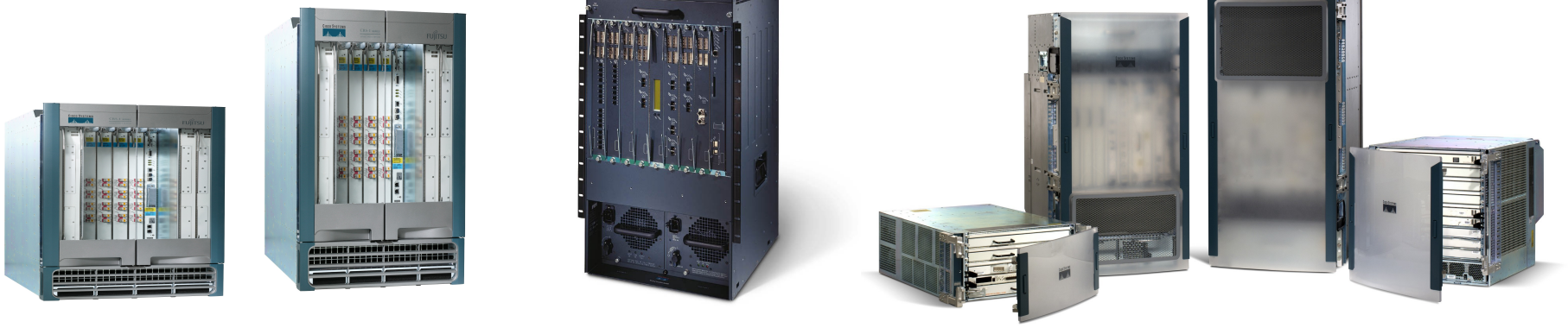
MikroTik RouterOS
Introduction to MPLS

Prague

MUM Czech Republic 2009

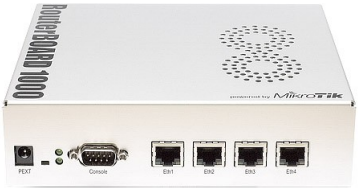
Q: Why haven't you heard about MPLS before?

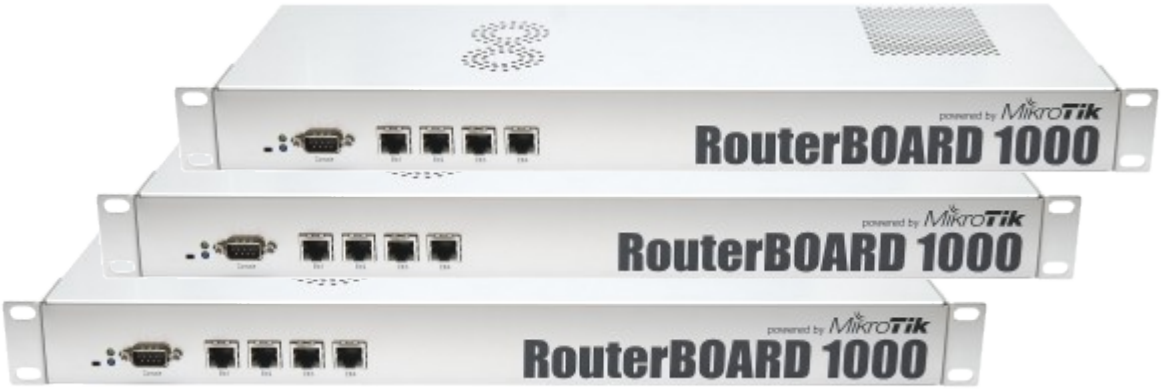
A: Probably because of the availability and/or price range



Q: Why should you care about MPLS now?

A: Probably because of the availability and/or price range...





A: ...and the reasons mentioned further in this presentation!

Networking

There are 3 networking methods available to manage computer networks:

- Routing
  - Protocols: RIP, OSPF, BGP
- Bridging
  - Protocols: STP, RSTP, MESH
- **Switching**
  - Protocols: **MPLS**, ATM, Frame Relay

Concept of Switching

Switching

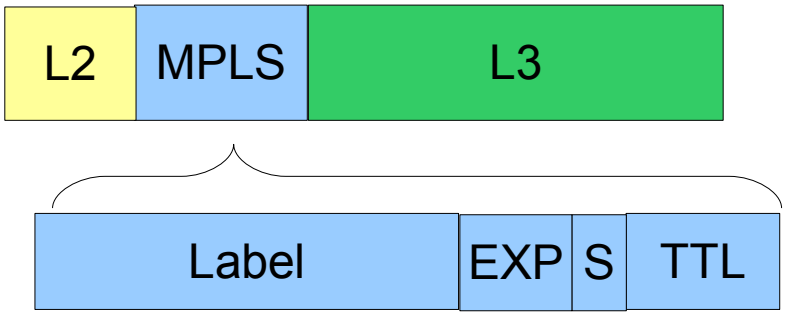
- Switching is a network communications method that groups all transmitted data (no matter of content, type, or structure) into suitably-sized blocks
- Each block is then transmitted over the network independently of each other
- Network is capable of allocating transmission resources as needed, in this way optimizing utilization of link capacity and robustness of communication

MPLS

- MPLS stands for Multi Protocol Label Switching
- MPLS is a packet forwarding method based on labels attached to the packet and a label forwarding table with minimal lookup overhead
- With MPLS the packet forwarding decision is no longer based on IP header and routing table
- Efficiency of forwarding process is the main benefit of MPLS

MPLS Header

- Also called Layer2.5 (because it is placed between OSI Layer2 and Layer3)
- Header can consist of one or several 32bit shims:
  - Label (20 bits)
  - EXP (3 bits) – Class of Service
  - End of stack flag(1 bit) – is it last label?
  - TTL (8 bits)

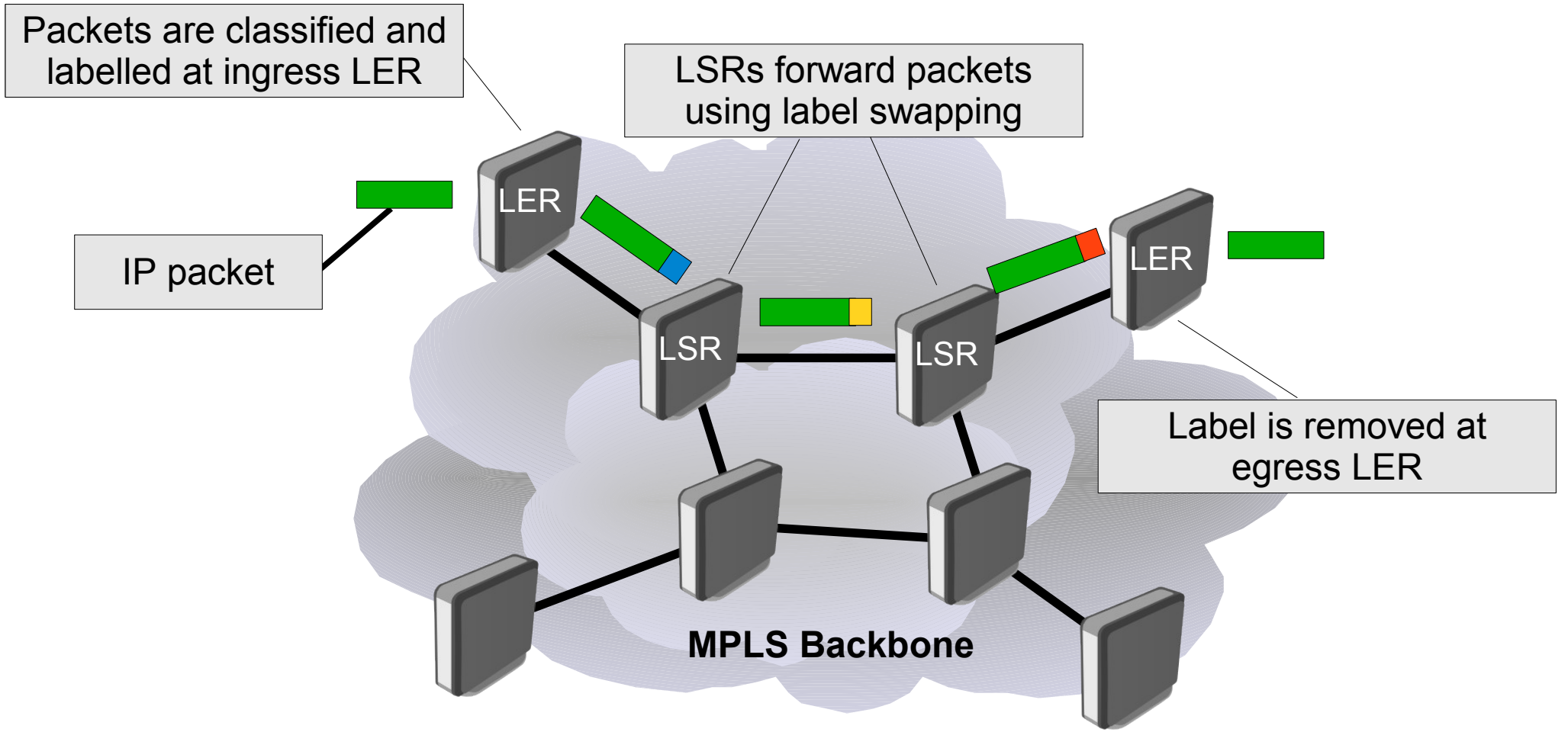


MPLS LDP

- MPLS labels are assigned and distributed by the Label Distribution Protocol (LDP)
- LDP requirements:
  - IP connectivity – properly configured IP routing (static,OSPF,RIP) between all hosts
  - “loopback” IP address that **isn't** attached to any real network interface (recommended)
  - Homogeneous MPLS cloud – all devices inside the MPLS cloud must have MPLS support

MPLS Basics

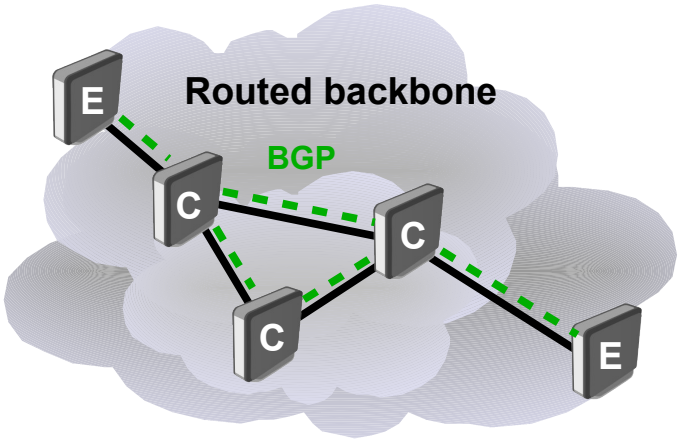
- **LER – Label Edge Router**
- **LSR – Label Switch Router**

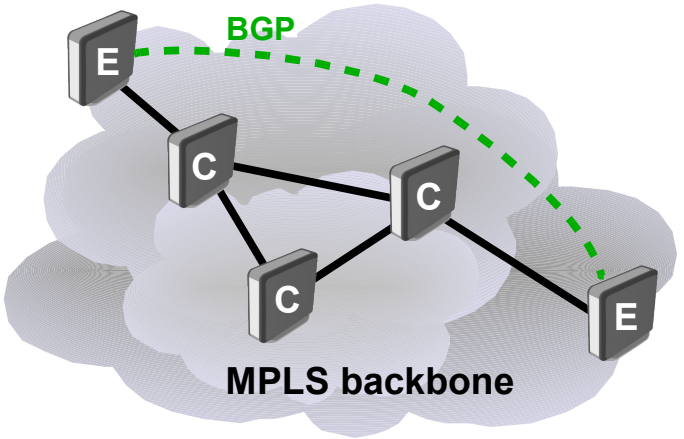


MPLS Benefits

- Increased scalability of the network
- Increased forwarding performance of the network
- Increased amount of possible VPN solutions that an ISP can offer to clients
- Traffic engineering
- Quality of Service
- Redundancy and failover

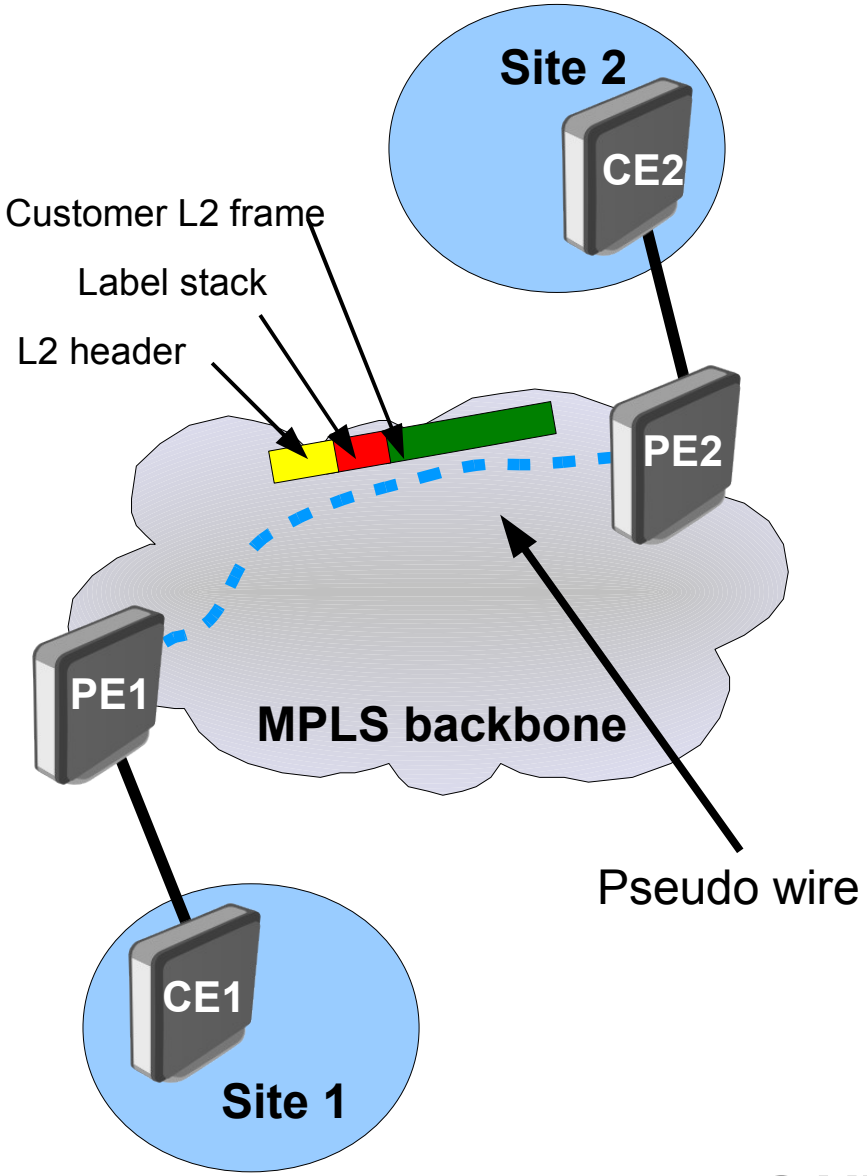
BGP Scalability with MPLS





- Traditionally you have to run BGP on all core routers
- With MPLS, you only need to run BGP on network edges
- Note: it is easy to migrate from routed backbone to MPLS enabled backbone

MPLS enabled L2 VPNs

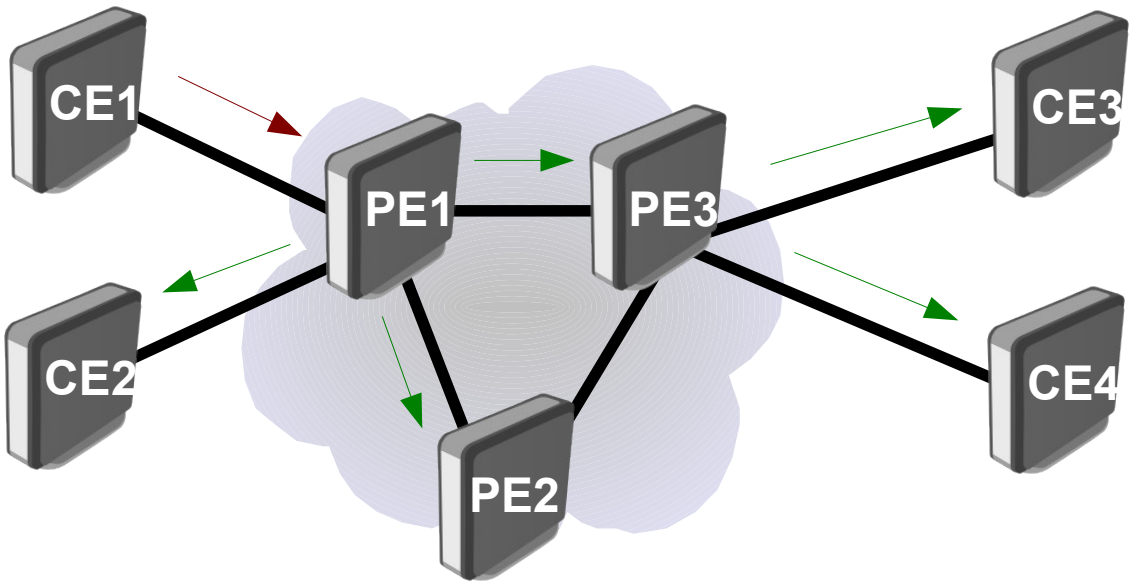


- Layer2 service without the drawbacks of Layer2 network
- Uses split-horizon method to prevent loops (RSTP is not required)
- New service is configured at the edge routers (no need to make changes to the network core)
- Simpler to configure, easier to manage
- Complete separation between providers network and customers network

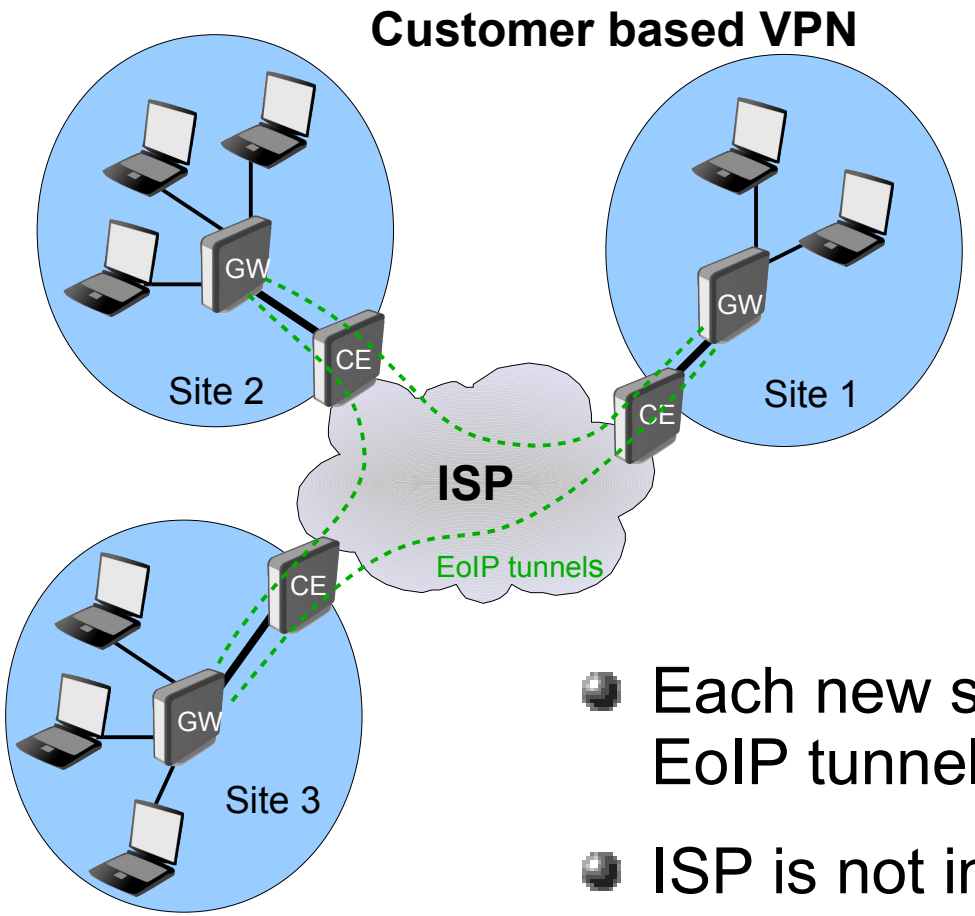
Split Horizon

- Forward Ethernet frame coming from PE to connected CEs
- Packets are not forwarded to interfaces with the same horizon value
- Horizon value is set in bridge port configuration

```
/interface bridge port
   add bridge=vpn interface=vpls1 horizon=1
```



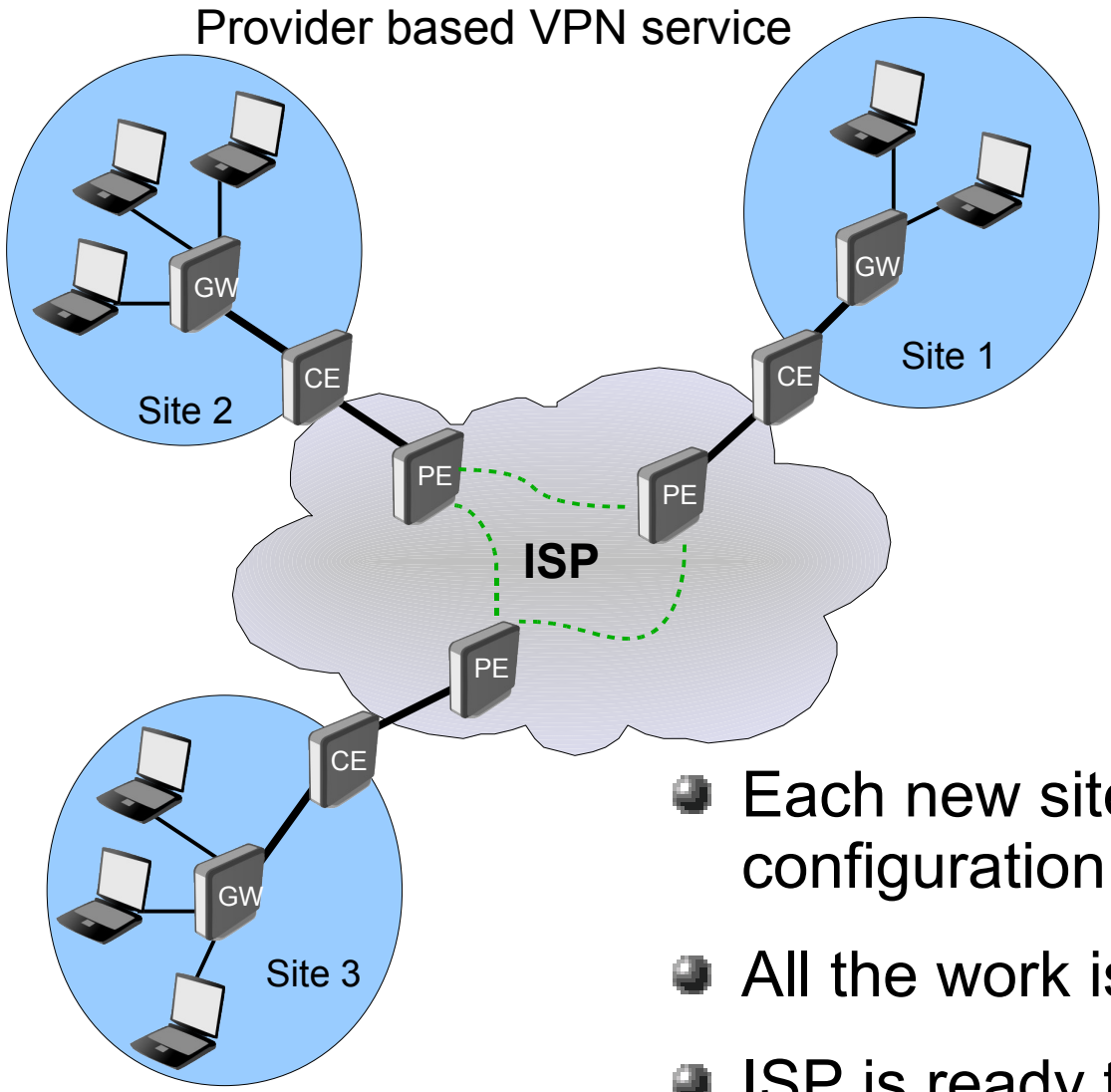
Current Layer2 VPNs



- Additional administration expenses
- Big Overhead (Ethernet+GRE+IP)
- Not very scalable

- Each new site requires configuration of EoIP tunnels to every existing site
- ISP is not involved

MPLS VPLS

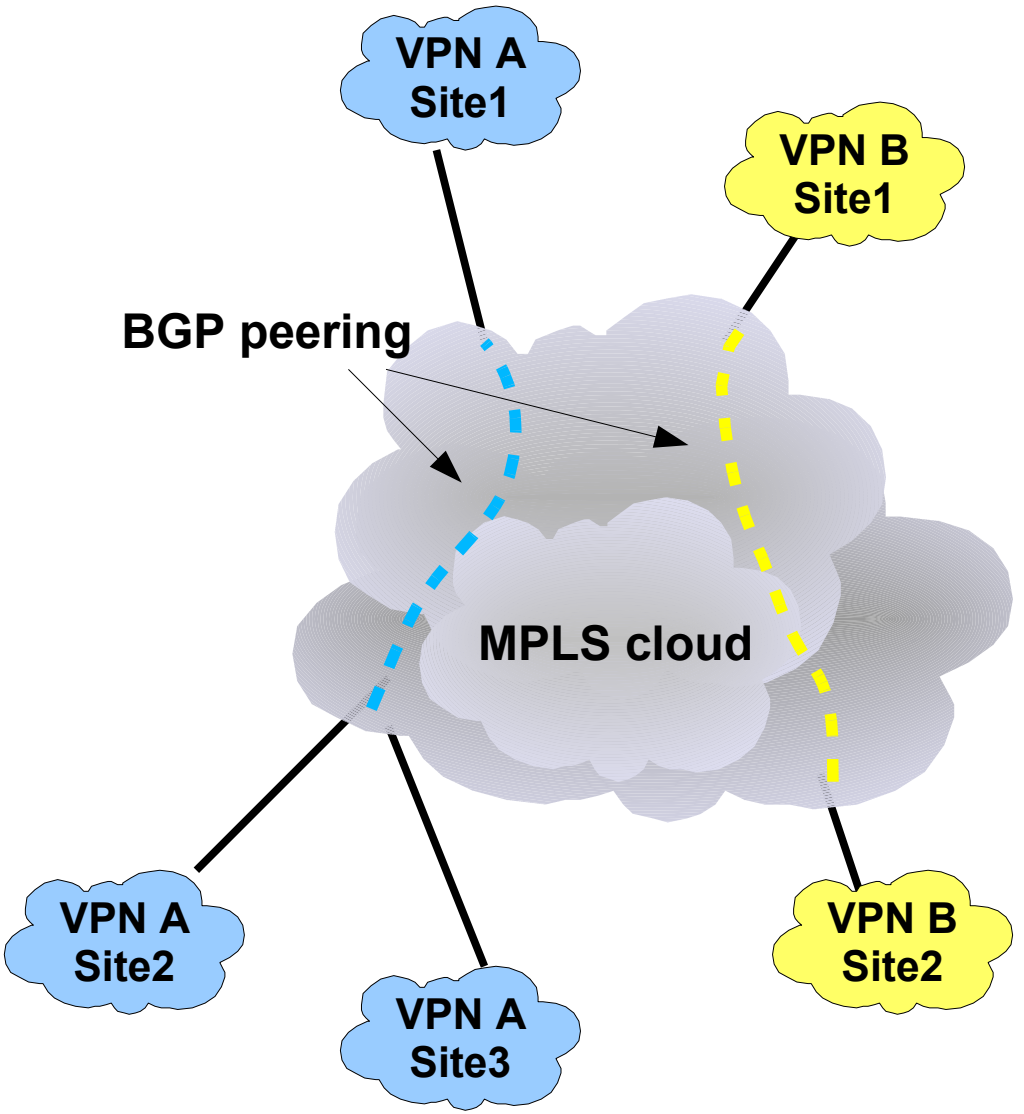


- Bandwidth improvements
- Smaller Overhead (Ethernet+2 labels)
- Can ask provider for guaranteed VPLS bandwidth

- Each new site only requires correct PE configuration
- All the work is done by the ISP
- ISP is ready to sell new type of service

Layer3 VPNs

- VPN scalability
- Each VPN has unique routing table (VRF table)
- Customer IP address freedom (overlapping private IPs)
- Can be set over existing BGP network

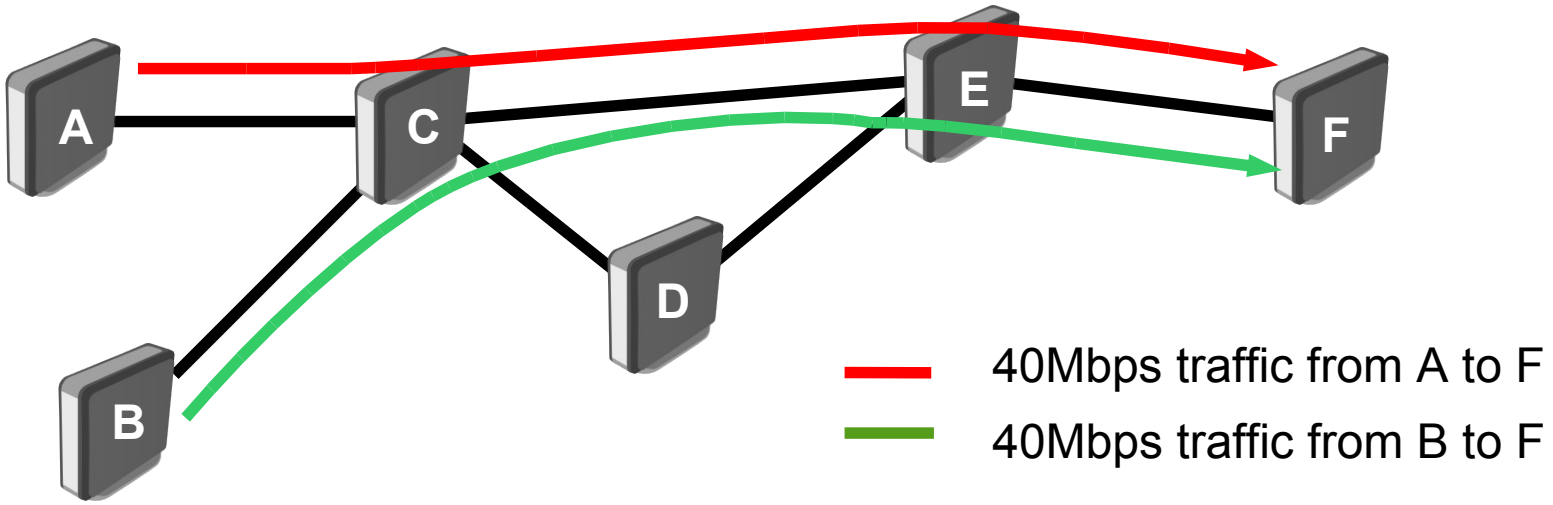


VRF Table

- Means 'Virtual Routing and Forwarding Table'
- VRF tables are similar to policy routing, except:
  - Each VRF table is independent - main routing table will not be used if VRF table fails to resolve route
  - BGP can be used to distribute routes between different VRF tables in the router

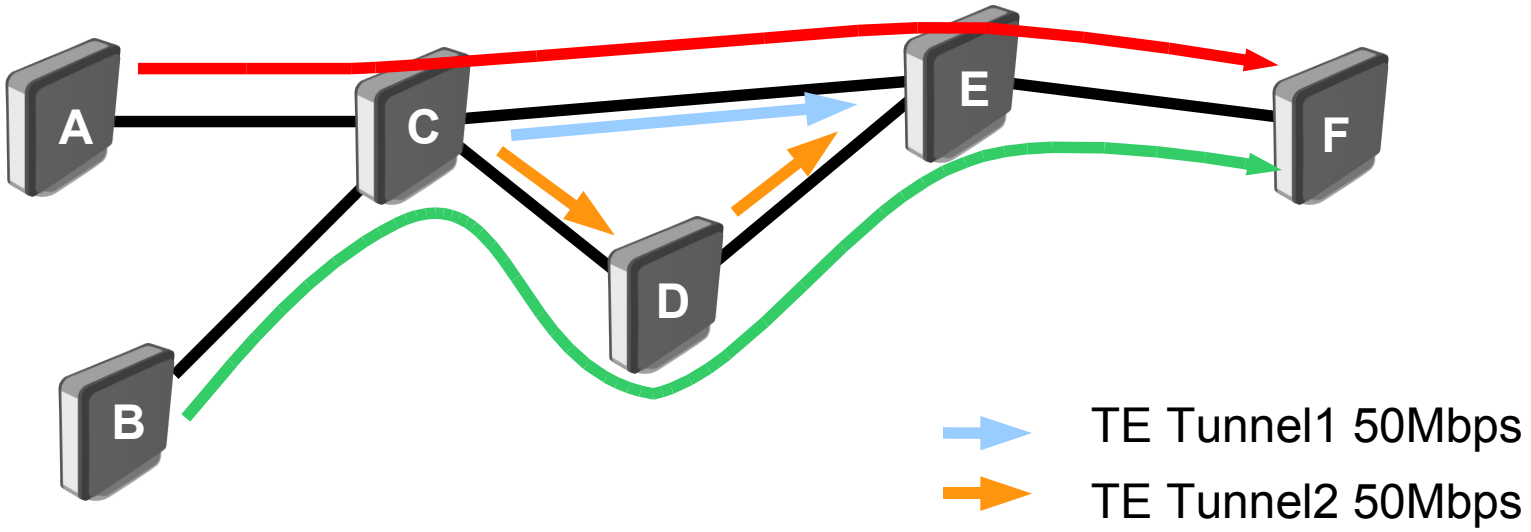
IP Routing Limitation

- After two IP traffic flows for the same destination are merged, it is impossible to split them and reroute over different paths
- Overloaded link from Router C to Router E



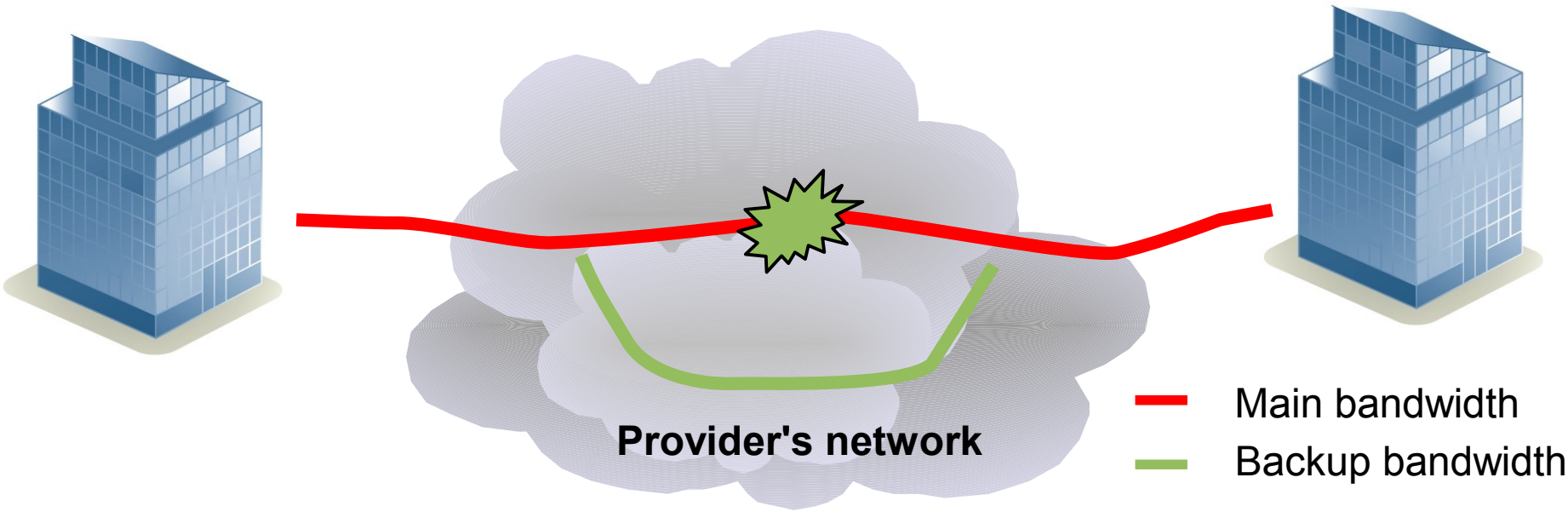
Traffic Engineering

- TE tunnels can be used to shift the traffic load onto less utilized links



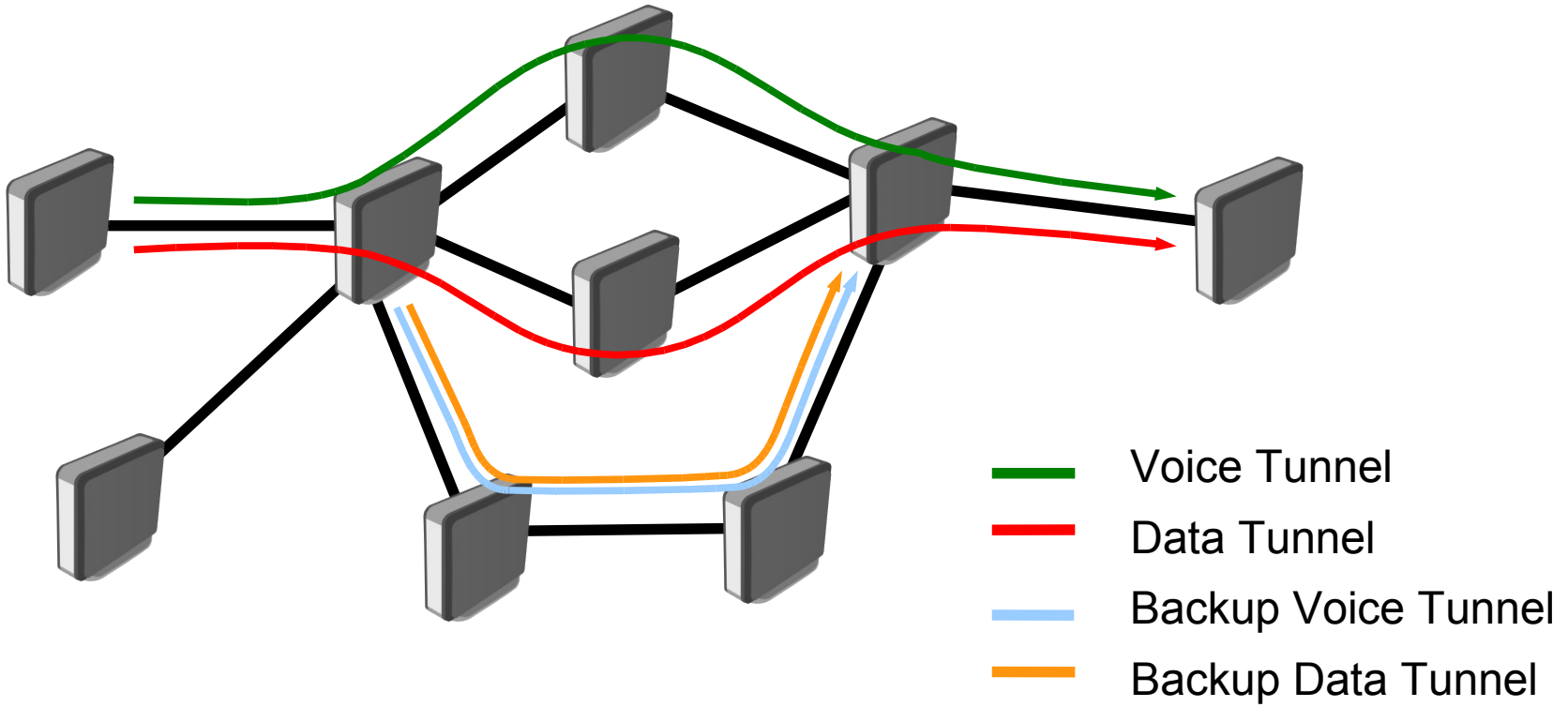
Customers Bandwidth Protection

- Customers do not care how it is offered by the provider
- With TE it is easy to deliver guaranteed bandwidth from point A to point B



Bandwidth Optimization

- Separate tunnels for voice, video, or data
- Backup tunnels over the third link



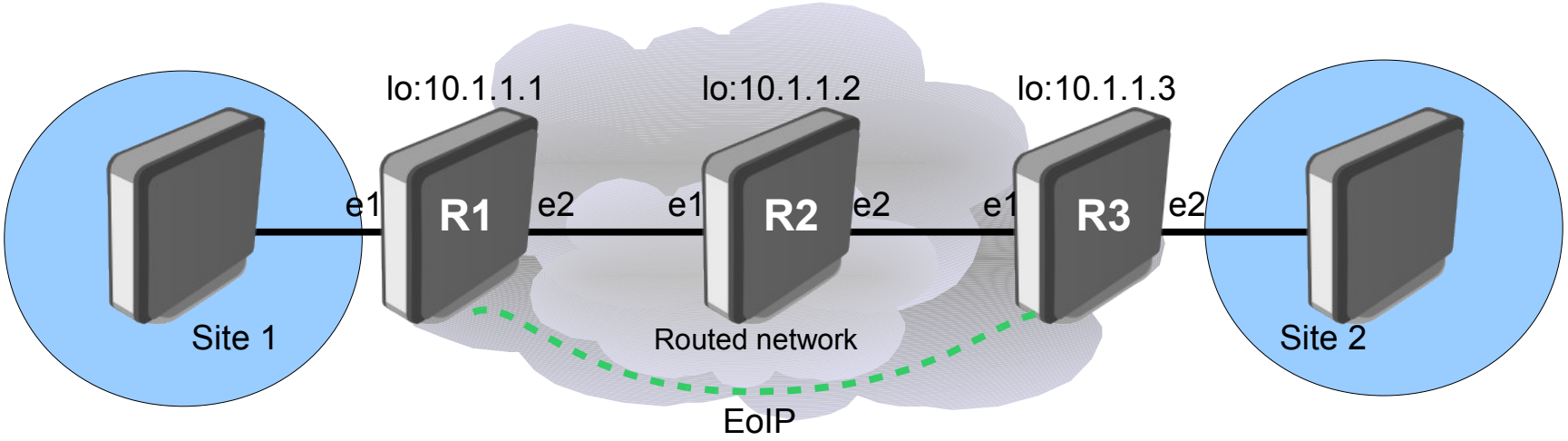
MPLS on RouterOS

- Supported features
  - Static label binding for Ipv4
  - LDP for Ipv4
  - Virtual Private Lan Service
    - LDP based VPLS
    - MP-BGP based autodiscovery and signaling
  - RSVP TE Tunnels
    - OSPF extension for TE tunnels
    - Explicit path and CSPF path selection
    - Forwarding VPN traffic on TE tunnels
  - OSPF as CE-PE

MPLS on RotuerOS

- Not yet supported
  - Ipv6
  - LDP features
    - Downstream on demand
    - Ordered label distribution protocol
  - RIP and iBGP as CE-PE protocols
  - TE features
    - Fast reroute
    - link/node protection
- Full feature list at http://wiki.mikrotik.com/wiki/MPLS

From EoIP to VPLS



- Example: We have a routed network between R1, R2 and R3
- EoIP tunnel is established between R1 and R3 to guarantee Layer2 connectivity between Site 1 and Site 2

From EoIP to VPLS

- Enable LDP

```
/mpls ldp
    set enabled=yes lsr-id=10.1.1.x \
    transport-address=10.1.1.x

# on R1
/mpls ldp interface
    add interface=ether2
# on R2
/mpls ldp interface
    add interface=ether2
    add interface=ether2
# on R3
/mpls ldp interface
    add interface=ether1
```

From EoIP to VPLS

- Configure VPLS

```
# on R1
/interface vpls add name=R1toR2 remote-peer=10.1.1.3 \
    vpls-id=10:10
/interface bridge port add bridge=vpn interface=R1toR2

# on R3
/interface vpls add name=R2toR1 remote-peer=10.1.1.1 \
    vpls-id=10:10
/interface bridge port add bridge=vpn interface=R2toR1
```

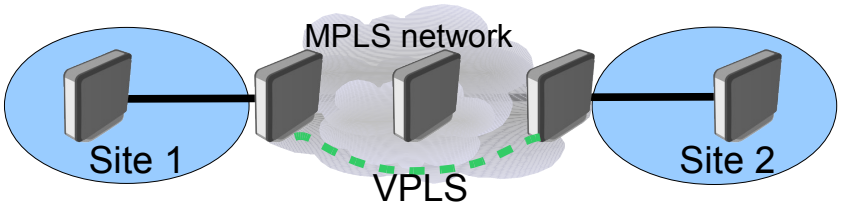
Speed tests

Label switching on RB1000

	64 byte pps	512 byte pps
Bridging	414 000	359 000
MPLS	410 000	358 000
Routing	236 000	229 700

- Almost 2x faster than IP forwarding
- The same speed as bridging

- 60% faster than EoIP tunnel over routed network



	64 byte pps	512 byte pps
EoIP	190 000	183 900
VPLS	332 500	301 000

Useful links

- http://wiki.mikrotik.com/wiki/MPLS
- General
  - http://wiki.mikrotik.com/wiki/MPLS_Overview
  - http://wiki.mikrotik.com/wiki/EXP_bit_behaviour
  - http://wiki.mikrotik.com/wiki/MPLS_TE_Tunnels
- L2VPNs
  - http://wiki.mikrotik.com/wiki/MPLSVPLS
  - http://wiki.mikrotik.com/wiki/BGP_based_VPLS
  - http://wiki.mikrotik.com/wiki/Cisco_VPLS
- L3VPNs
  - http://wiki.mikrotik.com/wiki/Virtual_Routing_and_Forwarding
  - http://wiki.mikrotik.com/wiki/A_complete_Layer-3_MPLS_VPN_example