MIGRATION OF AN ATM NETWORK CORE TO MPLS/IP

ELG 5369 Course Project
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Overview

» Problem In Hand
» Fundamentals & Limitations of ATM
» MPLS Fundamentals & Advantages
» Migration Options
» Analysis of Existing design
» Redesign & Implementation

Appendix: Configuration Notes and Details

Problem In Hand

Company D’s current Network

- Canada wide ATM WAN
- Growth of network resource usage
- Capacity upgrade needed
- Existing ATM doesn’t scale well & its costly

Requirements

- Scalability
- Migrate to MPLS over IP
- Redundant Tunnels
- Routing protocols must remain unchanged

Asynchronous Transfer Mode (ATM)

Fundamentals

- Circuit switching and packet switching
- Fixed size cells
- Asynchronous multiplexing
- Virtual Circuits

Limitations

- Header Overhead
- Delay added to IP data transmission
- Overhead due to cell drops
- Route Instability

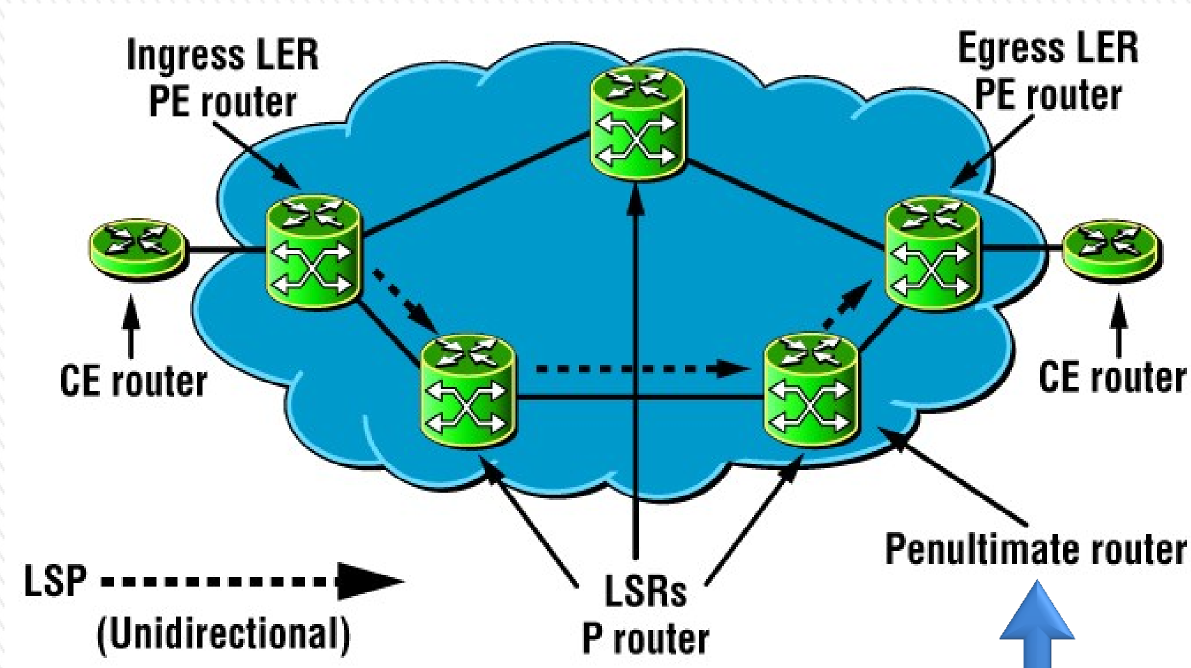
Multi Protocol Label Switching

Advantages

- QoS support
- Traffic engineering
- Multi Protocol
- Unified network infrastructure
- Integration over ATM
- The peer-to-peer model for MPLS VPN
- Low cost of implementation

Multi Protocol Label Switching

Architecture



Penultimate Hop Popping (PHP)
Reduce label processing overhead of LER

- Label edge router (LER)
- Label switching router (LSR)
- Label switched path (LSP)

Multi Protocol Label Switching

Two Major Functions

» Forwarding

- Exact match algorithm instead of Longest match
- Faster

» Controlling

- LDP
- RSVP –TE
- CR-LDP
- Multiprotocol BGP

Exact Match

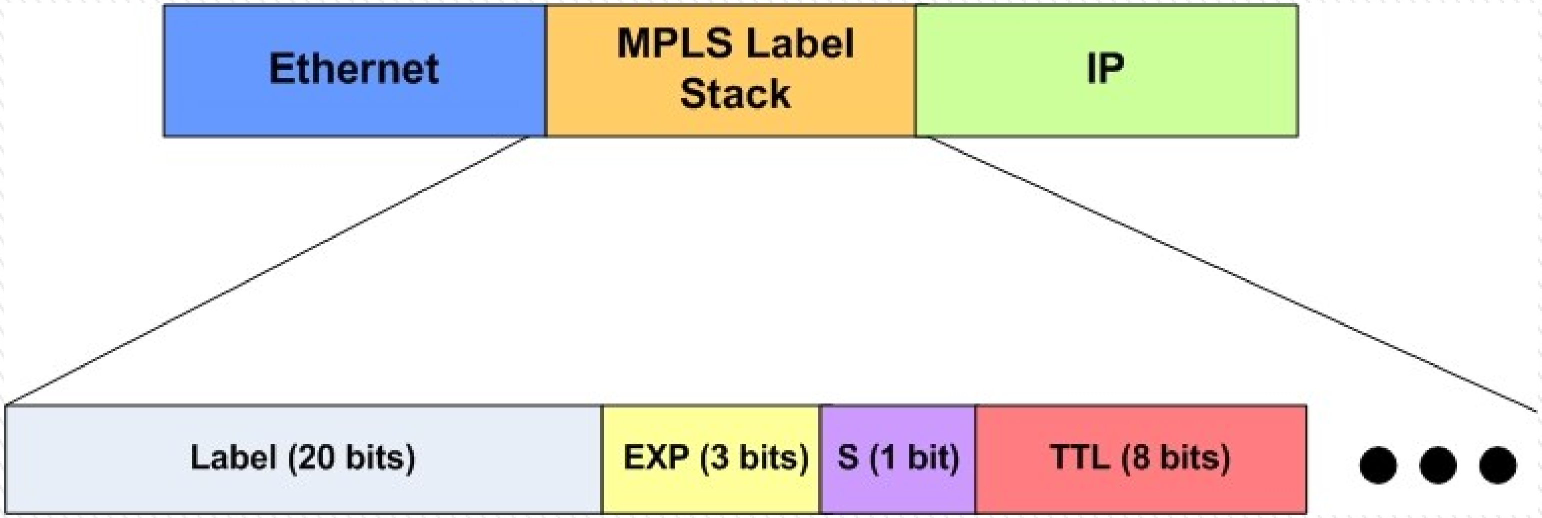
Incoming label	Outgoing Label
12	22
13	23
14	24

Longest Match

Incoming IP	Routing table entries
192.168.20.19	192.168.20.0 /24
	192.168.0.0 /16
	192.168.20.16 /28

Multi Protocol Label Switching

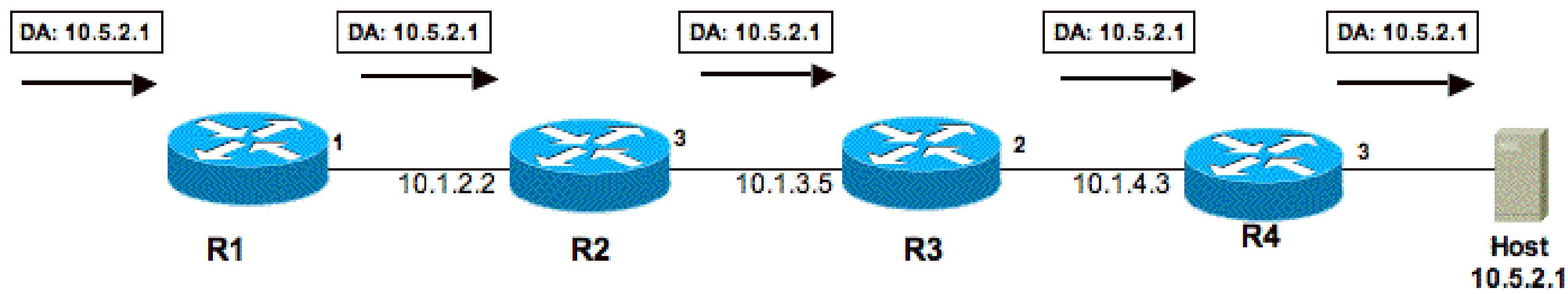
Label



- 20 bits - Forwarding pointer
- 3 bits – QoS
- 1 bit – Flag
- 8 bits - TTL

Multi Protocol Label Switching

Conventional Hop-by-Hop routing



R1 Routing Table

Prefix	Next Hop
10.5.0.0/16	10.1.2.2, IF 1

R2 Routing Table

Prefix	Next Hop
10.5.0.0/16	10.1.3.5, IF 3

R3 Routing Table

Prefix	Next Hop
10.5.0.0/16	10.1.4.3, IF 2

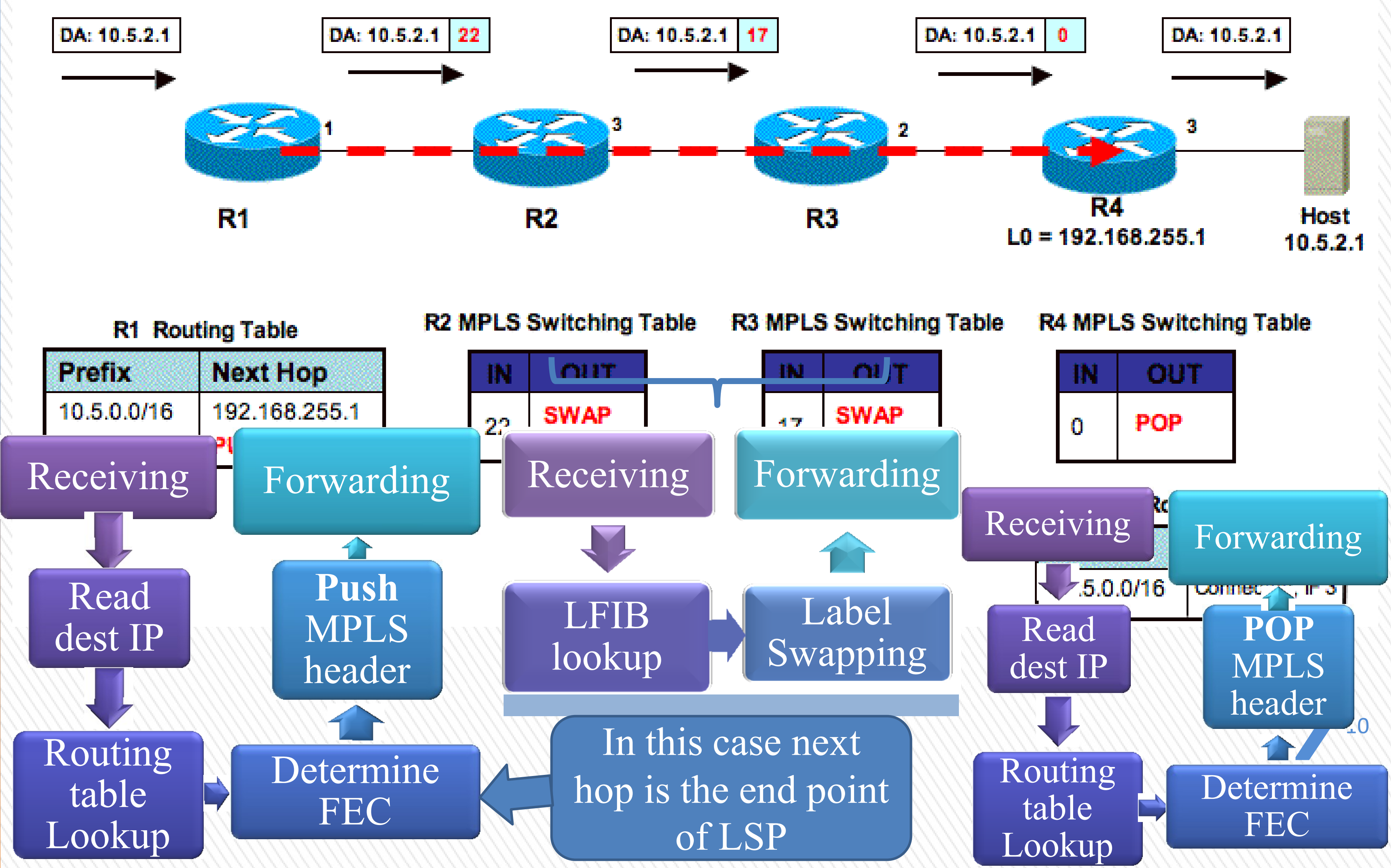
R4 Routing Table

Prefix	Next Hop
10.5.0.0/16	Connected, IF 3

Packets arrives at R → Read dest IP → Routing table Lookup → Determine FEC → Forward to next LSR

Multi Protocol Label Switching

Label Switching in MPLS



Migration to MPLS

Three Options

1. Label Switching with ATM
    - Label Controlled ATM
    - Tunneling through ATM
    - Ships in the night model

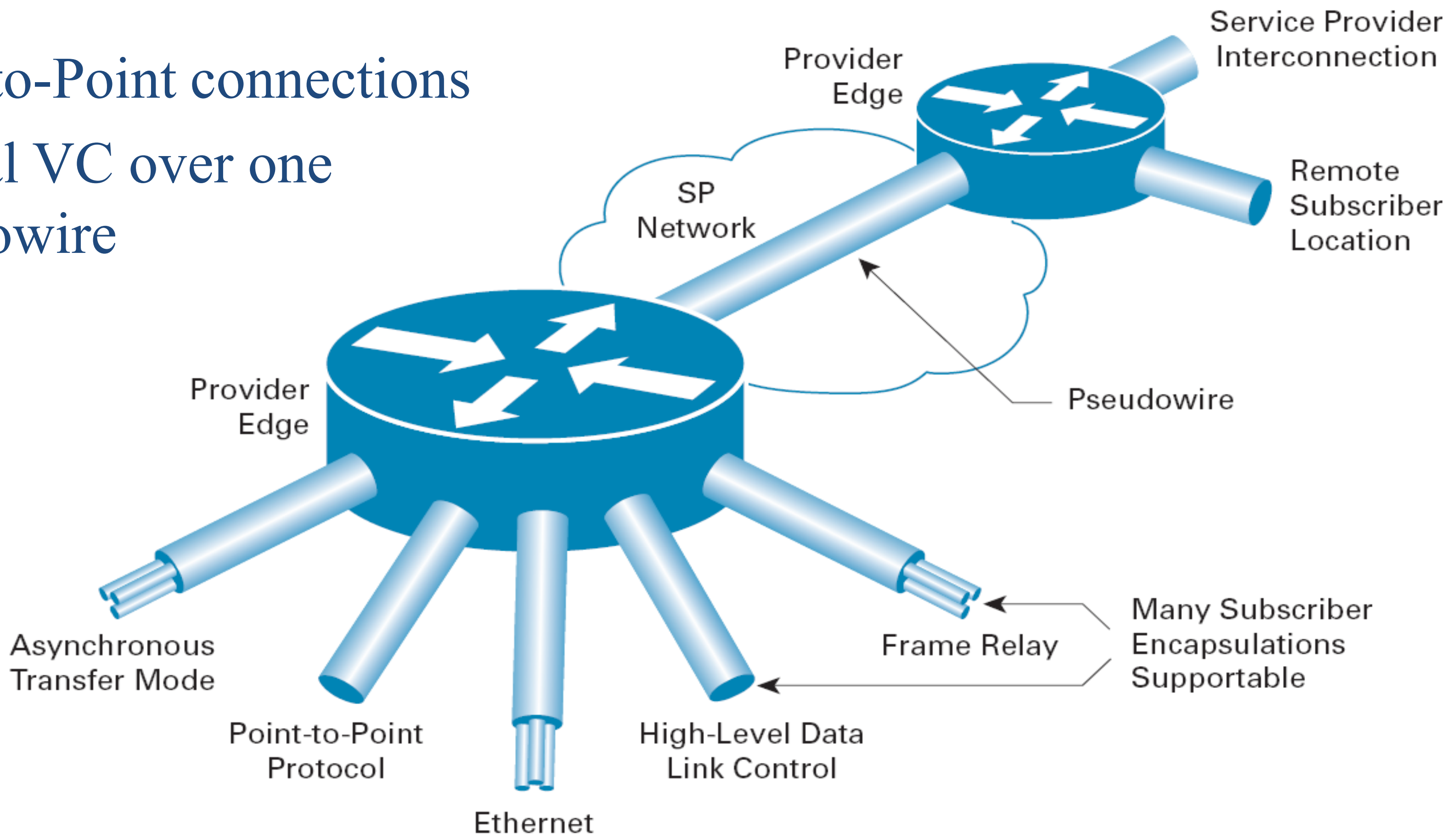
2. Layer 3 MPLS based VPNs
    - BGP/MPLS VPNs (RFC 2547bis)

3. Layer 2 MPLS based VPNs
    - Virtual private LAN service (VPLS)
    - Virtual private wire service (VPWS)

Migration to MPLS

Virtual Private Wire service (VPWS)

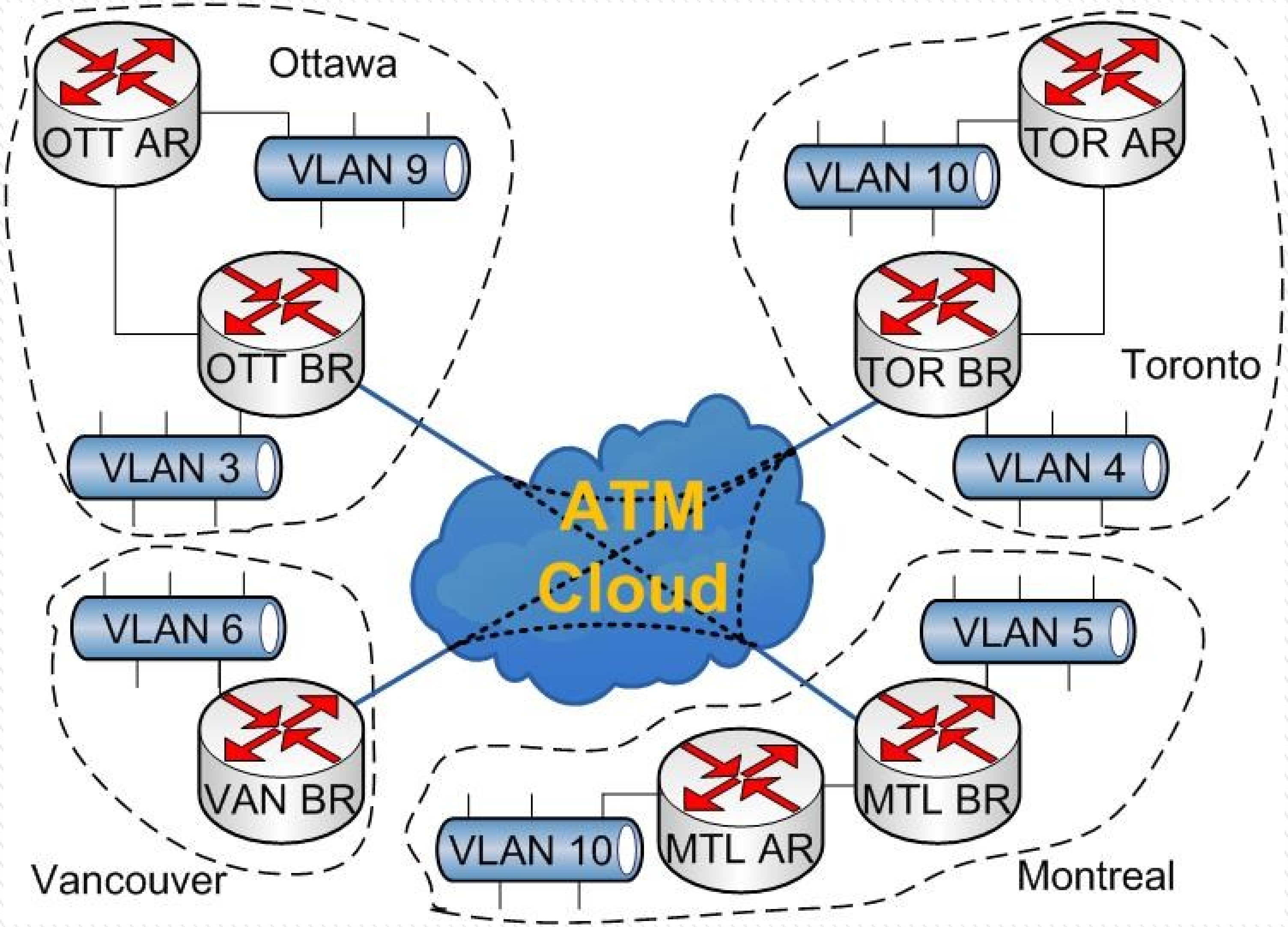
- Point-to-Point connections
- Several VC over one Pseudowire



L2 Header	Outer Label	Inner Label	Payload

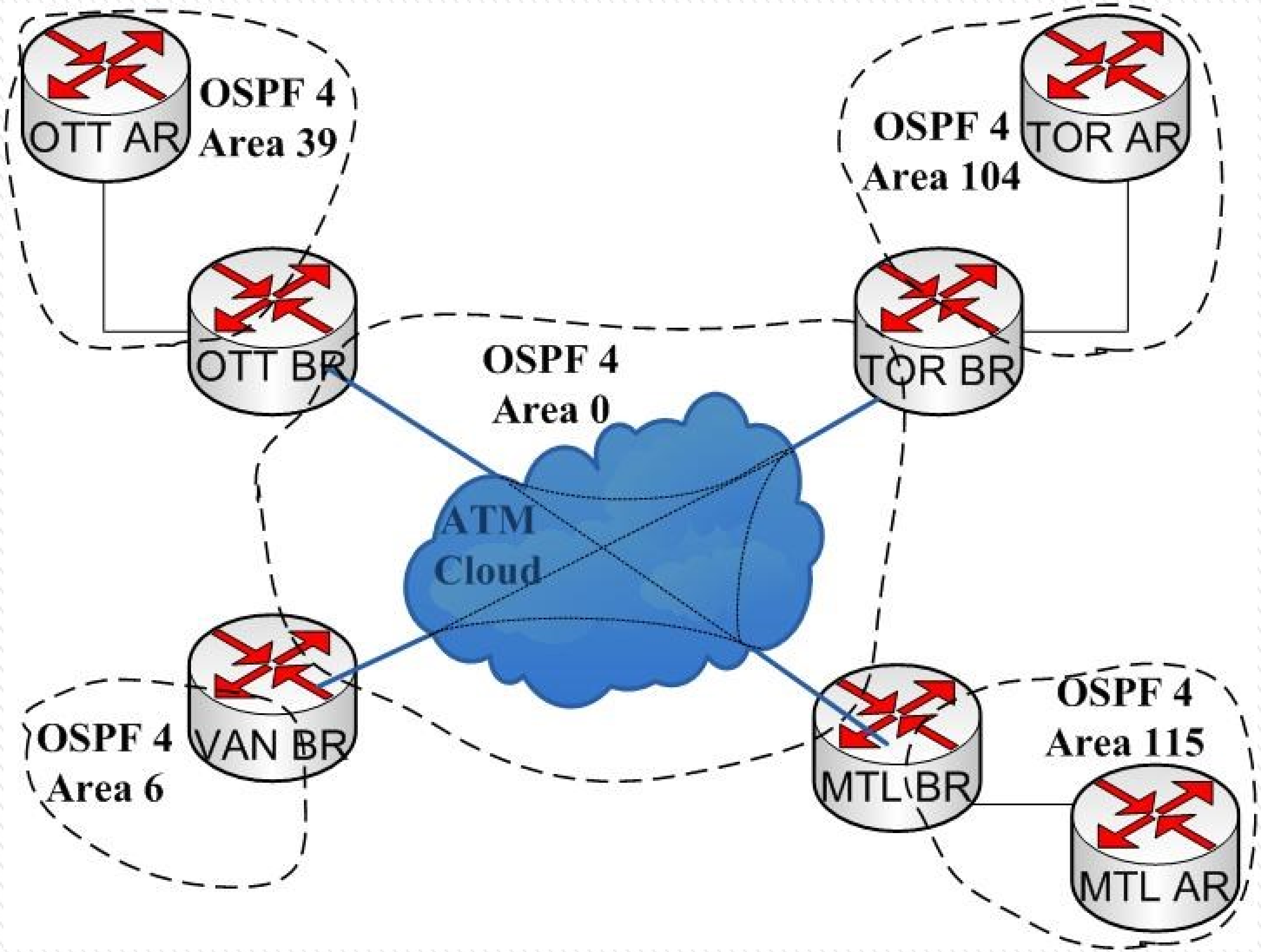
Analysis of Existing design

Company D's Network



Analysis of Existing design

Routing Network



Re-design & implementation

Analysis of Requirements

» Migrate to MPLS-over-IP

- ATM Hybrid models ← Out of the Picture

» Point to point VPN's

- L2 VPLS ← Out of the Picture

» Routing protocols of customer network must remain unchanged

- L3 BGP/MPLS ← Out of the Picture

VPWS (AToM)

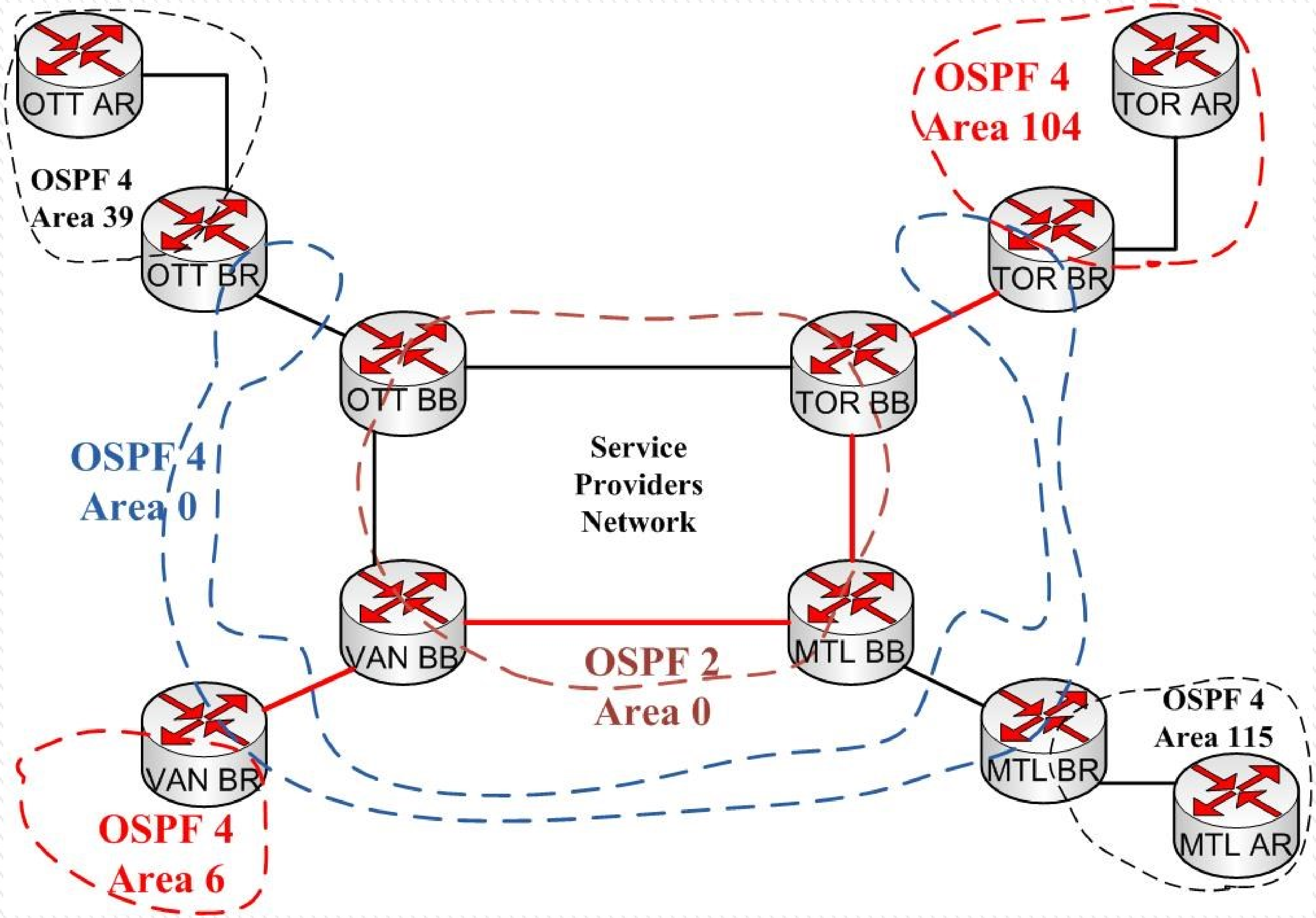
Re-design & implementation

Approach

1. Configuring ISP core routers with IGP –OSPF
2. Enabling MPLS on Service provider routers
3. Configuring Customer BR
4. Configuring EoMPLS AToM pseudowire

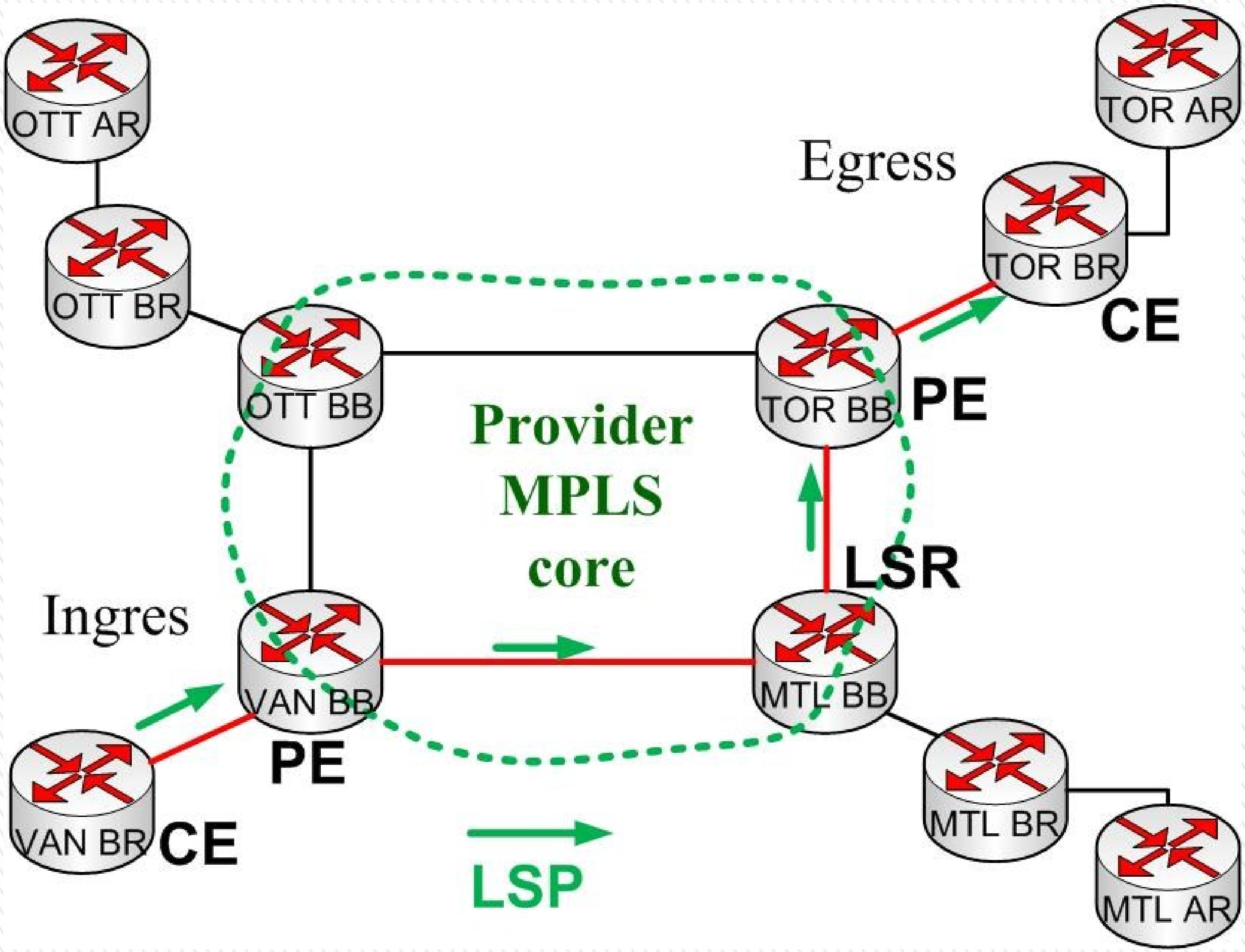
Re-design & implementation

Routing



Re-design & implementation

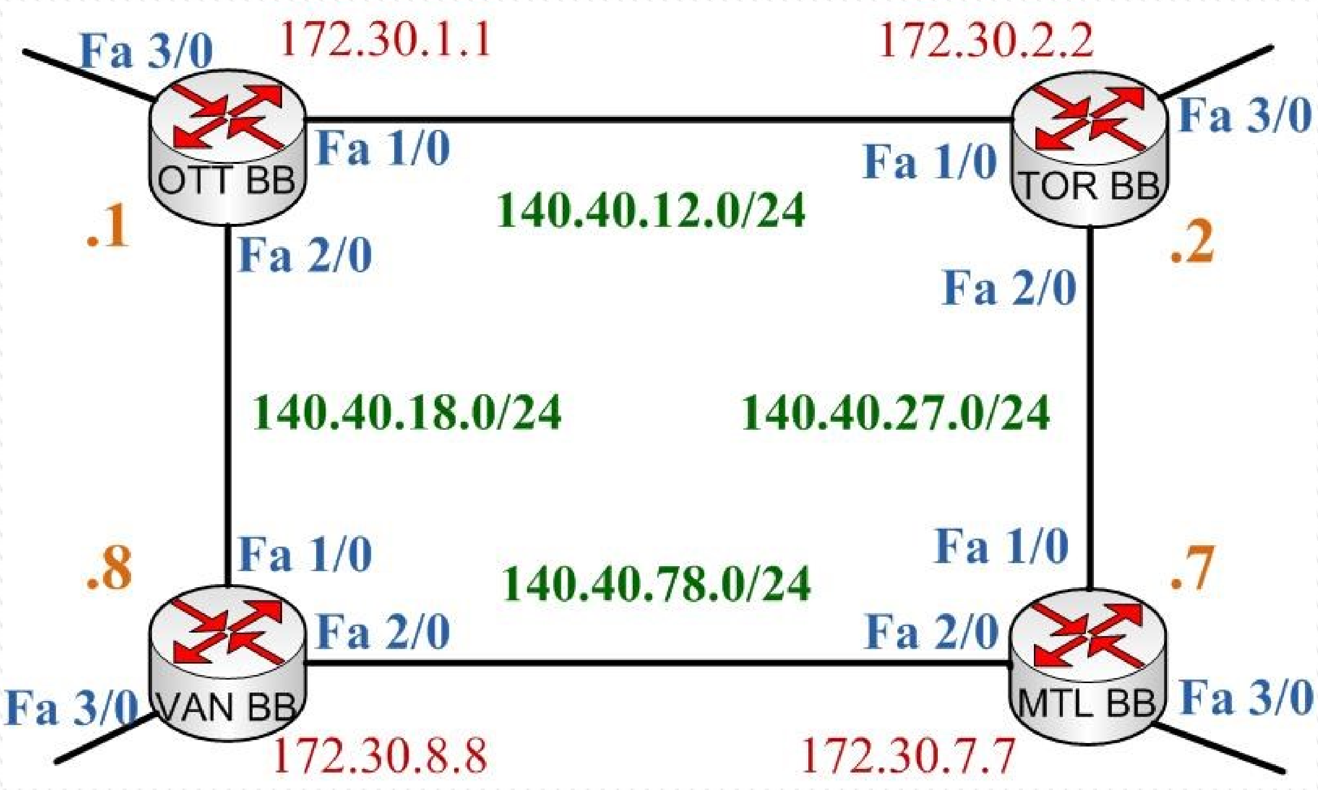
MPLS



Re-design & implementation

Configuring ISP core routers with IGP –OSPF

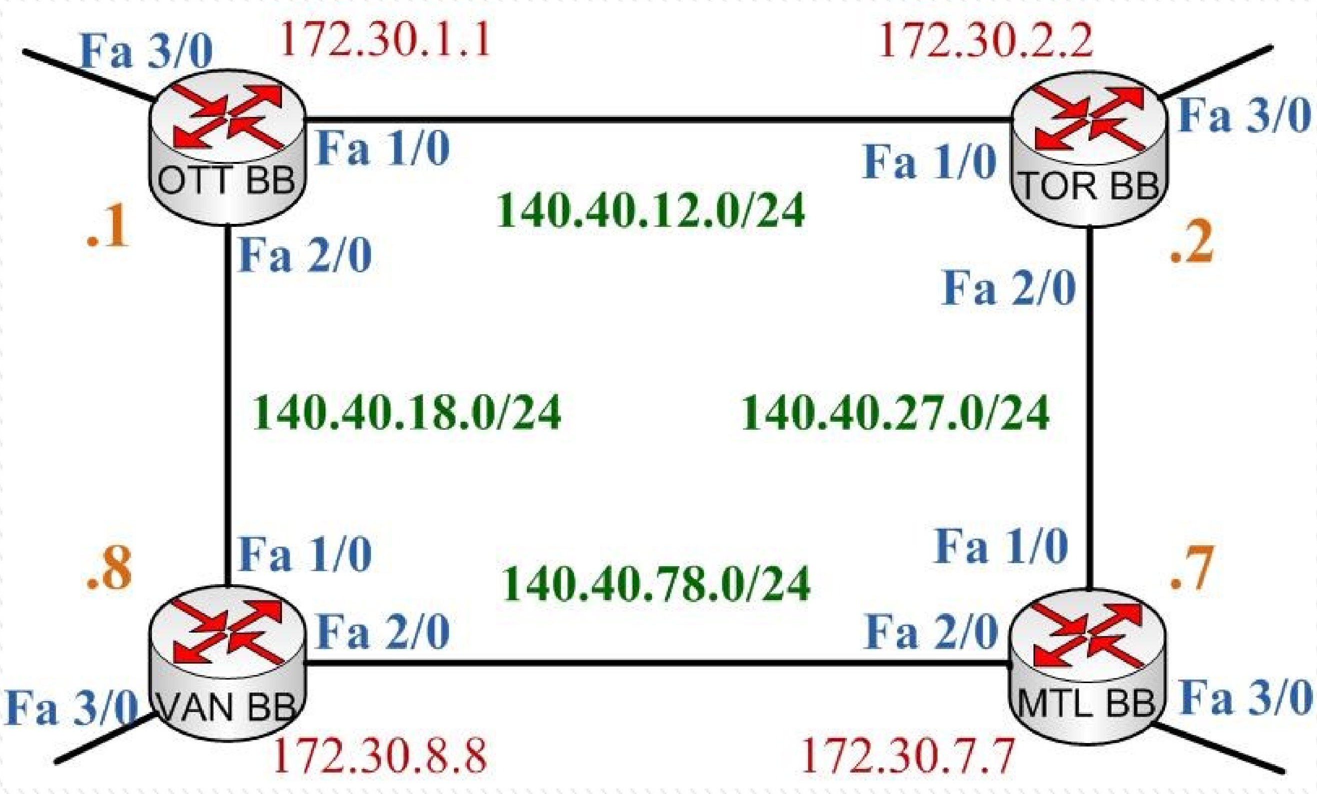
- » Configure loopback 0
- » Enable OSPF in routers
  - » “Passive-interface default” can be used
  - » No OSPF on customer facing interfaces



Re-design & implementation

Enabling MPLS on Service provider routers

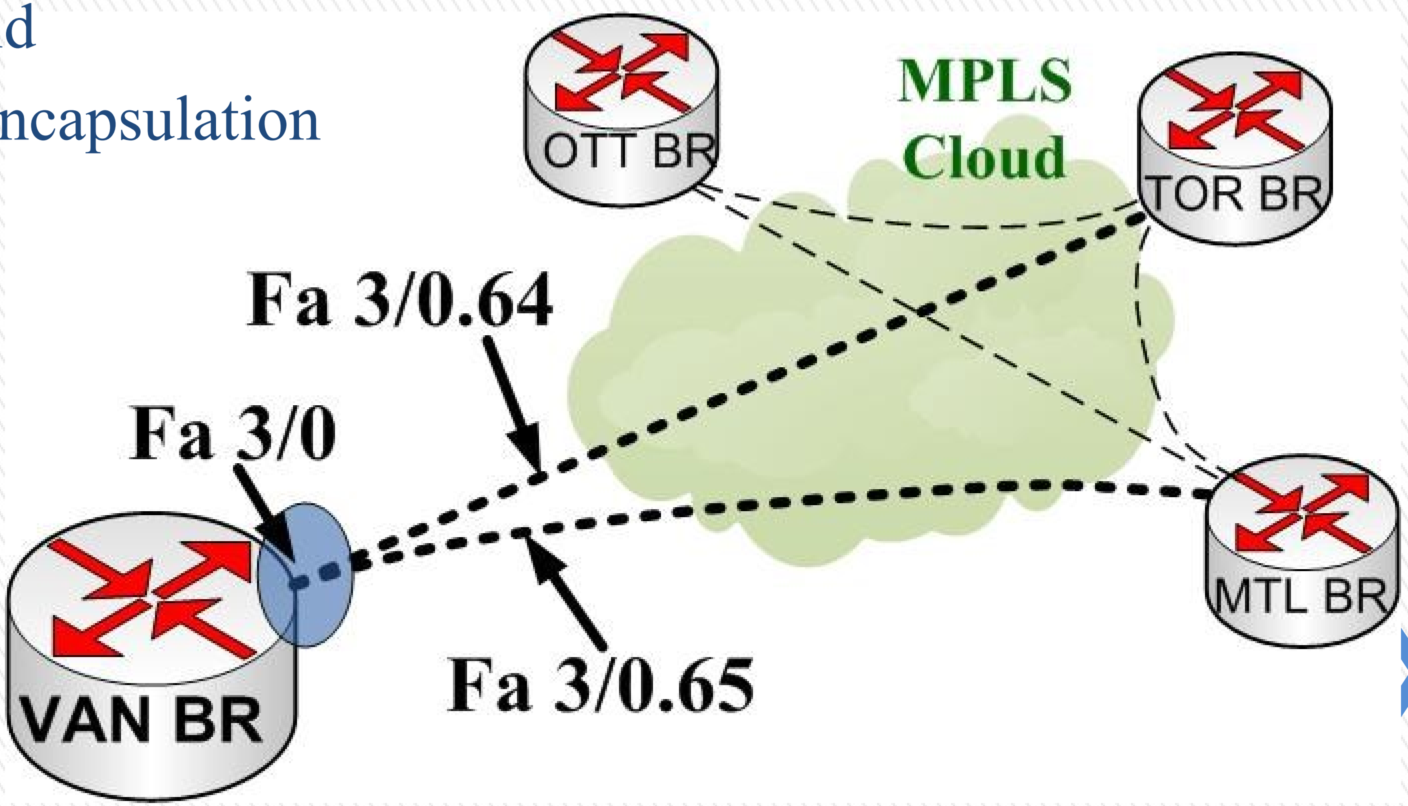
- » Assigning IP addresses to Interfaces
- » Configure MPLS on interfaces
  - » No MPLS on customer connected interfaces



Re-design & implementation

Configuration steps

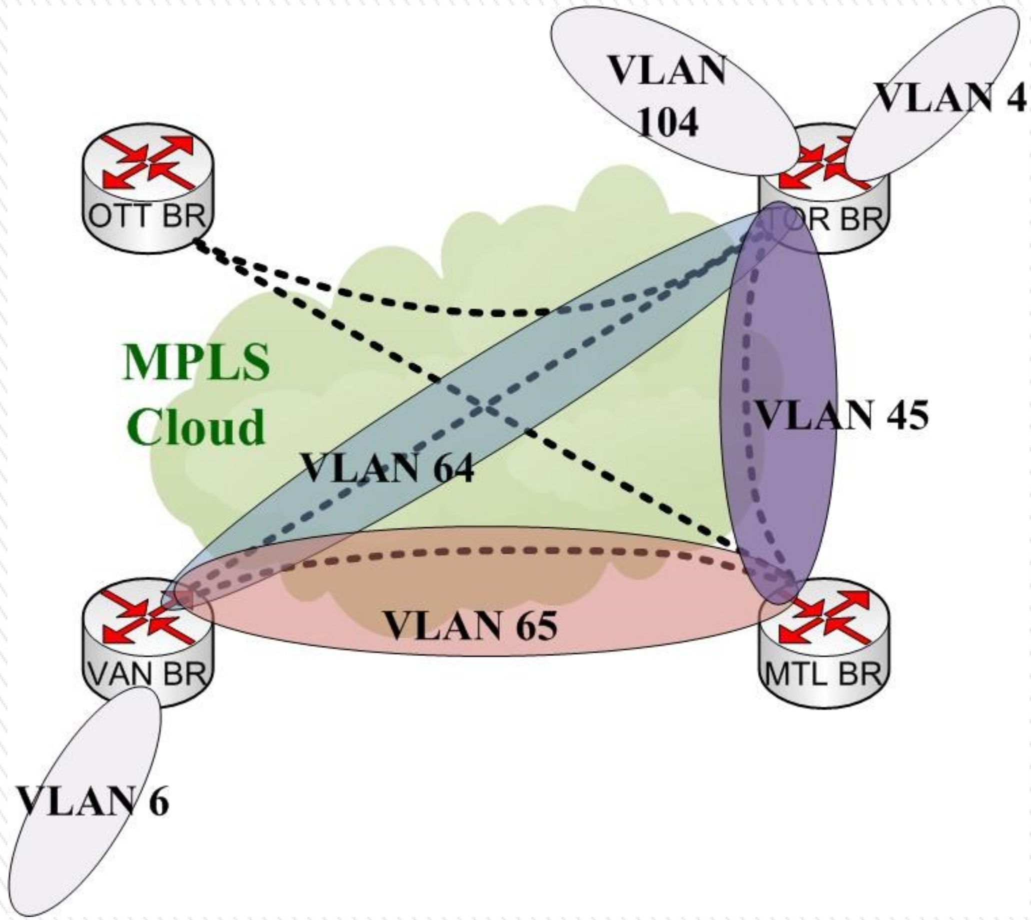
- » Configuring Sub Interfaces
- » Assigning IP addresses
- » Enable OSPF process 4 on each sub-interface
- » VLAN id
- » dot1Q encapsulation



Re-design & implementation

Customer BR Configuration notes

- » MPLS network is transparent to Customer BE routers
- » BE routers perform inter-vlan routing
- » OSPF 4, Area 0 on sub-interfaces will talk with far end BR



Re-design & implementation

Configuring EoMPLS AToM pseudowire (example VAN_BB to TOR_BB)

- On VAN_BB router
  - Pseudowire-class EoMPLS
  - Encapsulation MPLS
  - TOR_BB IP & circuit ID need to be given by xconnect on Fa 3/0 (customer connected int)
- On TOR_BB router
  - Pseudowire-class VLoMPLS
  - Encapsulation MPLS
  - Interworking ethernet
  - VAN_BB IP & same circuit ID by xconnect on Fa 3/0

Questions

Thank You

Appendix: Configuration Details and Notes

Configuration Notes

For example, in Vancouver BB

1. Configure Loopback

    VAN#config t
    VAN_BB(config)#**interface Loopback0**
    VAN_BB(config-if)#**ip address 172.30.8.8 255.255.255.255**
    VAN_BB(config-if)#end

passive-interface default allow all interfaces to be set as passive by default using a single command to obtain routing information
no passive-interface command can use to configure individual interfaces where adjacencies are desired

2. Enable OSPF

    VAN_BB#config t
    VAN_BB(config)#**router ospf 2**
    VAN_BB(config-router)#**router-id 172.30.8.8**
    VAN_BB(config-router)#**log-adjacency-changes**
    VAN_BB(config-router)#**passive-interface default**
    VAN_BB(config-router)#**no passive-interface Fa 3/0**
    VAN_BB(config-router)#**network 140.40.0.0 0.0.255.255 area 0**
    VAN_BB(config-router)#end

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Slide 19 (in the comments): actually you would want Fa3/0 to be passive and the other two not. Fa3/0 should be passive in order to prevent adjacencies forming over the link towards the BR routers; no big deal though, because Fa3/0 should not have IP addresses assigned, so OSPF cannot run on that interface anyway. On the other hand, Fa1/0 and Fa2/0 should not be passive because you need to form adjacencies to the other BB routers over these interfaces.

Configuration Notes

The next thing to do is to configure an interconnect between two routers and enable MPLS on the interface.
OSPF will establish IGP with the neighbor router and LDP will start signaling.
Since All are ethernet interfaces, LDP is activated by default when MPLS is configured

1. Configure MPLS on interfaces
   For example, Vancouver BB

   VAN_BB#config t
   VAN_BB(config)#interface Fa 2/0
   VAN_BB(config-if)#**ip address 140.40.78.8 255.255.255.0**
   VAN_BB(config-if)#**mpls ip**
   VAN_BB(config)#interface Fa 1/0
   VAN_BB(config-if)#**ip address 140.40.18.8 255.255.255.0**
   VAN_BB(config-if)#**mpls ip**
   VAN_BB(config-if)#end

==

- Slide 20: sounds good, LDP is enabled by default when you enable MPLS.
The only thing that's missing is enabling MPLS globally on each router (mpls ip in global configuration mode).

Configuration Notes

In Montreal BB

MTL_BB#config t
MTL_BB(config)#interface Fa 2/0
MTL_BB(config-if)#**ip address 140.40.78.7 255.255.255.0**
MTL_BB(config-if)#**mpls ip**
MTL_BB(config)#interface Fa 1/0
MTL_BB(config-if)#**ip address 140.40.27.7 255.255.255.0**
MTL_BB(config-if)#**mpls ip**
MTL_BB(config-if)#end

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- Slide 20: sounds good, LDP is enabled by default when you enable MPLS.
The only thing that's missing is enabling MPLS globally on each router (mpls ip in global configuration mode).

Configuration Notes

The point-to-point links should replace the ATM PVCs. Now since you have at least two PVCs on each ATM interface and only one Ethernet interface to replace the ATM interface with, you must use 802.1q encapsulation on the interface and have e.g. Fa3/0.34 (VLAN 34) and Fa3/0.35 (VLAN 35) on the OTT BR. Then you would create a pseudowire that bridges Fa3/0.34 with the corresponding interface on the TOR BR, and another pseudowire that bridges Fa3/0.35 with the corresponding interface on the MTL BR.

As far as each subinterface is concerned, they don't notice the MPLS cloud and it's as if they were directly facing the corresponding interface on the opposite BR router.

This way, you will enable OSPF process 4 on each subinterface and it will form an adjacency with the far-end BR router and not with the near-end BB router, so from a routing protocol point of view, nothing would have changed except for the fact that you use Ethernet interfaces instead of ATM interfaces.

On VAN BR

```
VAN_BR#Config t
VAN_BR(config)#int fa 3/0.65
VAN_BR(config-subif)#ip add 140.40.64.6  255.255.255.0
VAN_BR(config-subif)#vlan id 64
VAN_BR(config-subif)#encap dot1q
```

Configuration Notes

Additional notes

QinQ encapsulation allows to encapsulate dot1Q packets from several VLANs within another dot1Q packet of VLAN to transfer through a network

encapsulation dot1q *vlan-id* **second-dot1q** {**any** | *vlan-id*[,*vlan-id*[-*vlan-id*]]}

Example:

Router(config-if)# encapsulation dot1q 100 second-dot1q 200

Defines the matching criteria to map Q-in-Q ingress frames on an interface to the appropriate service instance.

Configuration Notes

In Slide 21: we don't want QinQ because we are running over a routed (not switched) network. QinQ would be great for creating VPNs over switched networks but in this case it would introduce a level of complexity you simply don't need.
In the example, the correct way is to configure the encapsulation first and the IP address afterwards, i.e.

VAN_BR#conf t
VAN_BR(config)#int fa 3/0.65
VAN_BR(config-subif)#encap dot1q 64 <-- note the VLAN ID here VAN_BR(config-subif)#ip add 140.40.64.6 255.255.255.0

... otherwise the ip address command will be rejected and you'll have to enter it again after you have configured the encapsulation.

Also note that you will have to mirror the configuration on Fa3/0 on the BB router, i.e. you need to create a subinterface for each VLAN you want the interface to process but you should not assign IP addresses to those subinterfaces. Use Task #4 (the configuration on R7) as a guideline.

Configuration Notes

Slide 22: We just need to enable OSPF on the FastEthernet (sub) interface(s) newly enabled on the BR routers.

5.2 Configuring a Layer 2 MPLS VPN

```
conf t
pseudowire-class EoMPLS
encap mpls
int Gig 4/0
xconnect 172.30.7.7 17 encap mpls pw-class EoMPLS
End
```

In TOR router

```
conf t
pseudowire-class VLoMPLS
encap mpls
interworking eth
int Gig 4/0.70
xconnect 172.30.1.1 17 encap mpls pw-class VLoMPLS
```

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Slide 23: no, actually configurations will be very similar on all routers because you have at least 2 VCs ending on each router. You will need multiple xconnects but you can do with a single (identical) pw-class on each router.

- END of Configuration Notes -