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Architecture of dynamic VPNs in OpenFlow

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Observations

- Network Management Systems are growing in complexity
- VPNs used to share network resources and growing in numbers

➡ ***complex network management***

- Growing demand for application specific VPNs
- Leading to “Dynamic VPNs”

Dynamic VPNs

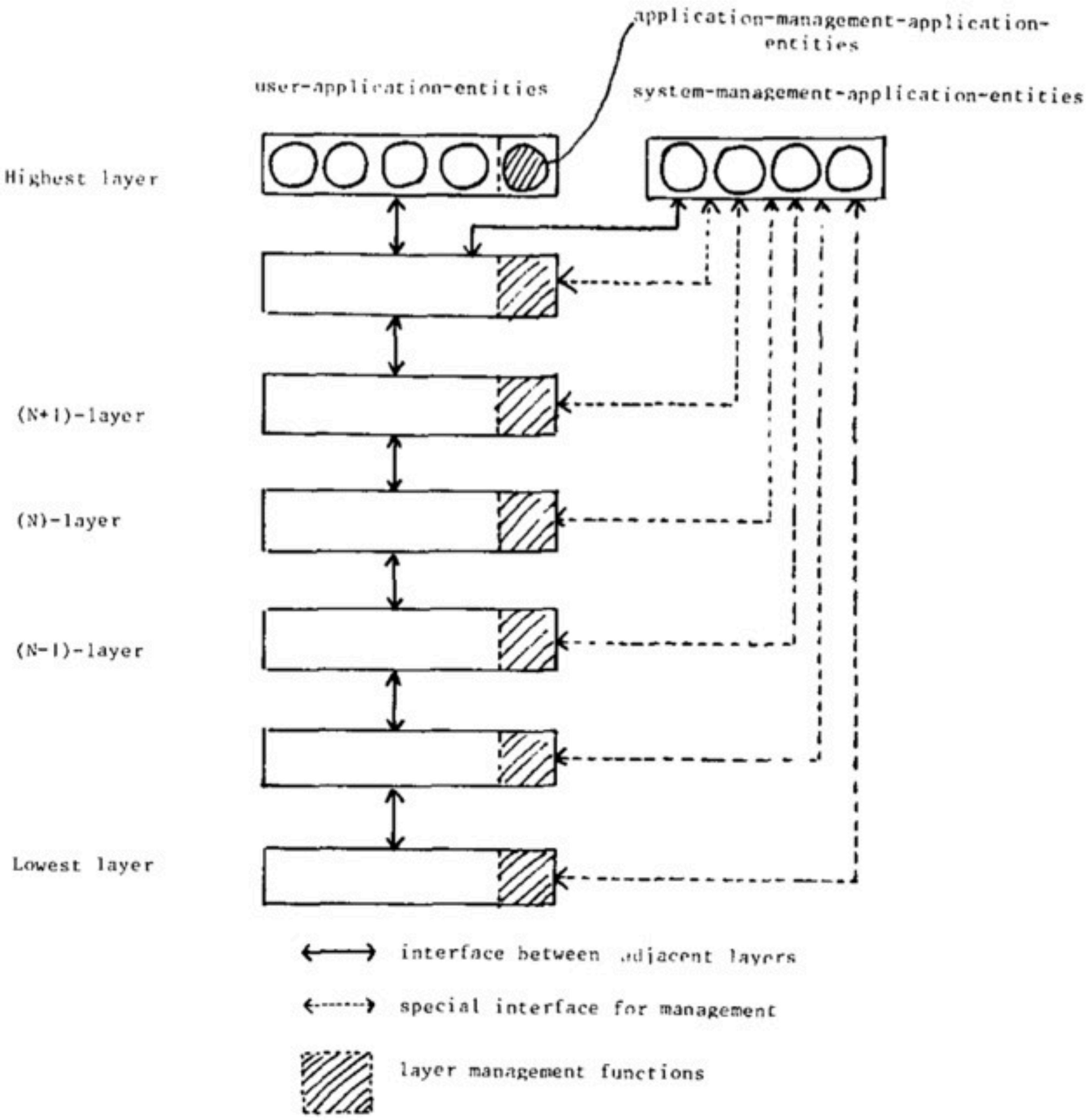
- Requirements:
    - All VPN features
    - Automated VPN creation, modification and deletion
        - Manage member ports
        - Adapt Paths to Network Resources and DVPN Requirements

Problem

- To implement DVPNs in the network:
  - Solve complexity of network management
  - Allow for granular control over network resources

Potential Solution

- OpenFlow and SDN
- Why the momentum?
- State of the art
- “Not supported”


application-management-application-entities
user-application-entities
system-management-application-entities
Highest layer
(N+1)-layer
(N)-layer
(N-1)-layer
Lowest layer
interface between adjacent layers
special interface for management
layer management functions

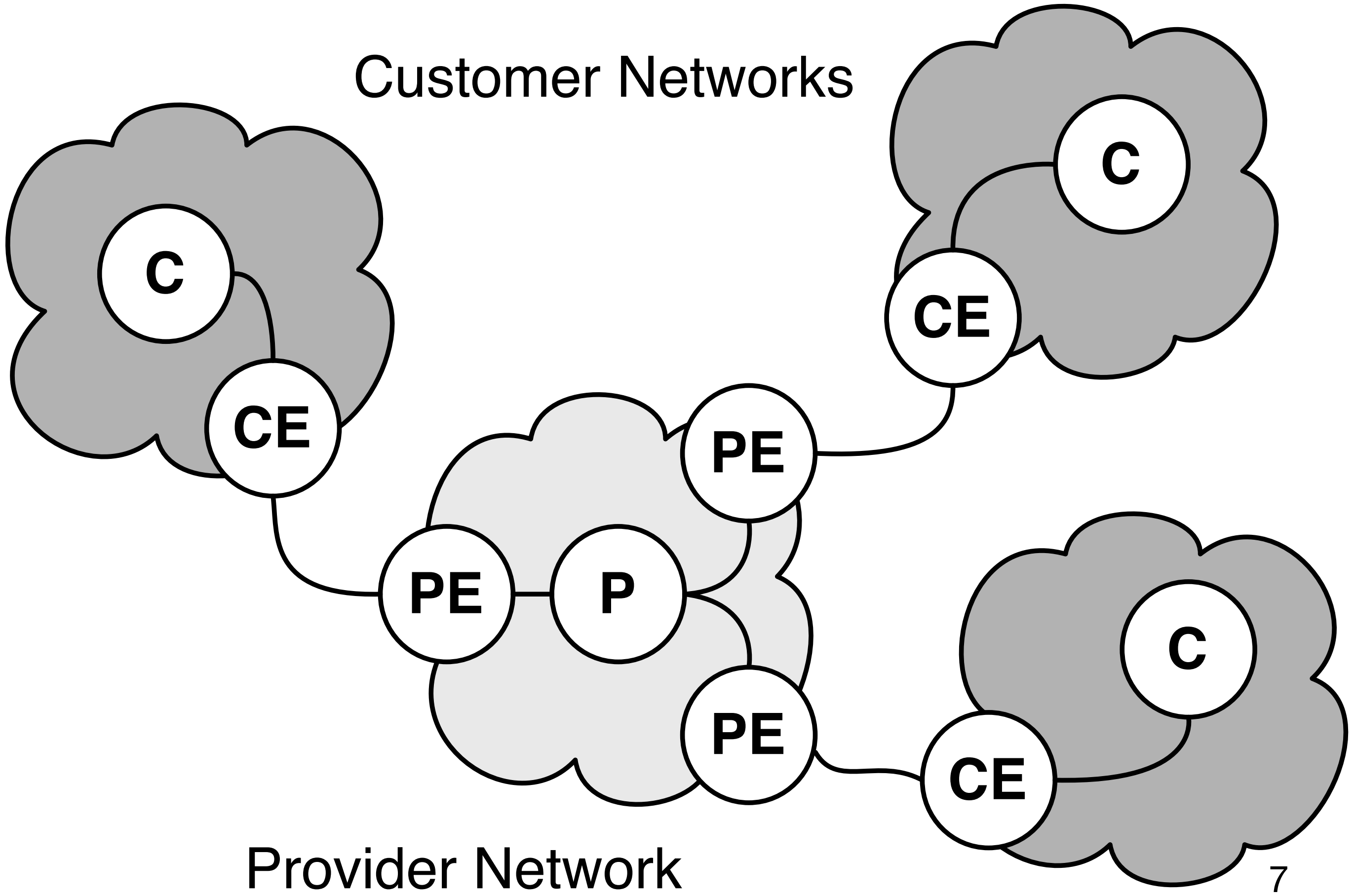
OSI Reference Model — H. Zimmermann — 1980

Research Questions

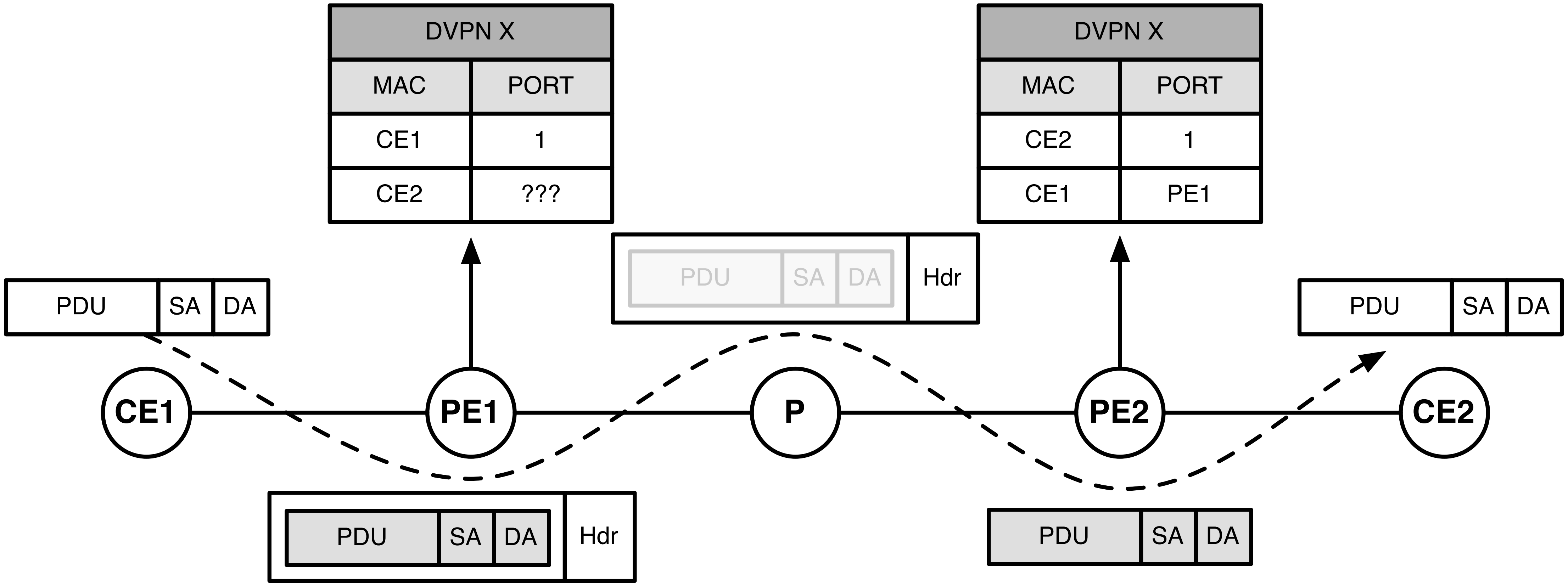
- Can DVPNs be implemented using contemporary technologies?
- Can DVPNs be implemented using OpenFlow?
- What are the differences?

VPN Service

- Provider Provisioned VPN
- Layer 2 Ethernet broadcast domain
- Transparent to Customer
- No exchange of routing info between provider and customer



VPN Transport



DVPN X	
MAC	PORT
CE1	1
CE2	???

DVPN X	
MAC	PORT
CE2	1
CE1	PE1

- VPN “coloring”
- Ethernet frame encapsulation

VPN Transport

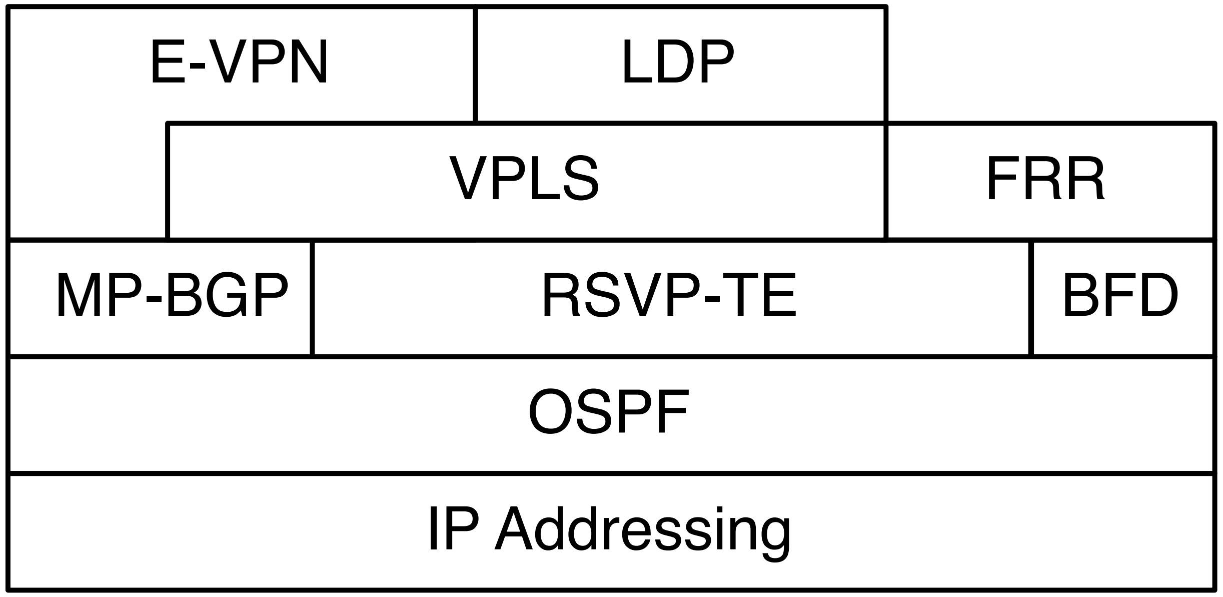
- Additional requirements for Carrier DVPN service:
  - MAC Scalability
  - Traffic Engineering (TE)
  - Load Sharing (ECMP)
  - Operations, Administration and Management (OAM)
  - Fast Failover
  - Rate Limiting of DVPN traffic
  - Rate Limiting of BUM traffic

DVPN Provisioning

- Base network to provide VPNs
- Install routes between PEs
- Automated VPN creation, modification and deletion:
  - Manage member ports
  - Adapt Paths to Network Resources and DVPN Requirements

MPLS Implementation

- MPLS with VPLS
  - Paths and VPN Coloring
- Protocol Stack Dependencies
- Complex configuration
  - Requires custom NMS
  - Lack of defined API
- Fast Failover using RSVP (another label)
- E-VPN MAC learning (draft)



E-VPN | LDP

VPLS | FRR

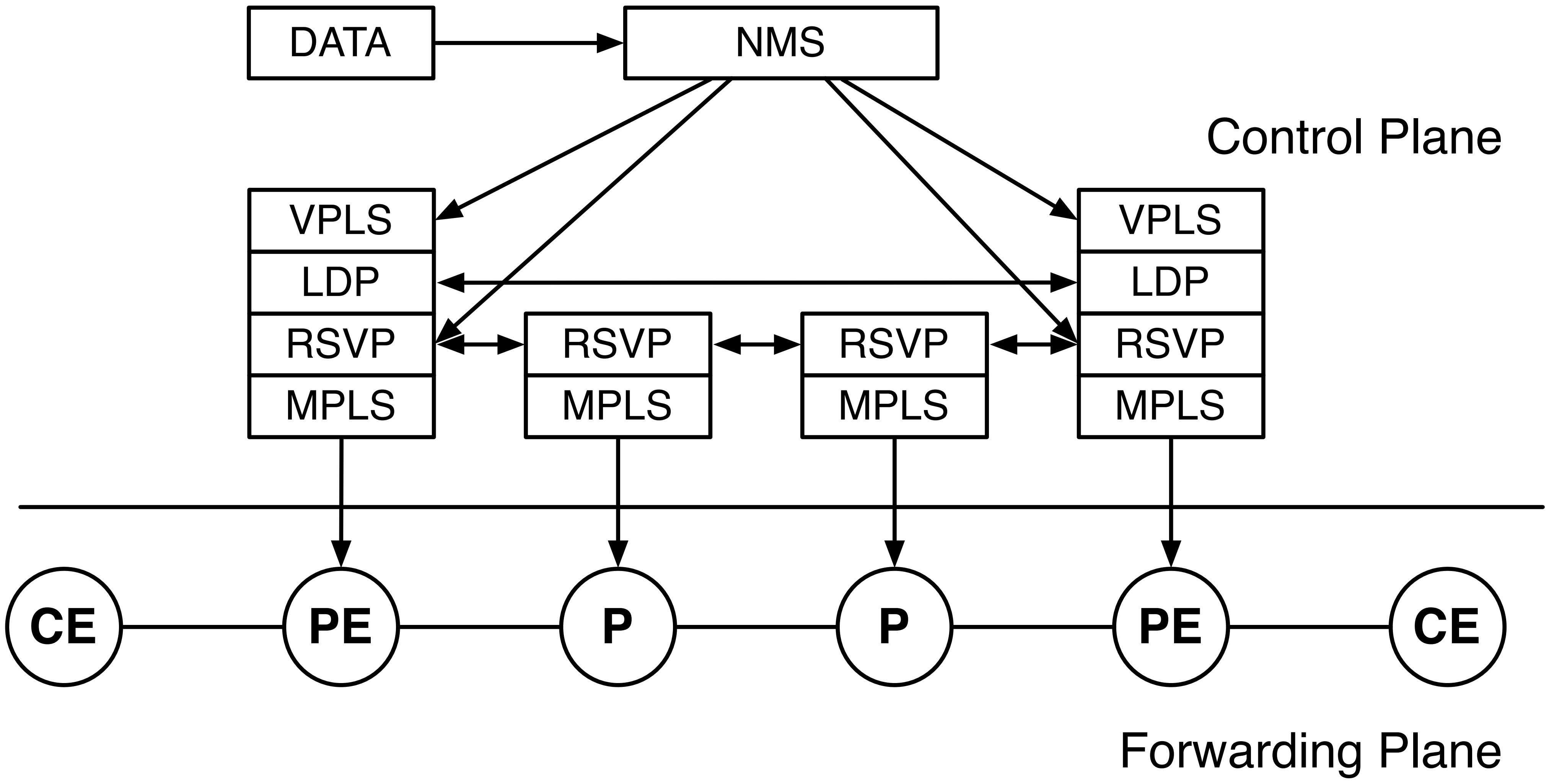
MP-BGP | RSVP-TE | BFD

OSPF

IP Addressing

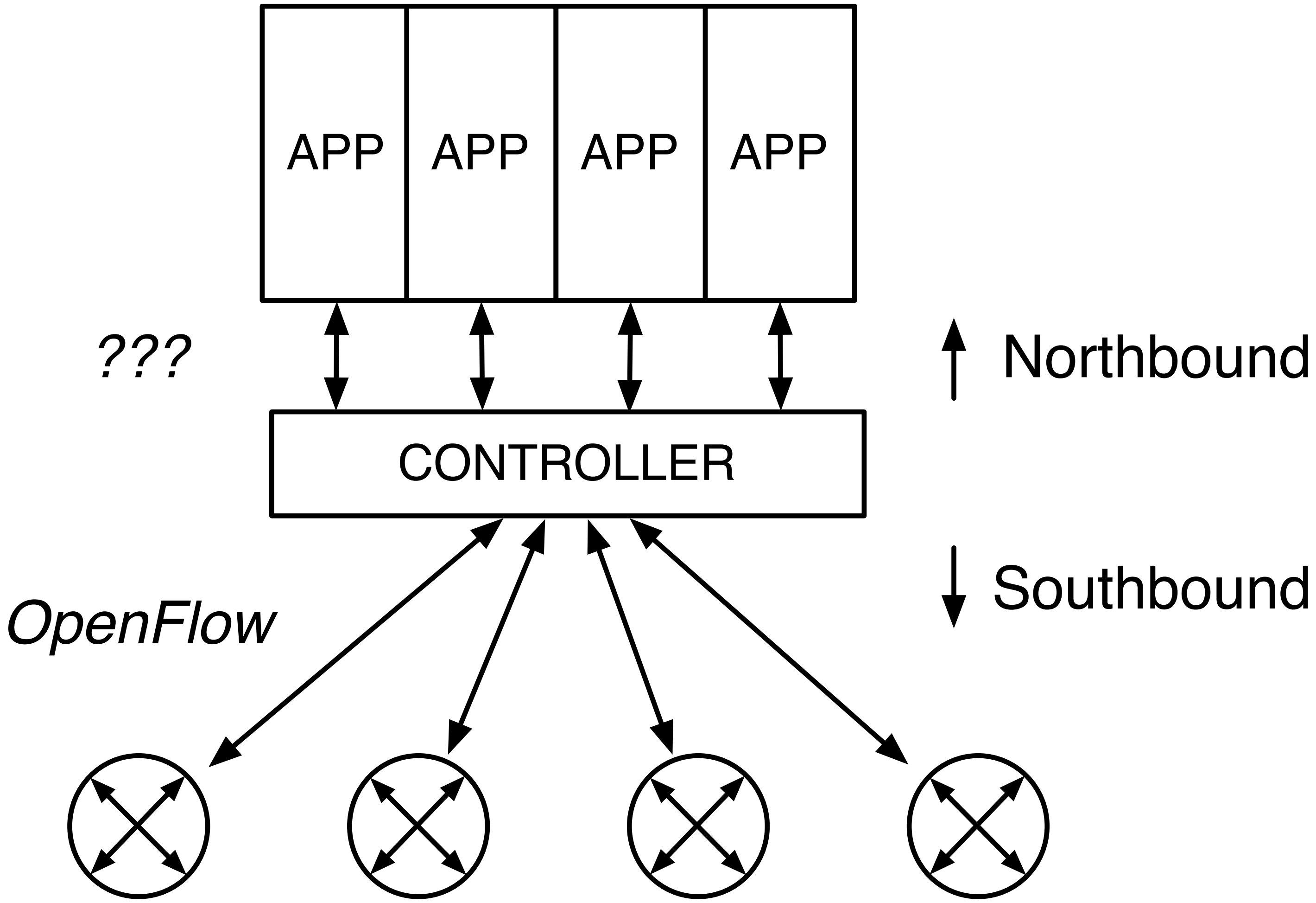
MPLS Implementation

- Provisioning of DVPNs through NMS
  - Needs topology information to provide paths
  - Installs paths in RSVP, end-points in VPLS



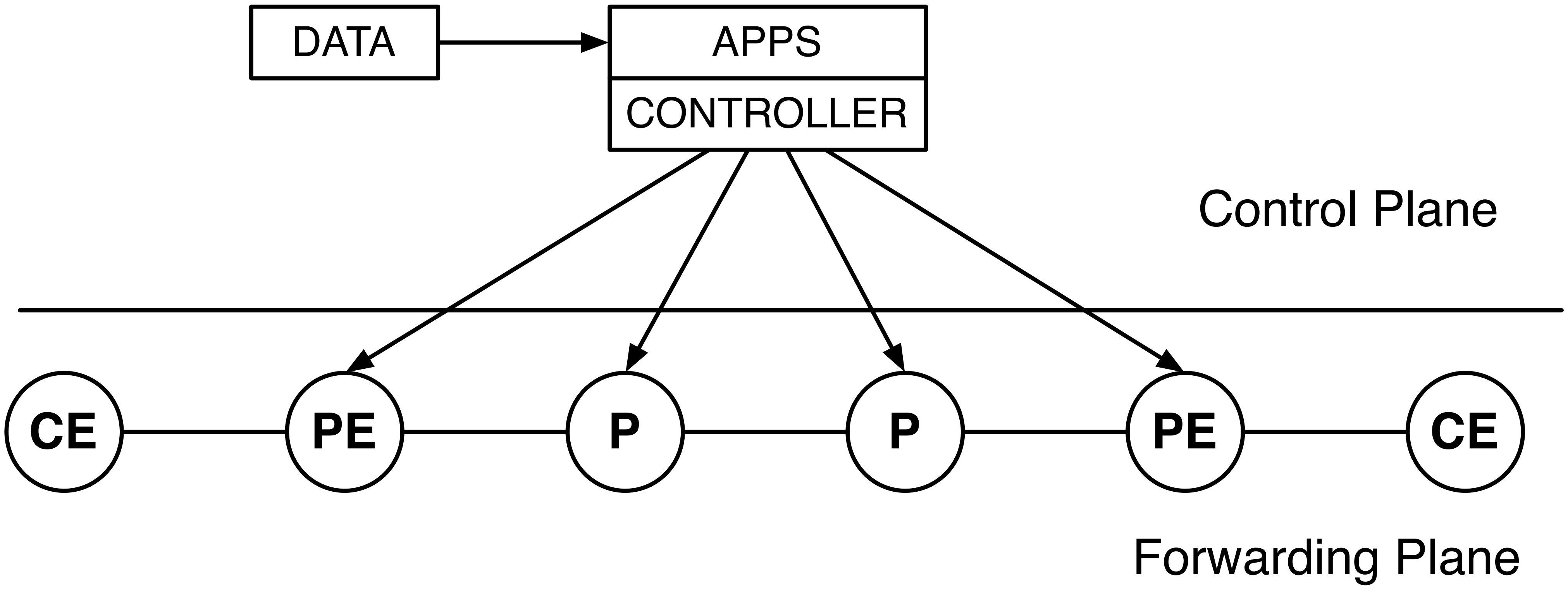
OpenFlow Implementation

- SDN Architecture with OpenFlow 1.3
- Abstraction of the network
- Centralized Applications
  - MAC Learning
  - Traffic Engineering
  - ECMP
  - Fast Failover..
- MPLS labels
- Rate Limiting per Flow



OpenFlow Implementation

- Provisioning of DVPNs through Applications
  - Has topology information available
  - Traffic Engineering Application allows rerouting
  - Install Paths in all intermediate P's



Research Answers

- Can DVPNs be implemented using contemporary technologies?
  - Yes, but management is complex and lacks control
- Can DVPNs be implemented using OpenFlow?
  - Yes, using MPLS labels and custom applications
- What are the differences?

Comparison

	MPLS	OpenFlow/SDN
Tagging of VPN Traffic	VPLS	MPLS
MAC Scalability	yes	yes
Topology Discovery	OSPF	centralized
Path Provisioning	RSVP / LDP	centralized
Traffic Engineering	RSVP	centralized
ECMP	yes	yes, using Groups
BUM limiting	dependent on HW	per flow
BUM traffic handling	flood	controller
Exchange C-MACs	E-VPN (draft)	centralized
Traffic Rate Limiting	dependent on HW	per flow
Fast Failover	FRR and BFD	yes, using Groups*
OAM	LSP Ping	centralized

MPLS

Pro's	Con's
• Known technology	• Large protocol stack • No consistent management interface • Complex NMS • E-VPN in draft

OpenFlow

Pro's

- Learn from MPLS
- MAC Exchange on PEs
- Rate Limiting per Flow

Con's

- No forwarding plane monitoring
- No Northbound standard
- Reimplement intelligence

Conclusion

- MPLS lacks in manageability
- SDN architecture solves complexity
- OpenFlow missing essential carrier function

Questions?