Everyone

**Benefits**

- Robust mission critical solution
- Flexible - Provides all types of legacy services:
  - T1 (cpipe)
  - Ethernet (epipe)
  - L2 switching (VPLS)
  - L3 routing (VPRN)
- Longer design life than IT and consumer grade equipment

**Costs**

- Complex design, configuration, and operation
- High lifecycle costs
  - Support contracts for software and hardware
  - Hardware refresh
  - Training
- Scarce experienced technicians and engineers