Orchestrating a brighter world NEC

ODENOS : An SDN Framework for Heterogeneous Network Orchestration

Kazuya Suzuki
Cloud System Research Laboratories,
NEC Corporation
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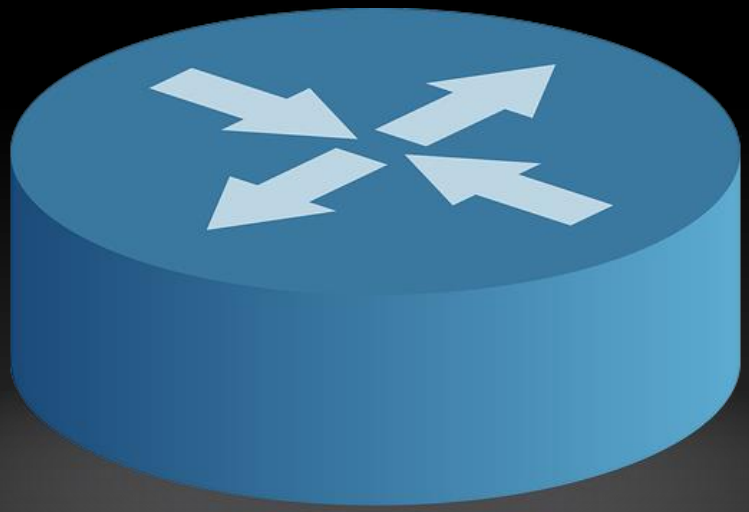
This research is executed under a part of a “Research and Development of Network Virtualization Technology” program commissioned by the Ministry of Internal Affairs and Communications.

At the time of a firmware update,

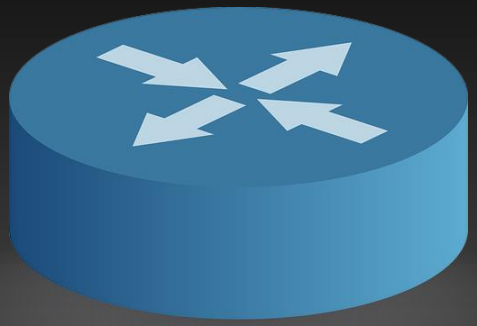
I want to move data flows on the device to another path.



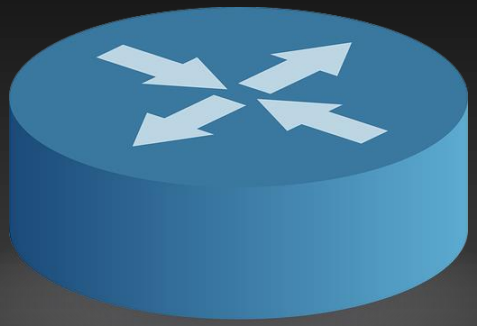
As communication quality gets wrong,

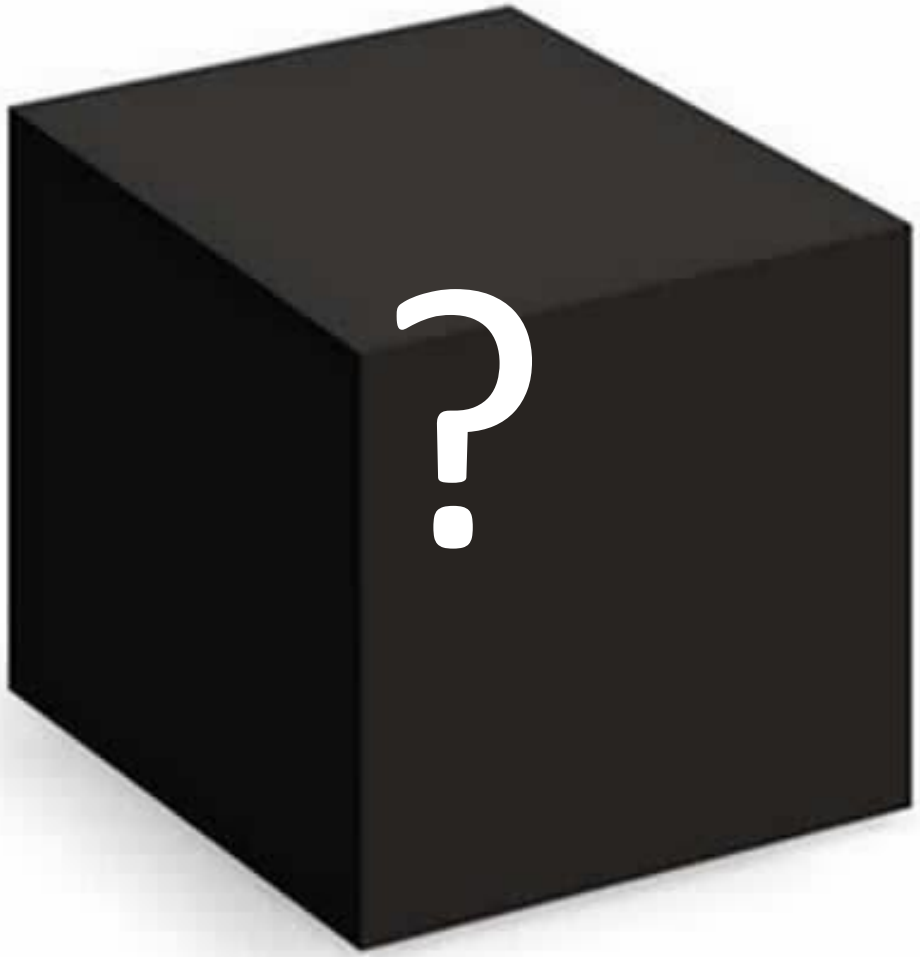
I want to use another path.

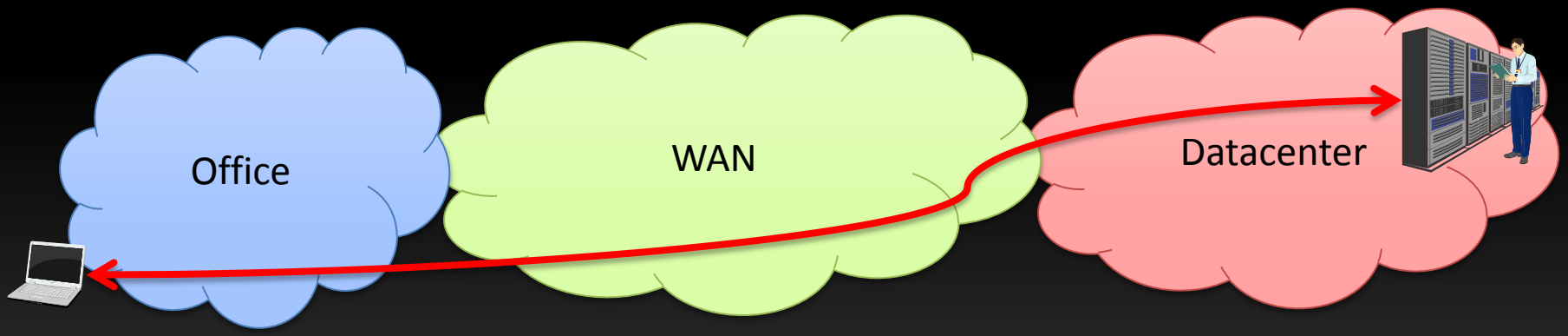
Network Visualization and Control

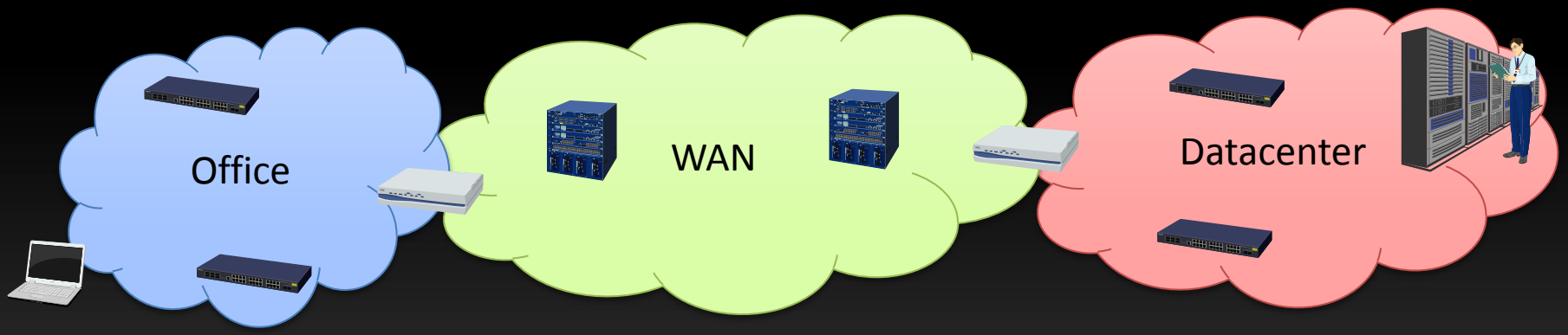


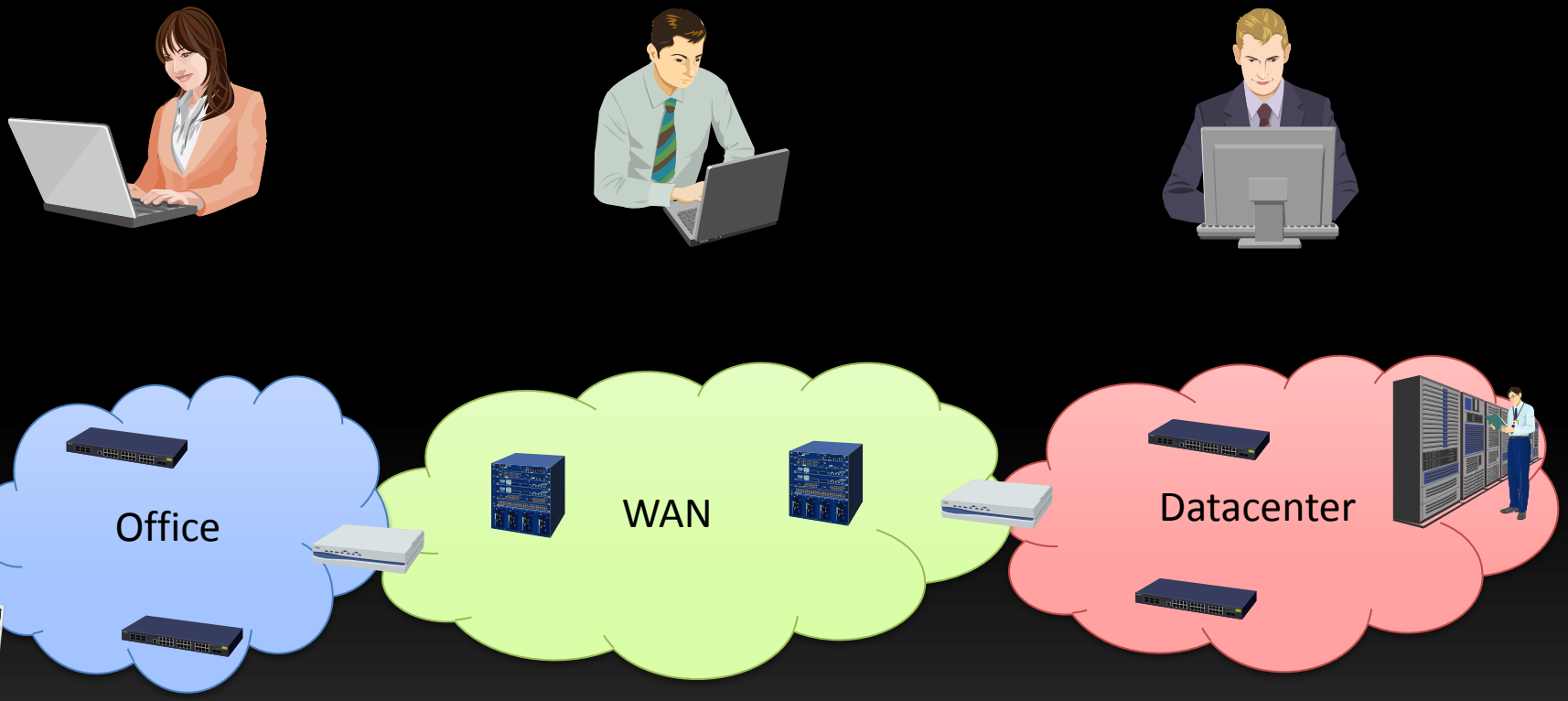
End-to-End
Network
Visualization and Control






Office
WAN
Datacenter


Office
WAN
Datacenter


Office
WAN
Datacenter

Network Virtualization

VLAN

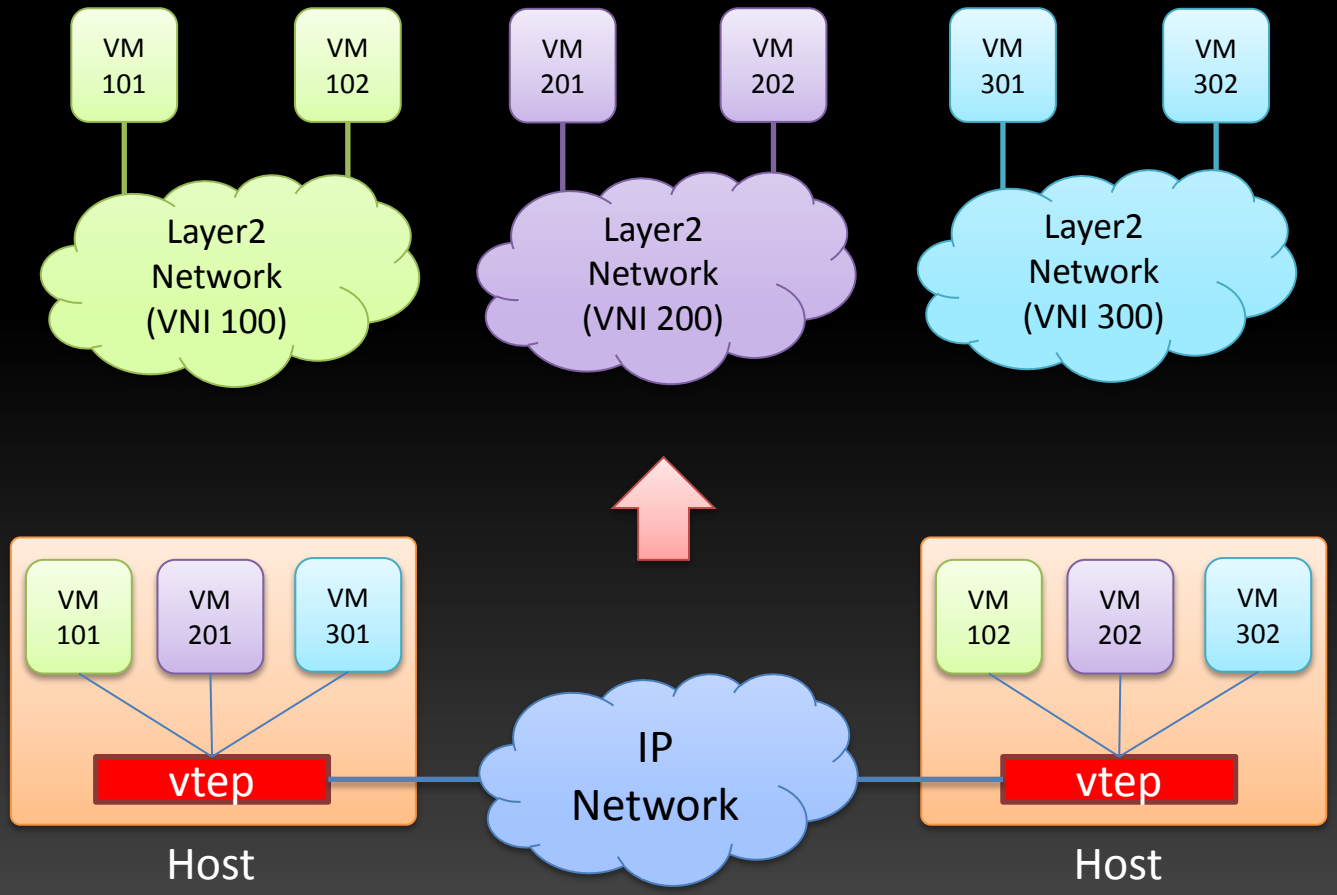
Layer2 Network (VLAN 10)

Layer2 Network (VLAN 20)

Layer2 Network (VLAN 30)

Layer2 Network

VXLAN

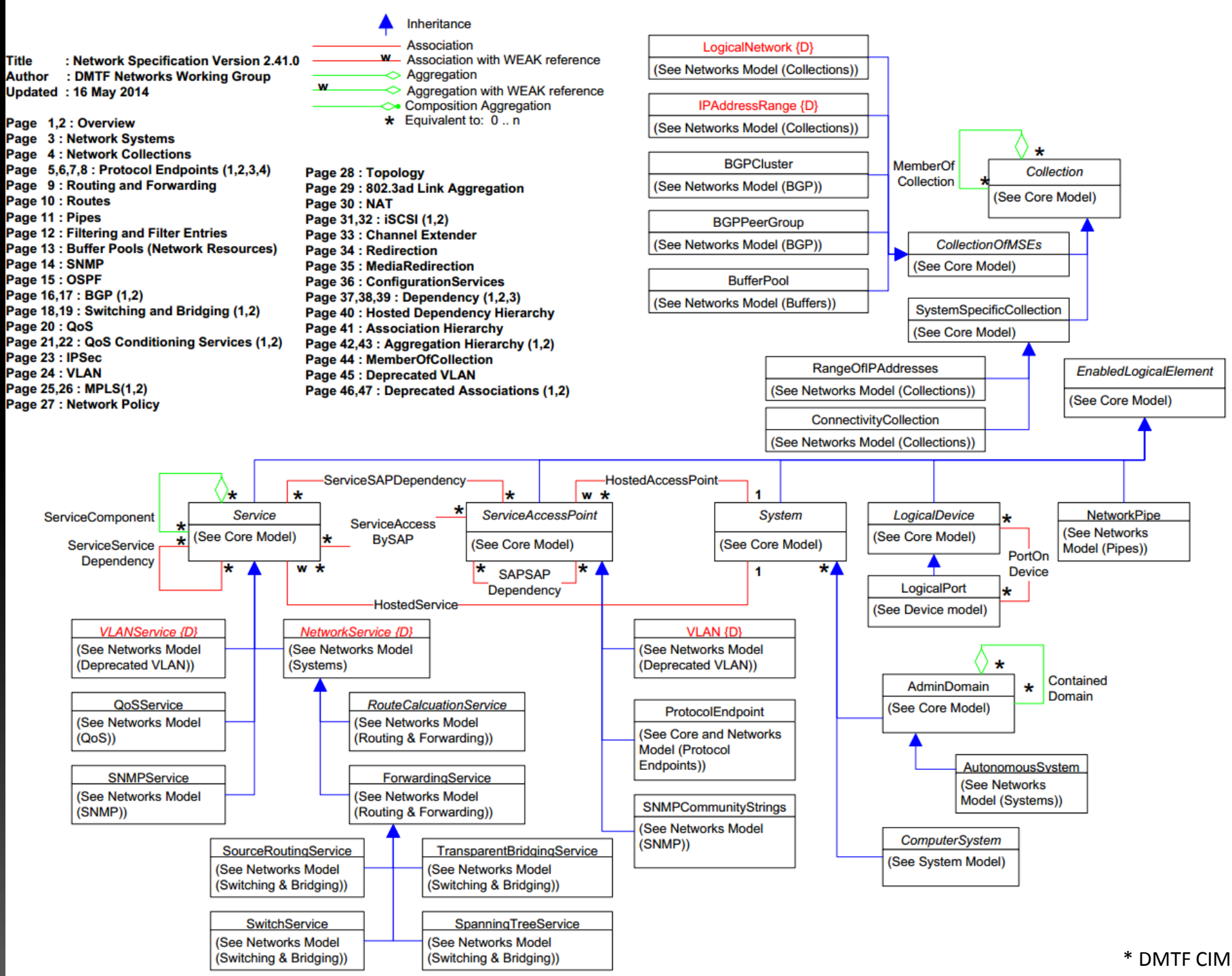

VM 101
VM 102
VM 201
VM 202
VM 301
VM 302
Layer2 Network (VNI 100)
Layer2 Network (VNI 200)
Layer2 Network (VNI 300)
VM 101
VM 201
VM 301
VM 102
VM 202
VM 302
vtep
vtep
IP Network
Host
Host

Multi-Layer

Multi-Vendor ✕ Virtualization

Multi-Domain

Relationship


Inheritance
Association
Association with WEAK reference
Aggregation
Aggregation with WEAK reference
Composition Aggregation
* Equivalent to: 0 .. n
Title : Network Specification Version 2.41.0
Author : DMTF Networks Working Group
Updated : 16 May 2014
Page 1,2 : Overview
Page 3 : Network Systems
Page 4 : Network Collections
Page 5,6,7,8 : Protocol Endpoints (1,2,3,4)
Page 9 : Routing and Forwarding
Page 10 : Routes
Page 11 : Pipes
Page 12 : Filtering and Filter Entries
Page 13 : Buffer Pools (Network Resources)
Page 14 : SNMP
Page 15 : OSPF
Page 16,17 : BGP (1,2)
Page 18,19 : Switching and Bridging (1,2)
Page 20 : QoS
Page 21,22 : QoS Conditioning Services (1,2)
Page 23 : IPSec
Page 24 : VLAN
Page 25,26 : MPLS(1,2)
Page 27 : Network Policy
Page 28 : Topology
Page 29 : 802.3ad Link Aggregation
Page 30 : NAT
Page 31,32 : iSCSI (1,2)
Page 33 : Channel Extender
Page 34 : Redirection
Page 35 : MediaRedirection
Page 36 : ConfigurationServices
Page 37,38,39 : Dependency (1,2,3)
Page 40 : Hosted Dependency Hierarchy
Page 41 : Association Hierarchy
Page 42,43 : Aggregation Hierarchy (1,2)
Page 44 : MemberOfCollection
Page 45 : Deprecated VLAN
Page 46,47 : Deprecated Associations (1,2)
LogicalNetwork {D}
(See Networks Model (Collections))
IPAddressRange {D}
(See Networks Model (Collections))
BGPCluster
(See Networks Model (BGP))
BGPPeerGroup
(See Networks Model (BGP))
BufferPool
(See Networks Model (Buffers))
MemberOf Collection
Collection
(See Core Model)
CollectionOfMSEs
(See Core Model)
SystemSpecificCollection
(See Core Model)
RangeOfIPAddresses
(See Networks Model (Collections))
ConnectivityCollection
(See Networks Model (Collections))
EnabledLogicalElement
(See Core Model)
ServiceSAPDependency
HostedAccessPoint
ServiceComponent
Service
(See Core Model)
ServiceService Dependency
ServiceAccess BySAP
ServiceAccessPoint
(See Core Model)
SAPSAP Dependency
HostedService
System
(See Core Model)
LogicalDevice
(See Core Model)
PortOn Device
LogicalPort
(See Device model)
NetworkPipe
(See Networks Model (Pipes))
VLANService {D}
(See Networks Model (Deprecated VLAN))
NetworkService {D}
(See Networks Model (Systems)
VLAN {D}
(See Networks Model (Deprecated VLAN))
QoSService
(See Networks Model (QoS))
RouteCalcuationService
(See Networks Model (Routing & Forwarding))
ProtocolEndpoint
(See Core and Networks Model (Protocol Endpoints))
AdminDomain
(See Core Model)
Contained Domain
SNMPService
(See Networks Model (SNMP))
ForwardingService
(See Networks Model (Routing & Forwarding))
SNMPCommunityStrings
(See Networks Model (SNMP))
AutonomousSystem
(See Networks Model (Systems))
SourceRoutingService
(See Networks Model (Switching & Bridging))
TransparentBridgingService
(See Networks Model (Switching & Bridging))
ComputerSystem
(See System Model)
SwitchService
(See Networks Model (Switching & Bridging))
SpanningTreeService
(See Networks Model (Switching & Bridging))

* DMTF CIM

A Mass of Specifications

makes applications

→ Complicated, and

→ Non-Reuseable.

An SDN Framework for Heterogeneous Networks

ODENOS

Abstraction

Abstract Model

?

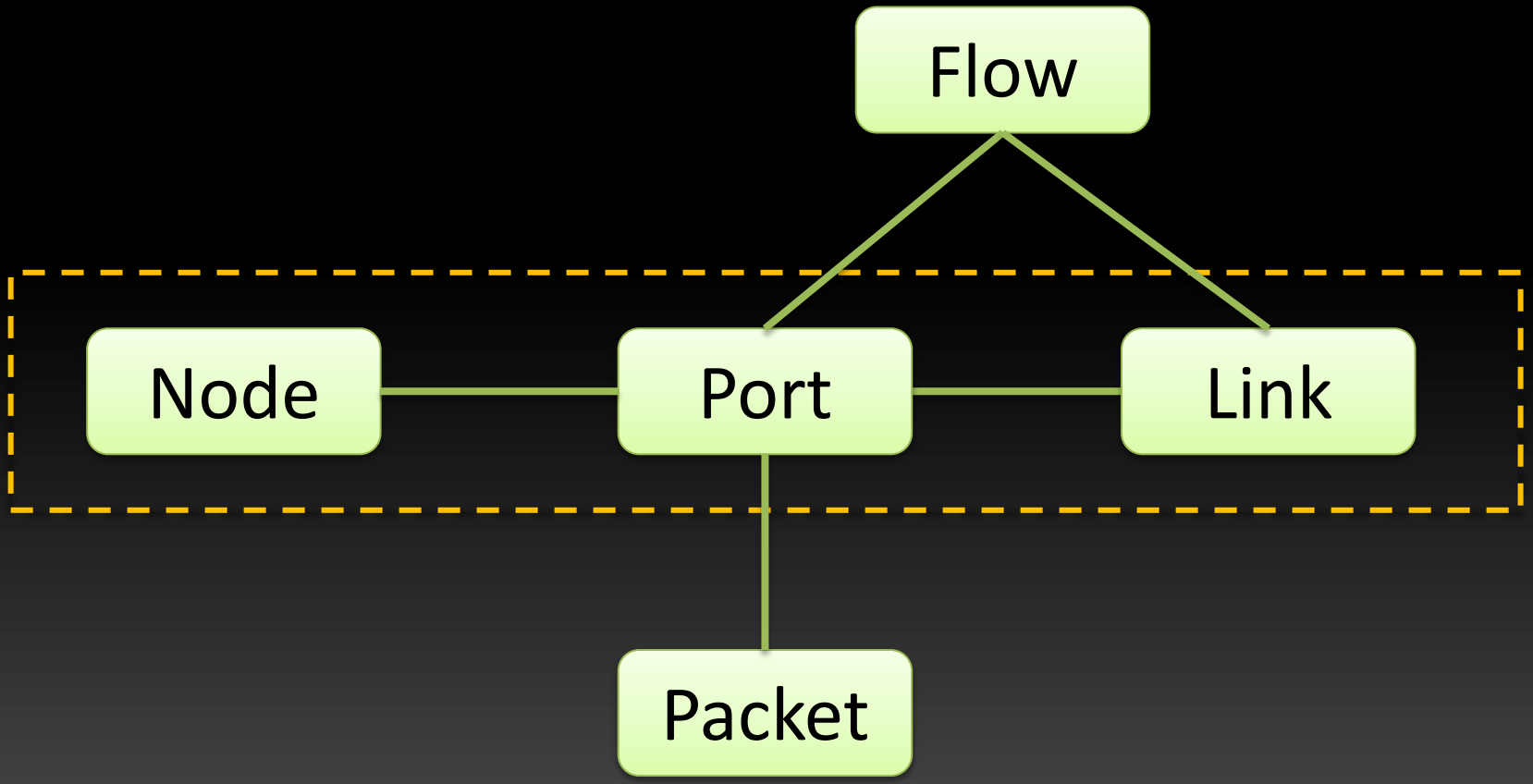
OpenFlow

Overlay

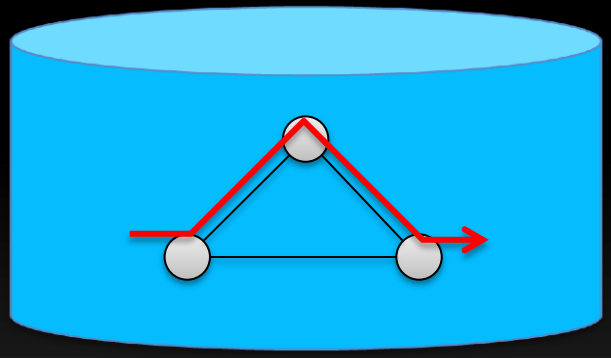
Packet Transport

Optical Transport

Network Model

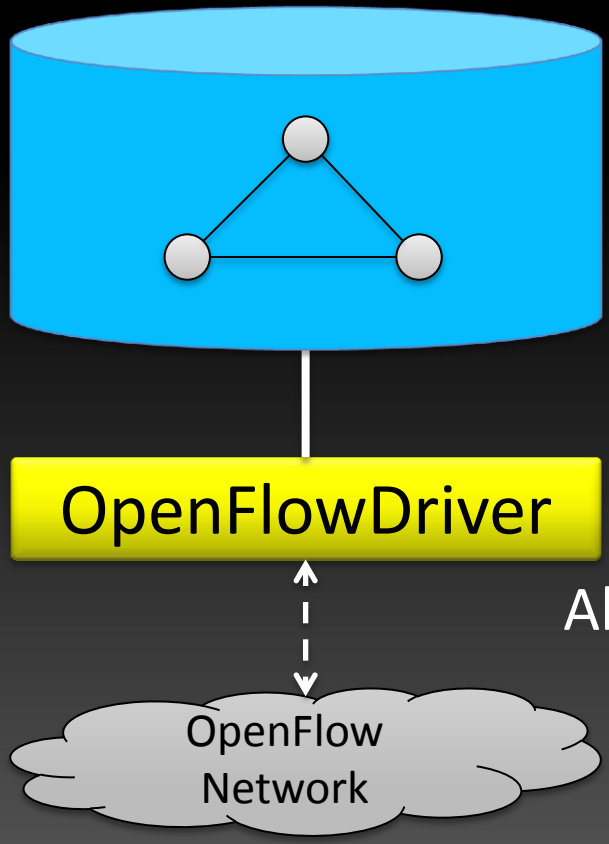


Network component



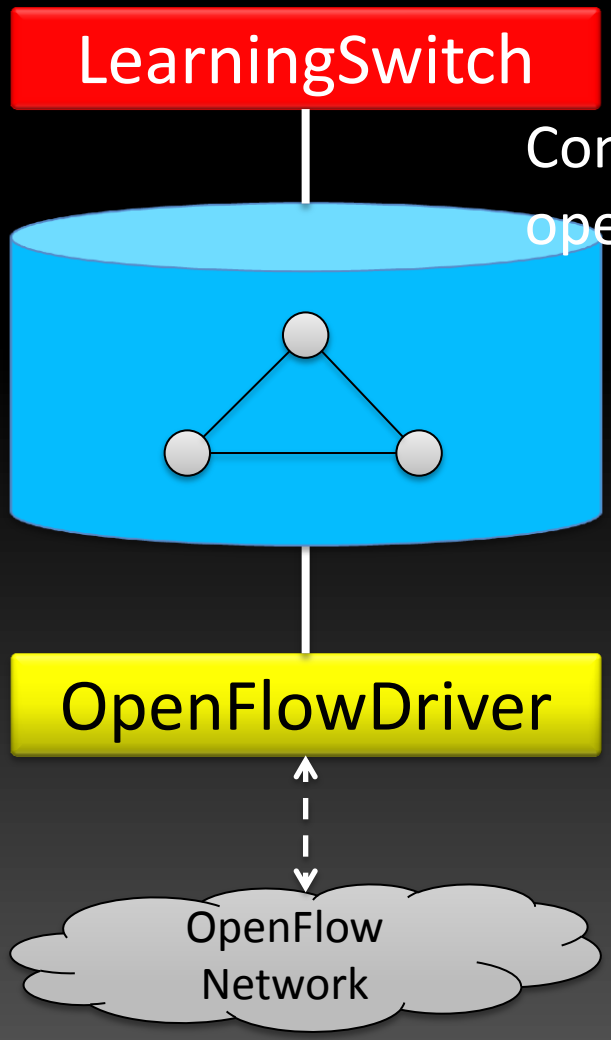
Stores modeled objects

Driver component



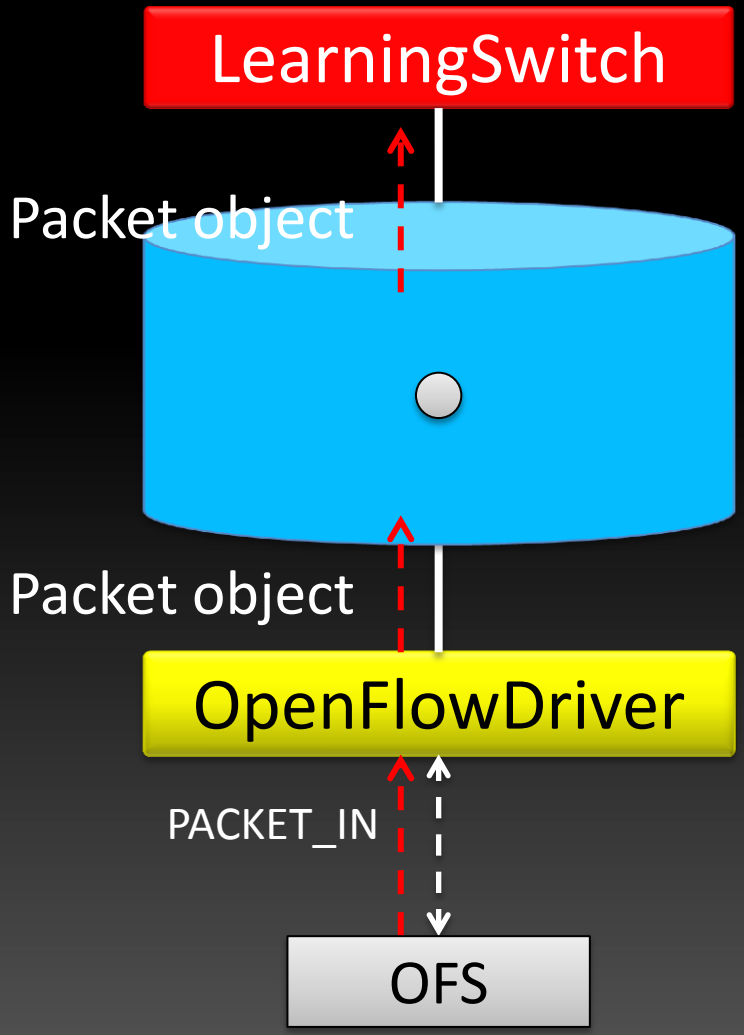
Abstracts actual network

Application component

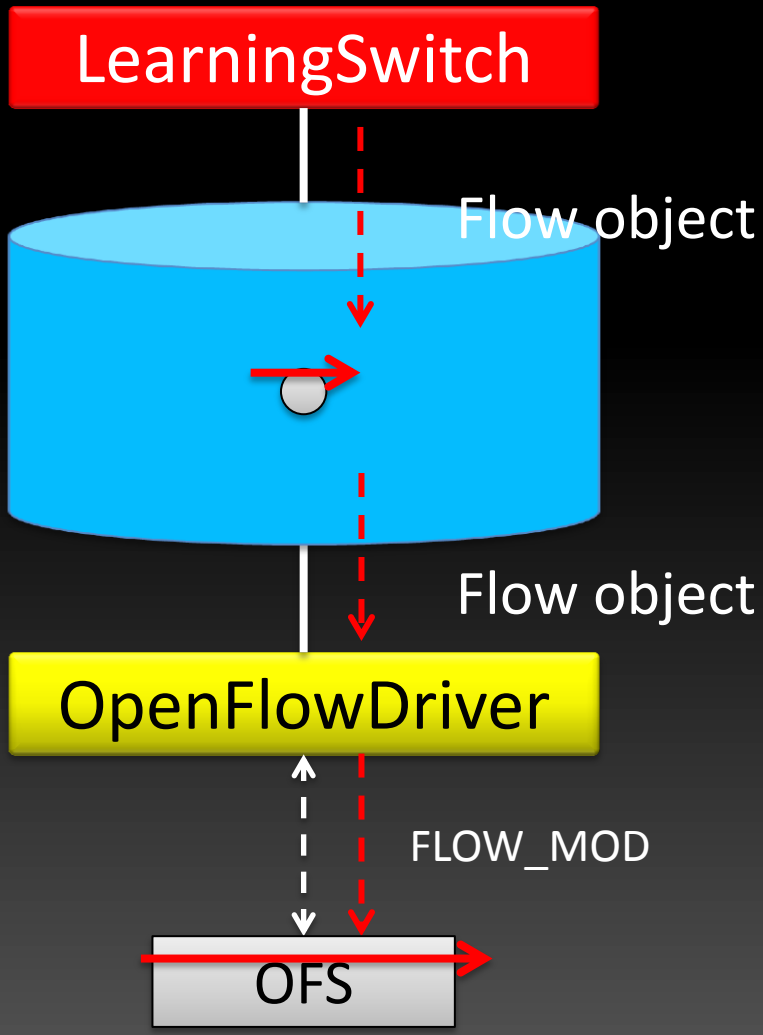


Controls actual network by operating modeled objects

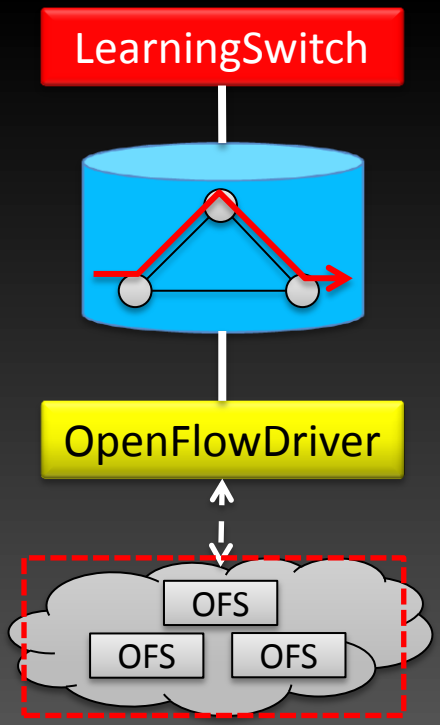
LearningSwitch Application



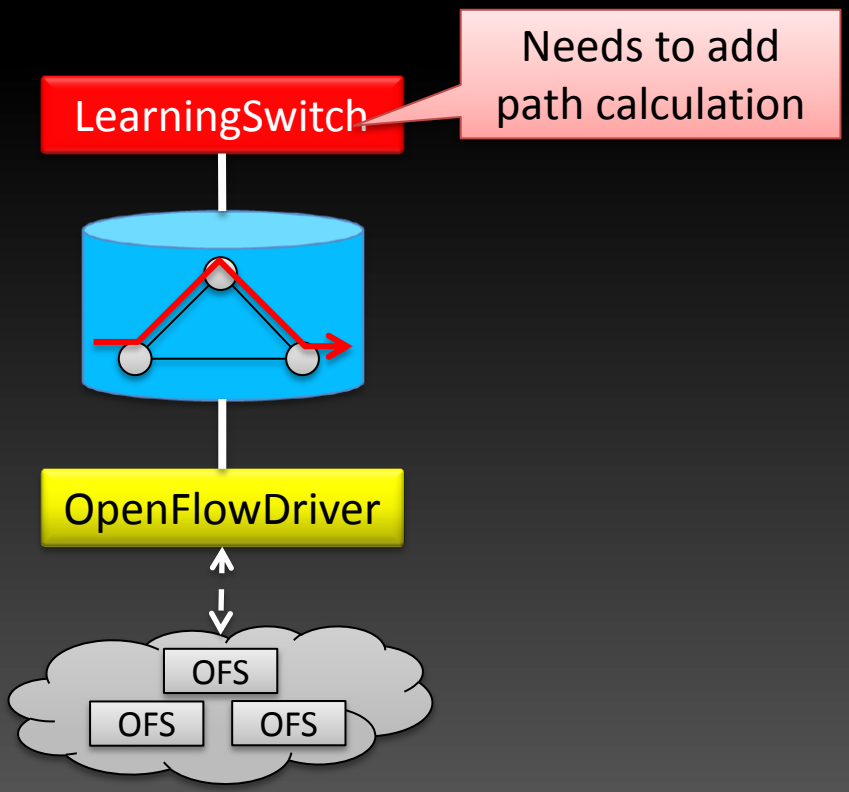
Controlling Single OpenFlow switch



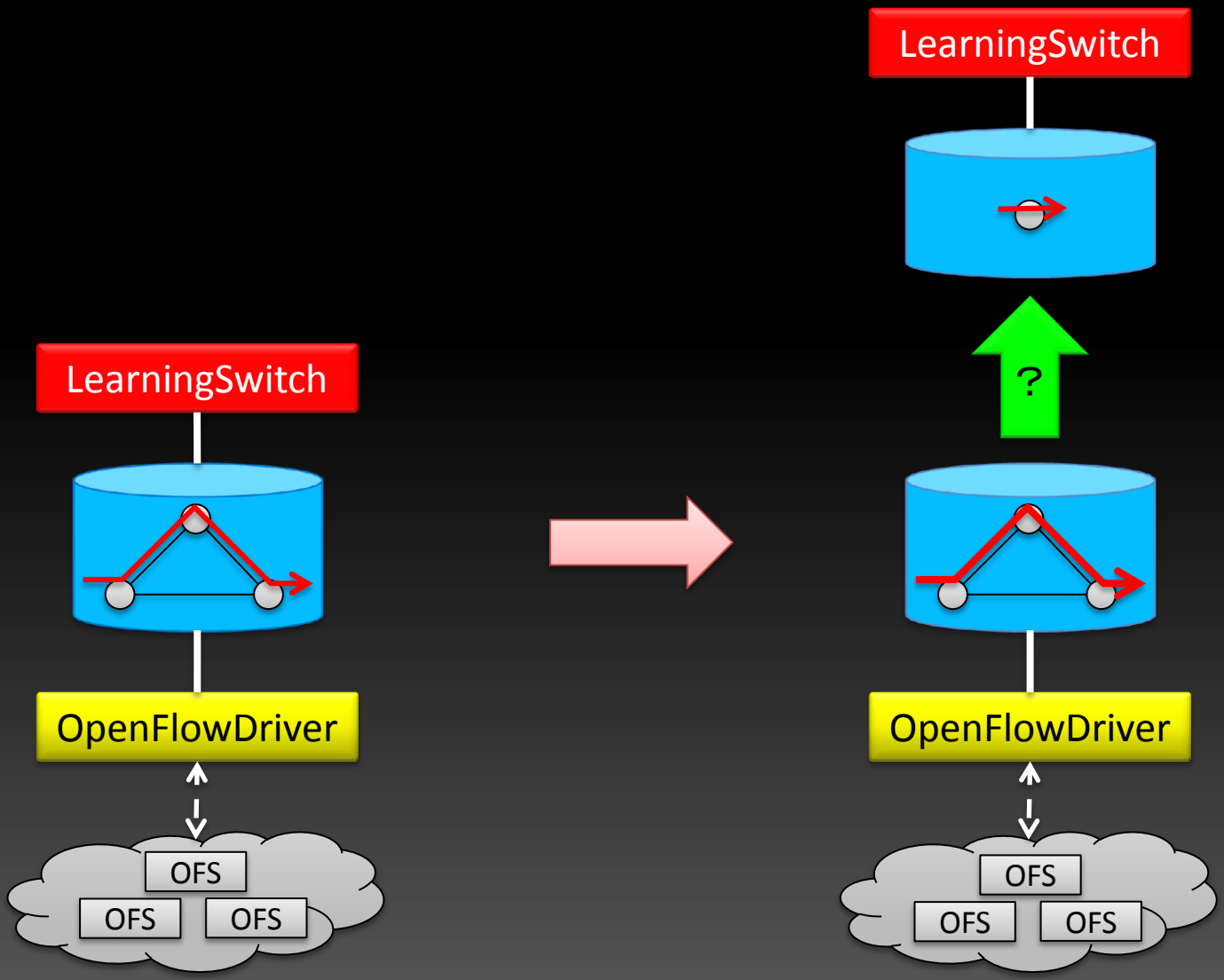
Controlling Multiple OpenFlow switches



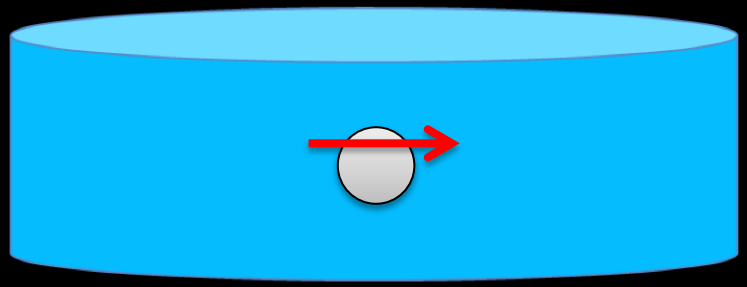
Controlling Multiple OpenFlow switches



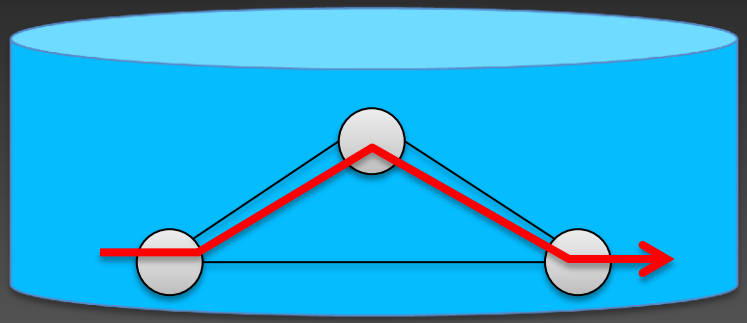
Converting modeled objects



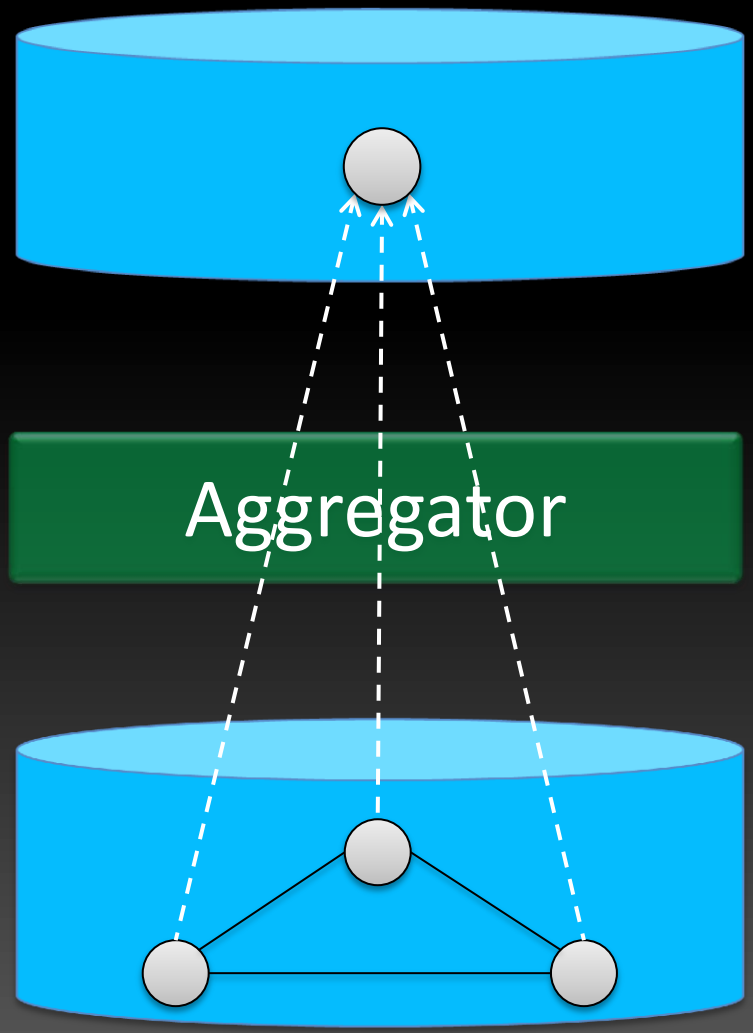
How to convert?



Aggregator

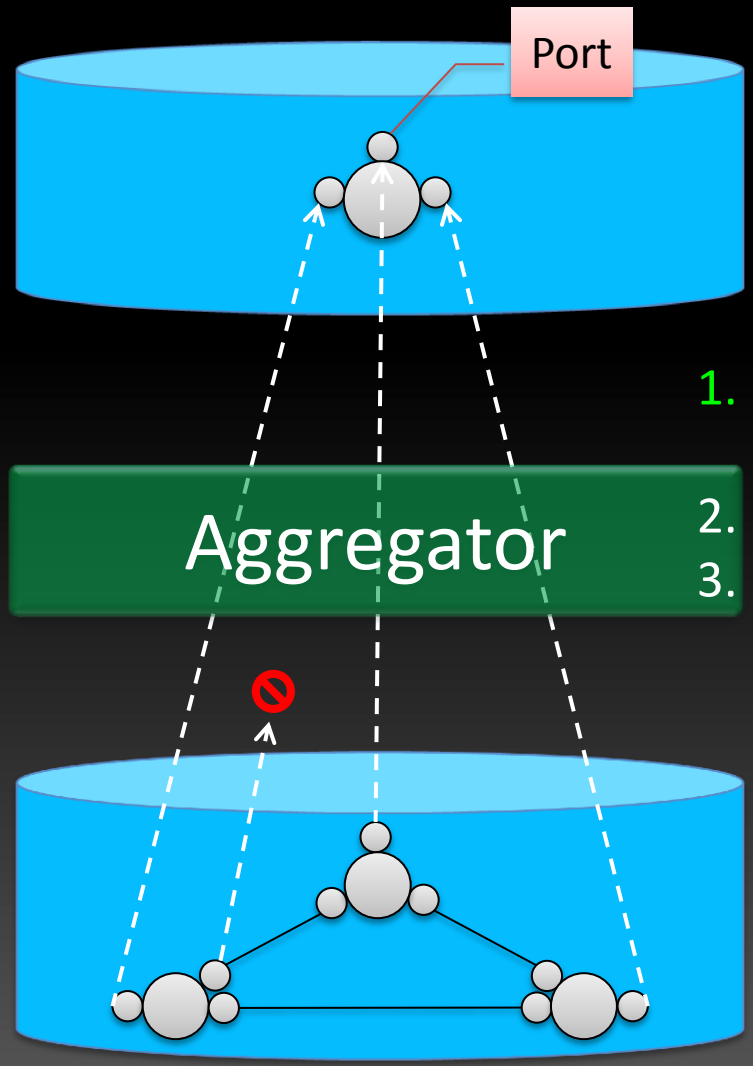


Topology



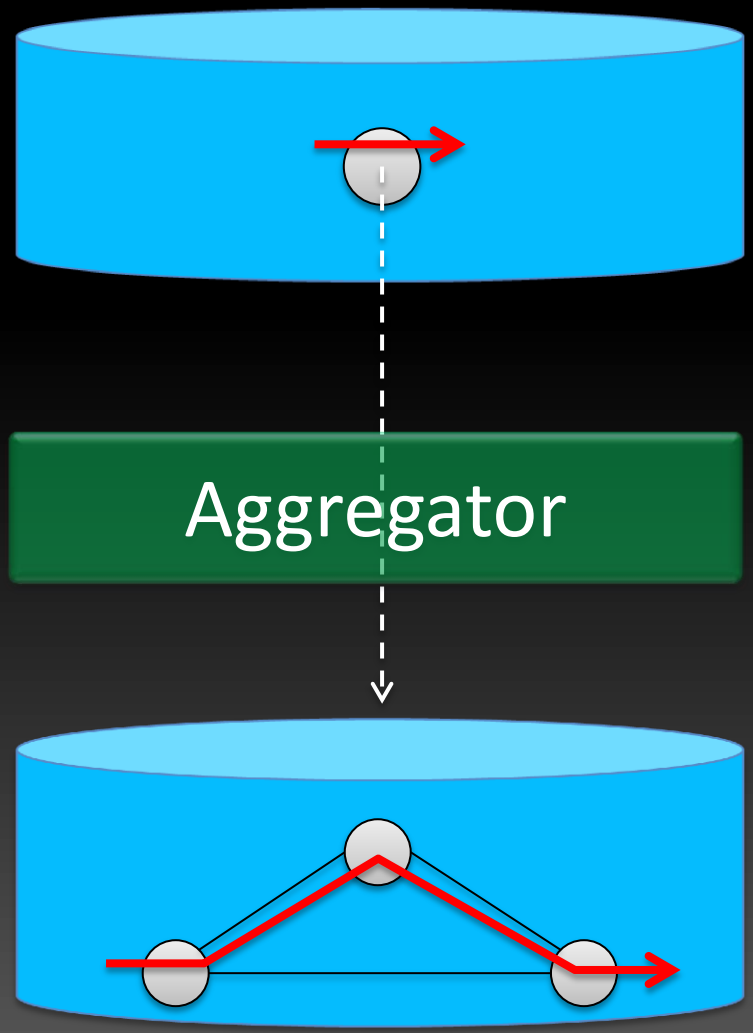
1. Aggregates multiple nodes to single node.

Topology



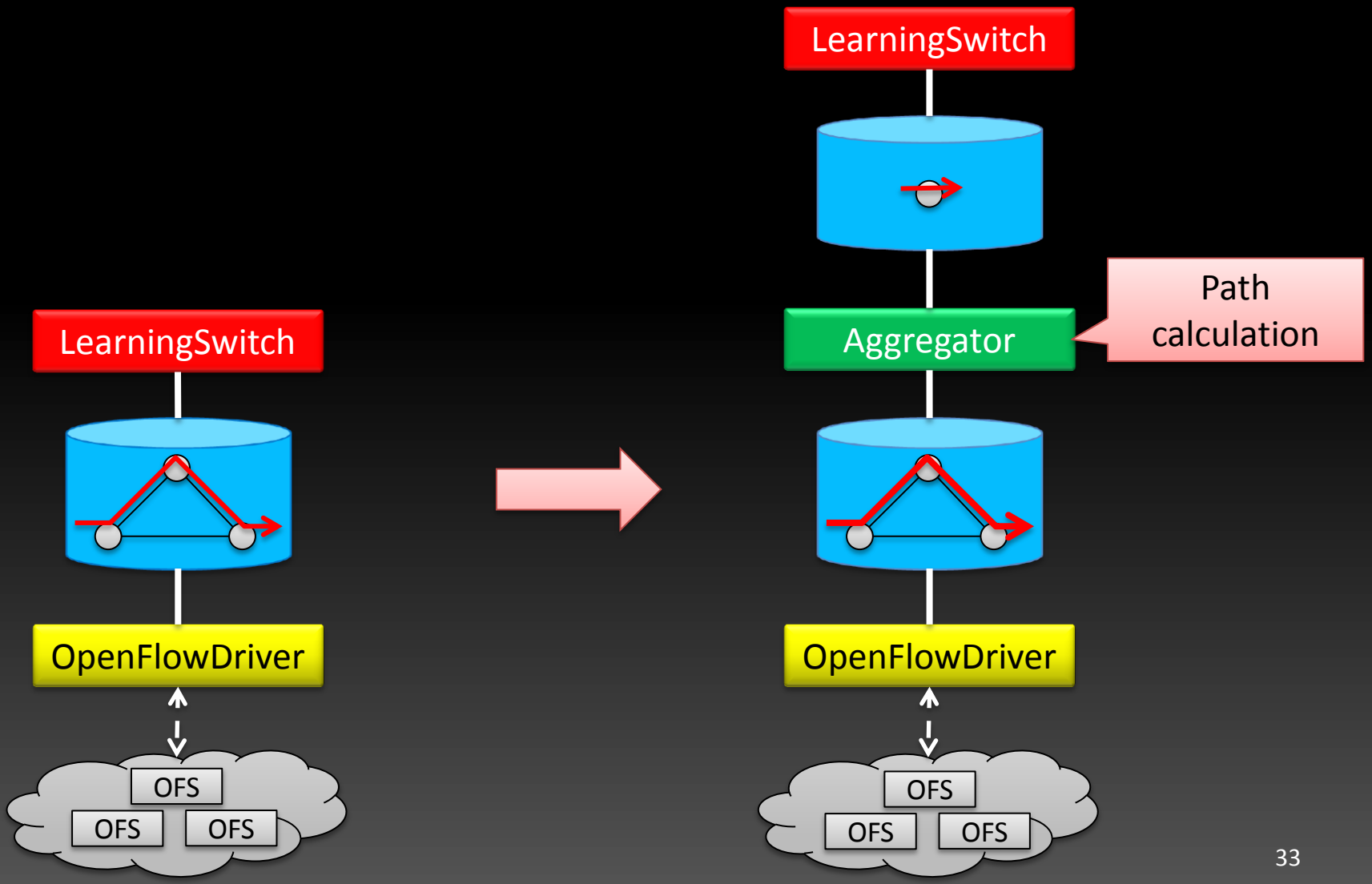
1. Aggregates multiple nodes to single node.
2. Copies outer ports
3. Discards inner ports

Flow

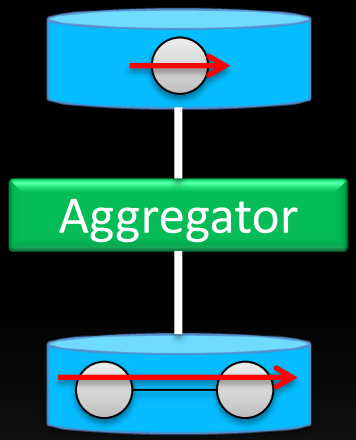


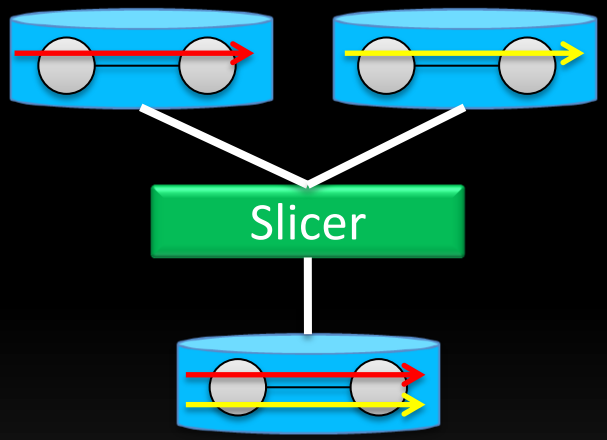
Expands the flow
by path calculation

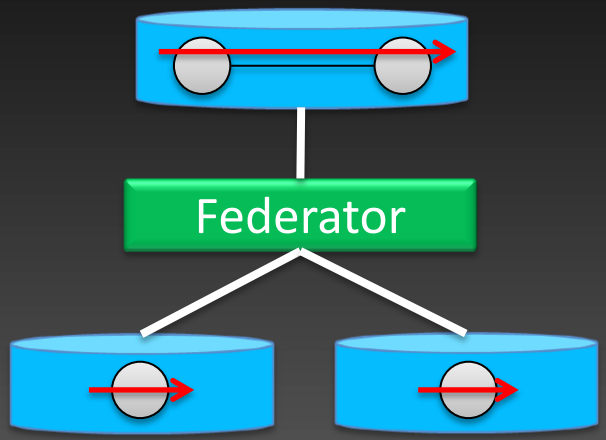
Reuse of Applications

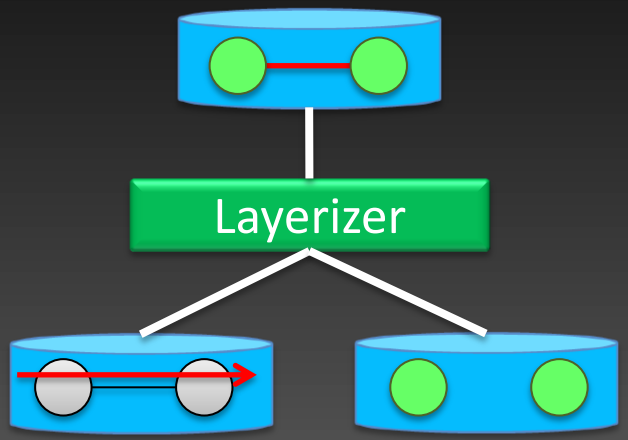


Logic Components



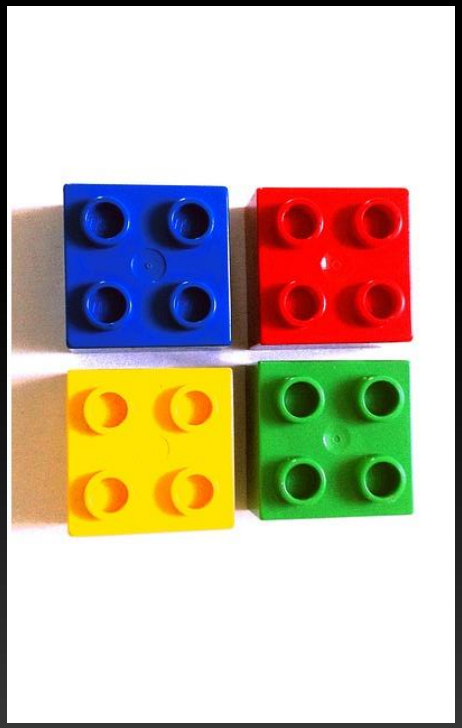






Network

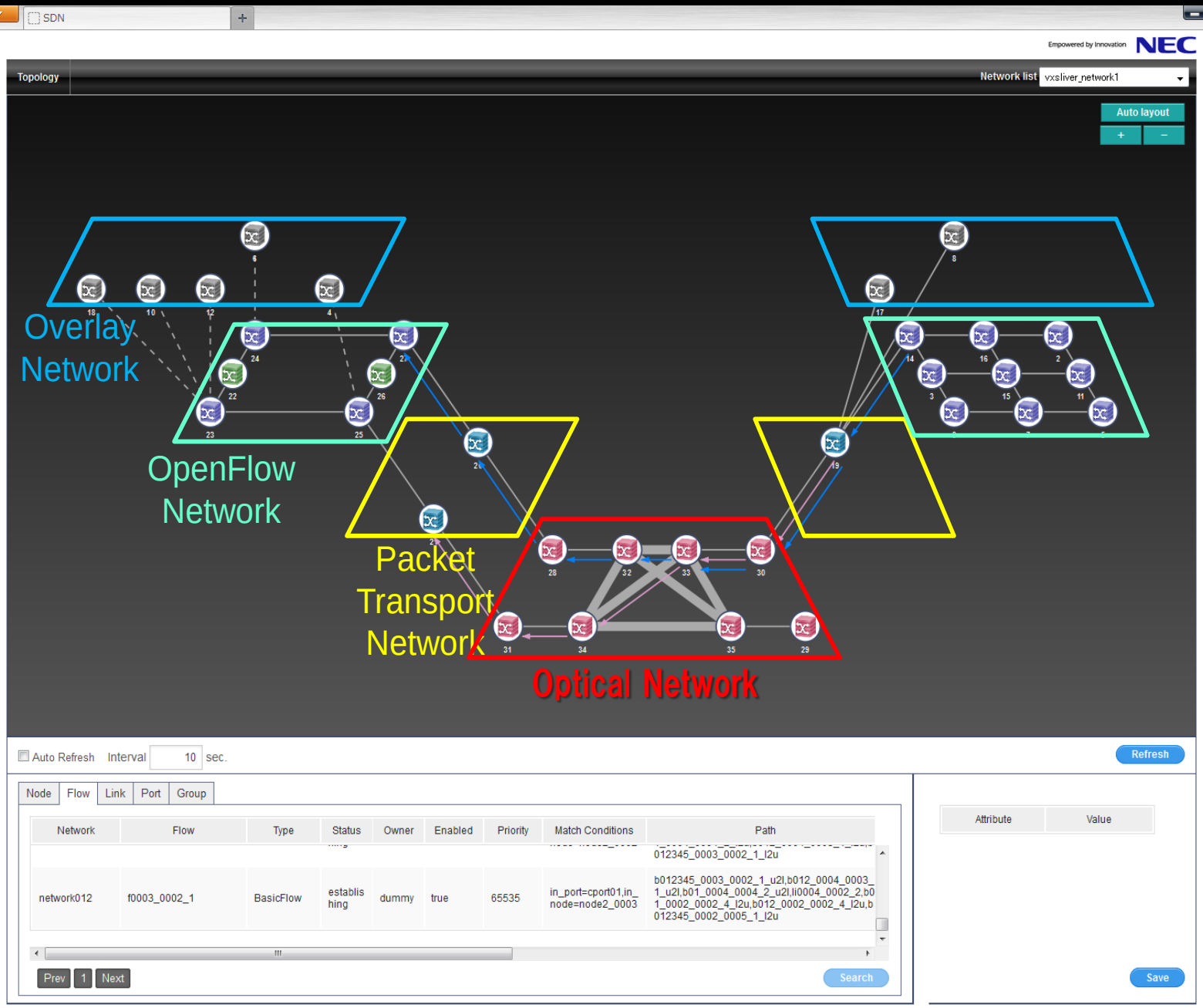
Application

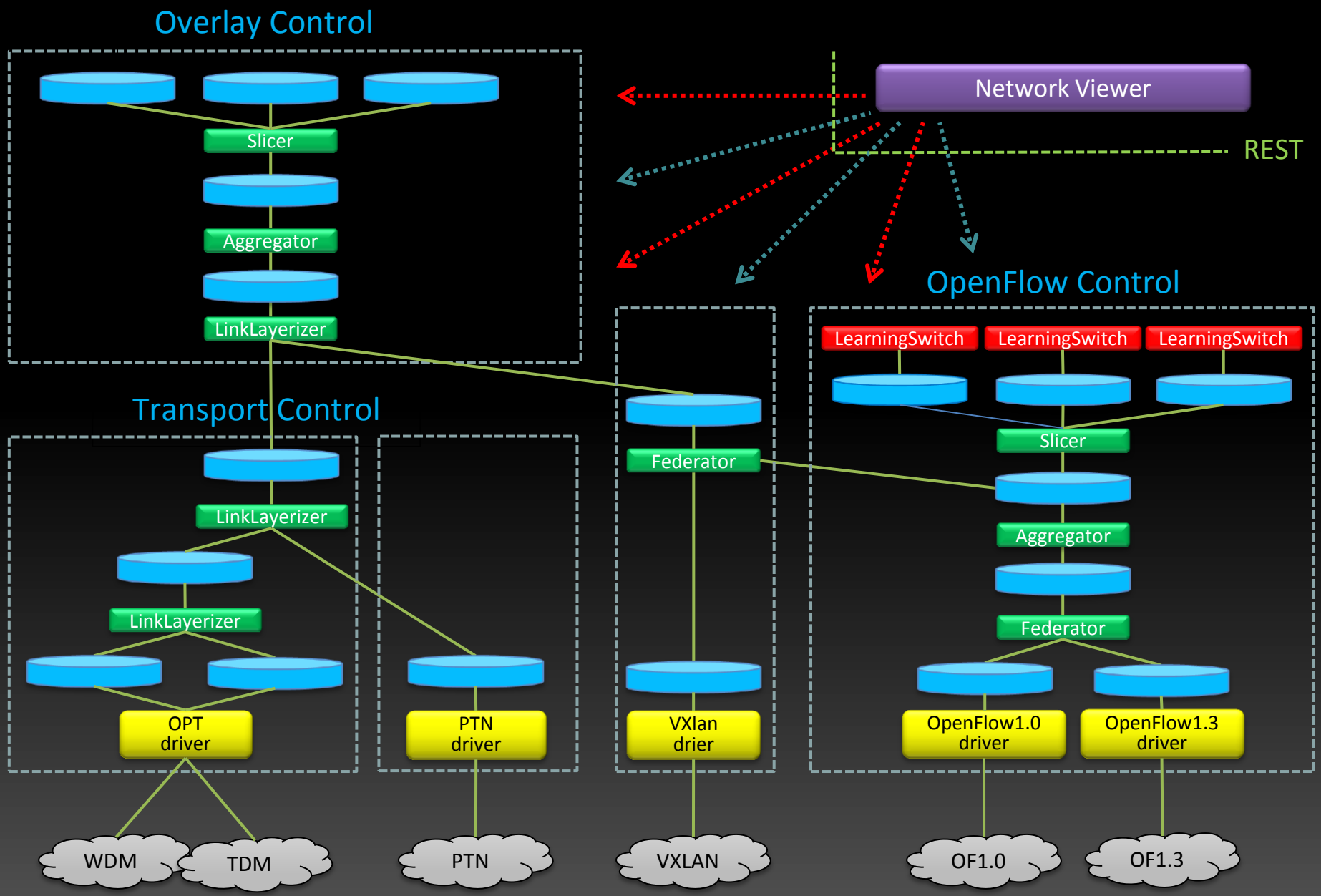


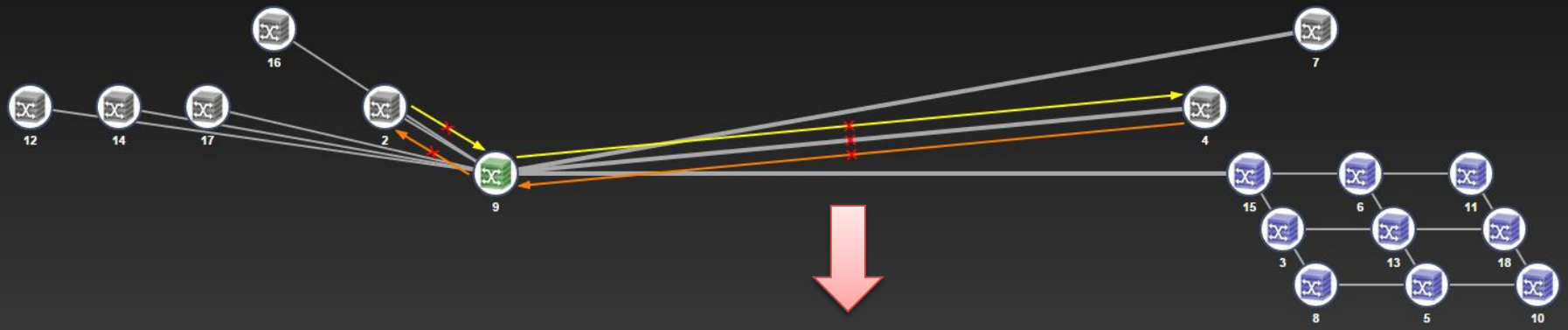
Driver

Logic

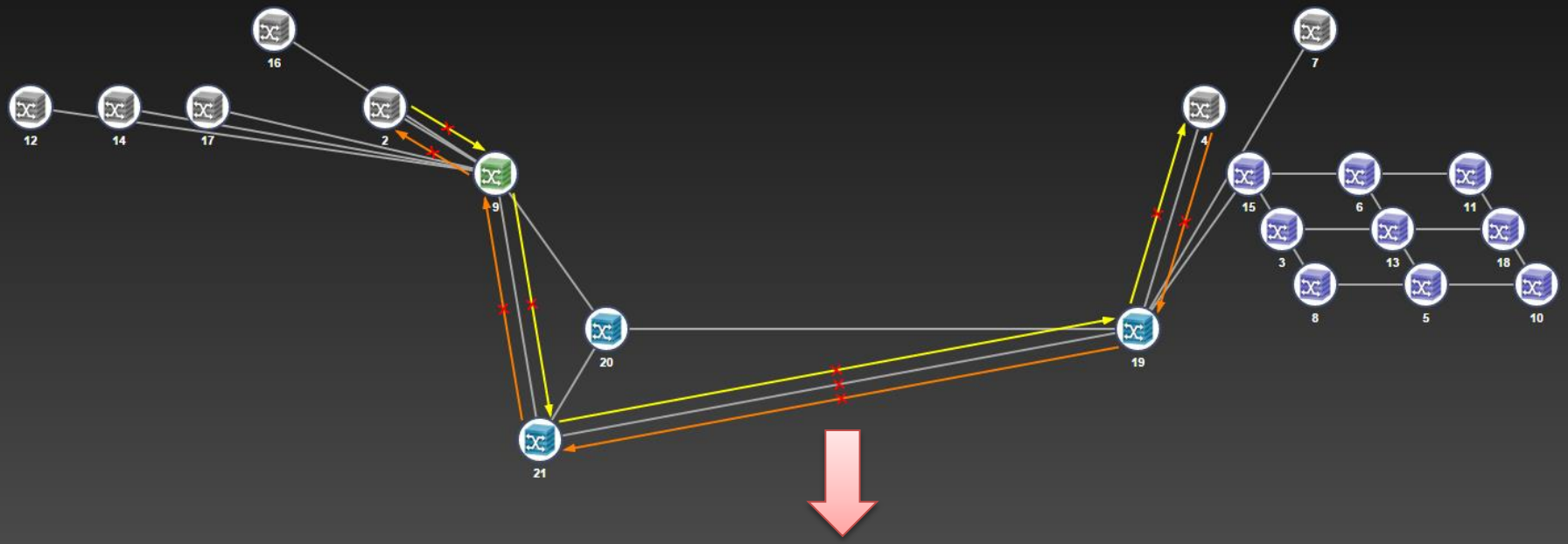
Network Visualization for Heterogeneous Networks


Firefox
SDN
Empowered by Innovation
NEC
Topology
Network list
vxsliver_network1
Auto layout
+
−
Overlay Network
OpenFlow Network
Packet Transport Network
Optical Network
Auto Refresh
Interval
10
sec.
Refresh
Node
Flow
Link
Port
Group
Network
Flow
Type
Status
Owner
Enabled
Priority
Match Conditions
Path
012345_0003_0002_1_l2u
network012
f0003_0002_1
BasicFlow
establis hing
dummy
true
65535
in_port=cport01,in_ node=node2_0003
b012345_0003_0002_1_u2l,b012_0004_0003_ 1_u2l,b01_0004_0004_2_u2l,li0004_0002_2,b0 1_0002_0002_4_l2u,b012_0002_0002_4_l2u,b 012345_0002_0005_1_l2u
Prev
1
Next
Search
Attribute
Value
Save

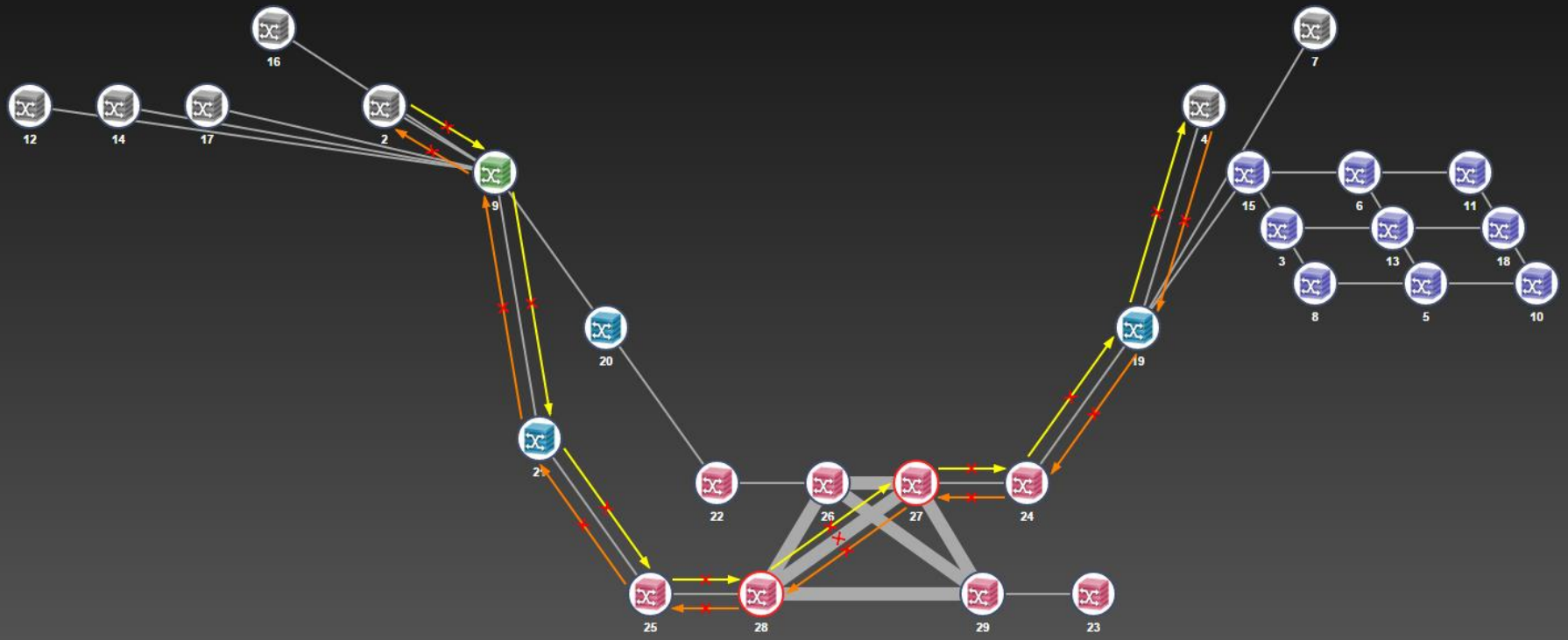

Overlay Control
Slicer
Aggregator
LinkLayerizer
Network Viewer
REST
OpenFlow Control
LearningSwitch
LearningSwitch
LearningSwitch
Slicer
Aggregator
Federator
Transport Control
LinkLayerizer
LinkLayerizer
Federator
OPT driver
PTN driver
VXlan drier
OpenFlow1.0 driver
OpenFlow1.3 driver
WDM
TDM
PTN
VXLAN
OF1.0
OF1.3



Failure of End-to-end Communication

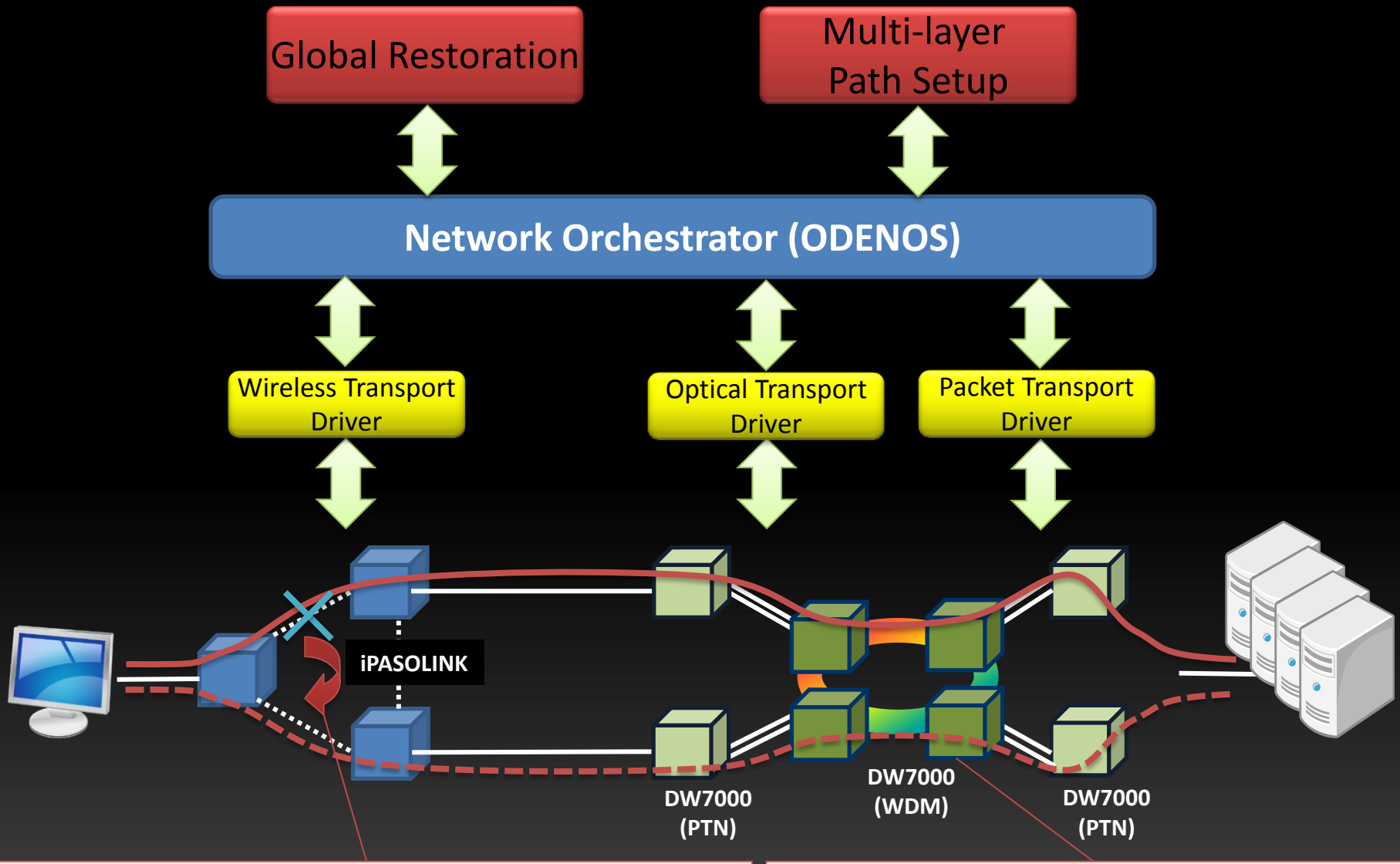


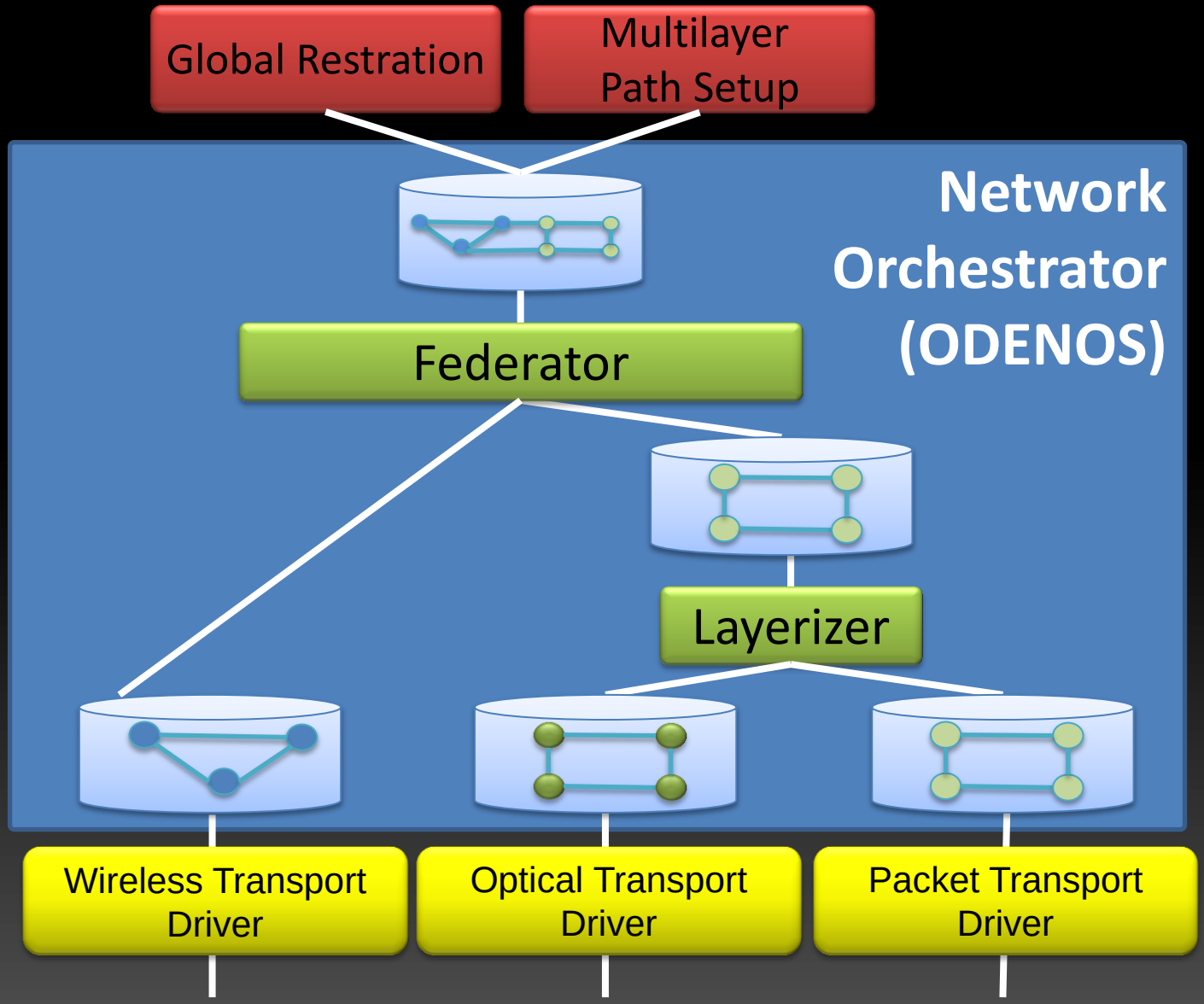
Cause Analysis by Drilled-Down Operation



Cause Analysis by Drilled-Down Operation

Multi-layer and Multi-domain Network Control


Global Restoration
Multi-layer Path Setup
Network Orchestrator (ODENOS)
Wireless Transport Driver
Optical Transport Driver
Packet Transport Driver
iPASOLINK
DW7000 (PTN)
DW7000 (WDM)
DW7000 (PTN)
Global Restoration
Multilayer Path Calculation


Global Restration
Multilayer
Path Setup
Network
Orchestrator
(ODENOS)
Federator
Layerizer
Wireless Transport
Driver
Optical Transport
Driver
Packet Transport
Driver

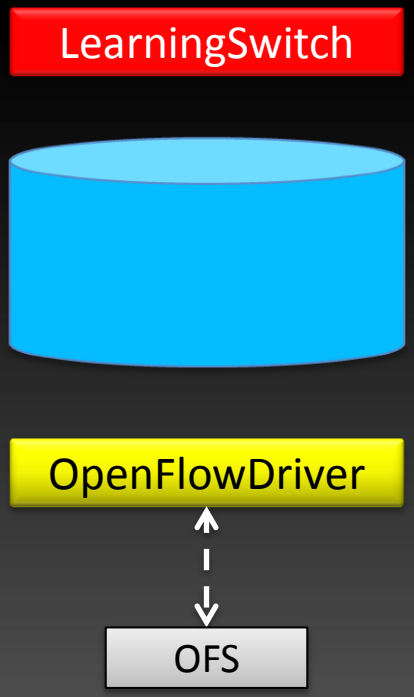
Conclusion

- ODENOS : An SDN framework for heterogeneous network orchestration
  - Possible to build reusable network orchestrator easily
  - Flexible end-to-end control of multi-layer and multi-domain network
- Open source software, distributed on GitHub now!
  - Support Java and python
  - https://github.com/o3project/odenos

APPENDIX

Creating Components

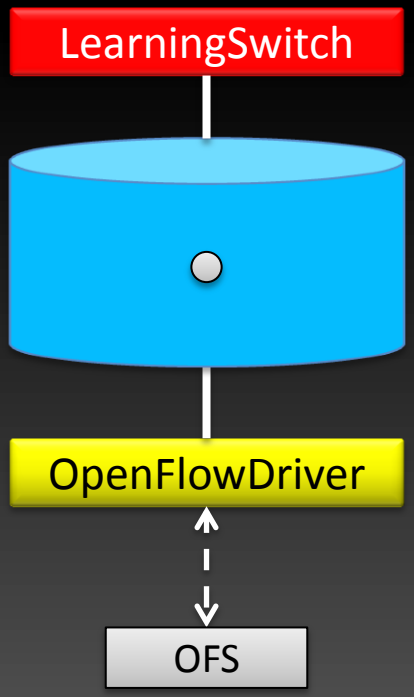
```
$ curl http://localhost:10080/systemmanager/components -X POST -d
  '{"type": "LearningSwitch", "id": "learning_sw1"}'

$ curl http://localhost:10080/systemmanager/components -X POST -d
  '{"type": "NetworkComponent", "id": "network1"}'

$ curl http://localhost:10080/systemmanager/components -X POST -d
  '{"type": "OpenFlowDriver", "id": "driver1"}'
```



Connecting Components

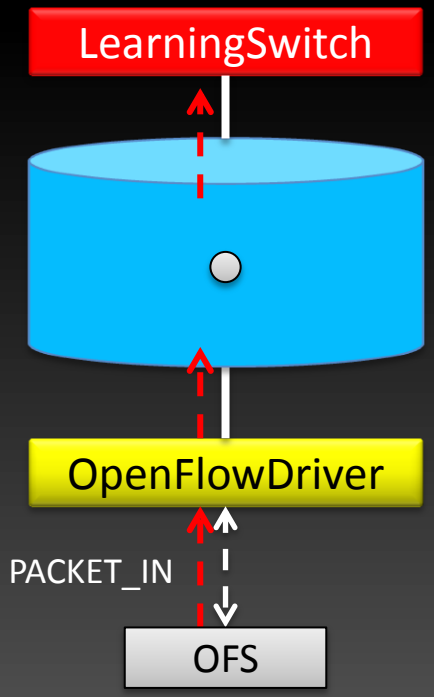
```
$ curl http://localhost:10080/systemmanager/components -X POST -d
  '{"type": "LearningSwitch", "id": "learning_sw1"}'

$ curl http://localhost:10080/systemmanager/components -X POST -d
  '{"type": "NetworkComponent", "id": "network1"}'

$ curl http://localhost:10080/systemmanager/components -X POST -d
  '{"type": "OpenFlowDriver", "id": "driver1"}'
```

```
$ curl http://localhost:10080/systemmanager/connections -X POST -d
  '{"connection_type": "original",
    "source_id": "learning_sw1", "destination_id":"network1"}'

$ curl http://localhost:10080/systemmanager/connections -X POST -d
  '{"connection_type": "original",
    "source_id": "driver1", "destination_id":"network1"}'
```

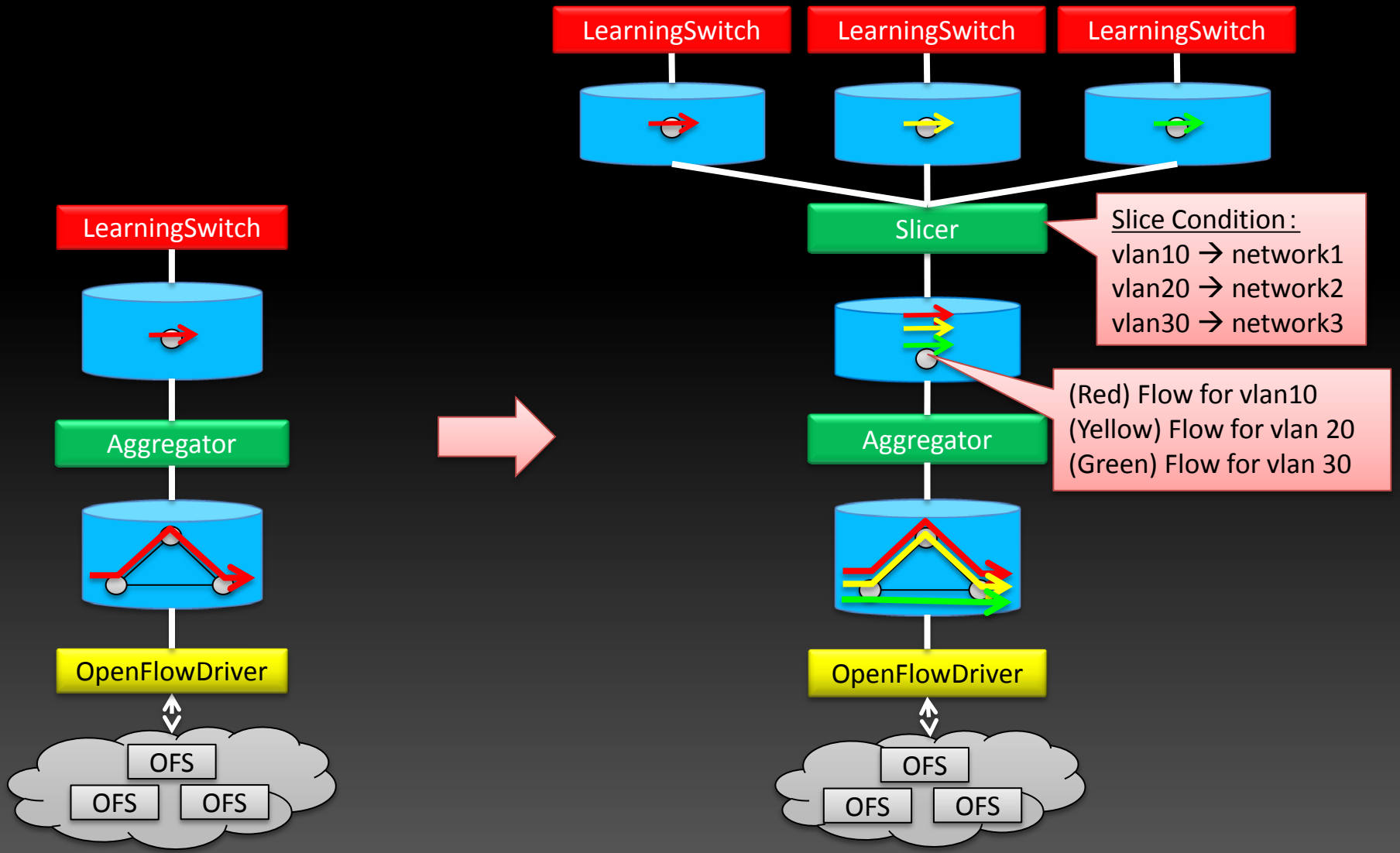


Implementation of LearningSwitch Application

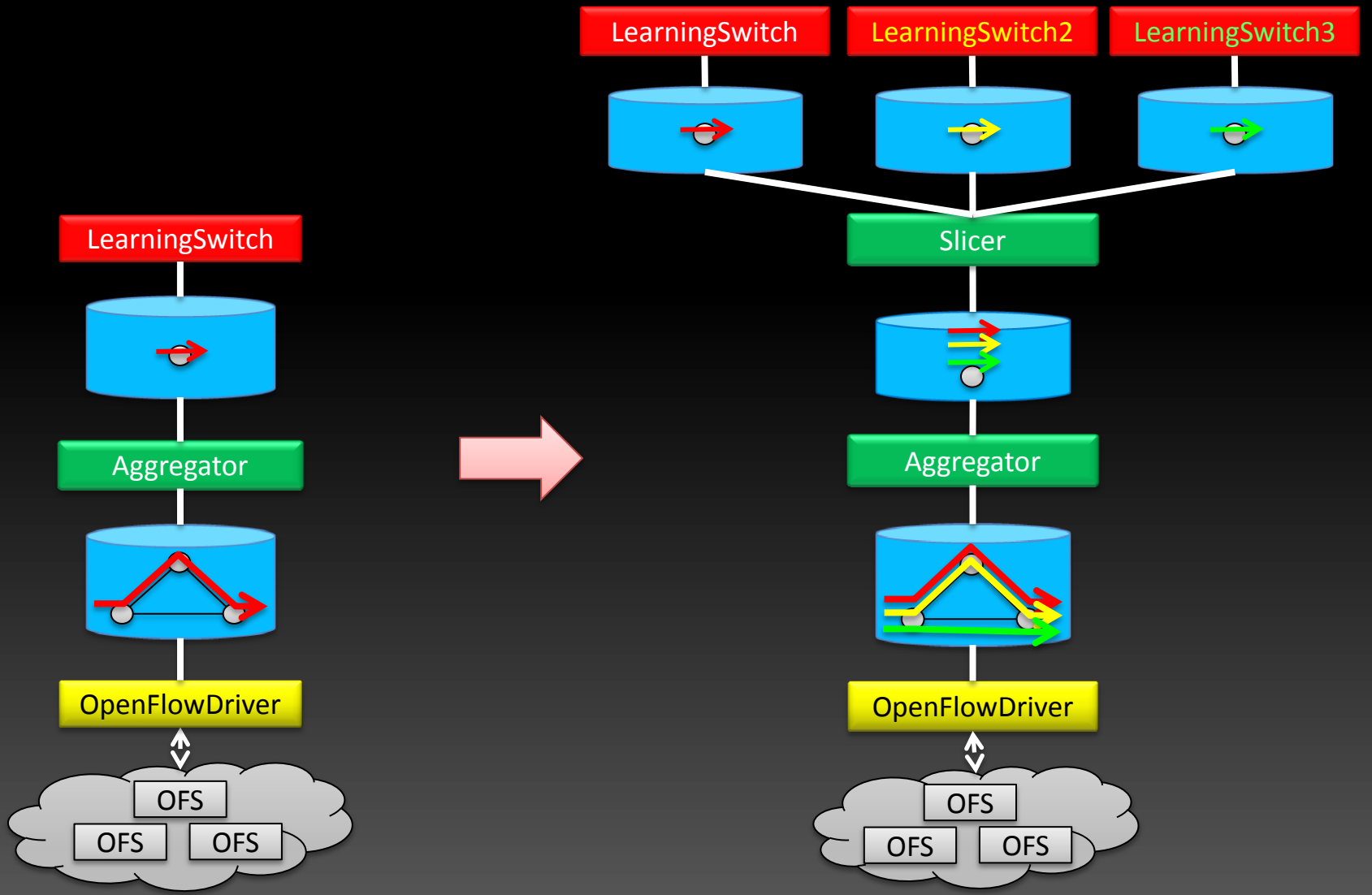
```
class LearningSwitch extends Logic {
  ...
  network.addInPacketAddedListener(
    new InPacketAddedListener() {
      ...
      public void processEvent(final InPacketAdded msg) {
        // Receives a packet
        InPacket pkt = network.getPacket(msg.id());

        // MAC Learning
        inPort = fdb.put(pkt.srcMacAddr(), pkt.inPort());

        // If the MAC has been learned, creates Flow
        outPort = fdb.get(pkt.dstMacAddr());
        if (outPort != NULL) {
          network.putFlow(
            Util.createL2Flow(pkt, outPort));
        }

        // Sends a packet
        network.postOutPacket(
          Util.createOutPacket(pkt, outPort));
      }});
      ...
}
```



Slicer : A Logic Component



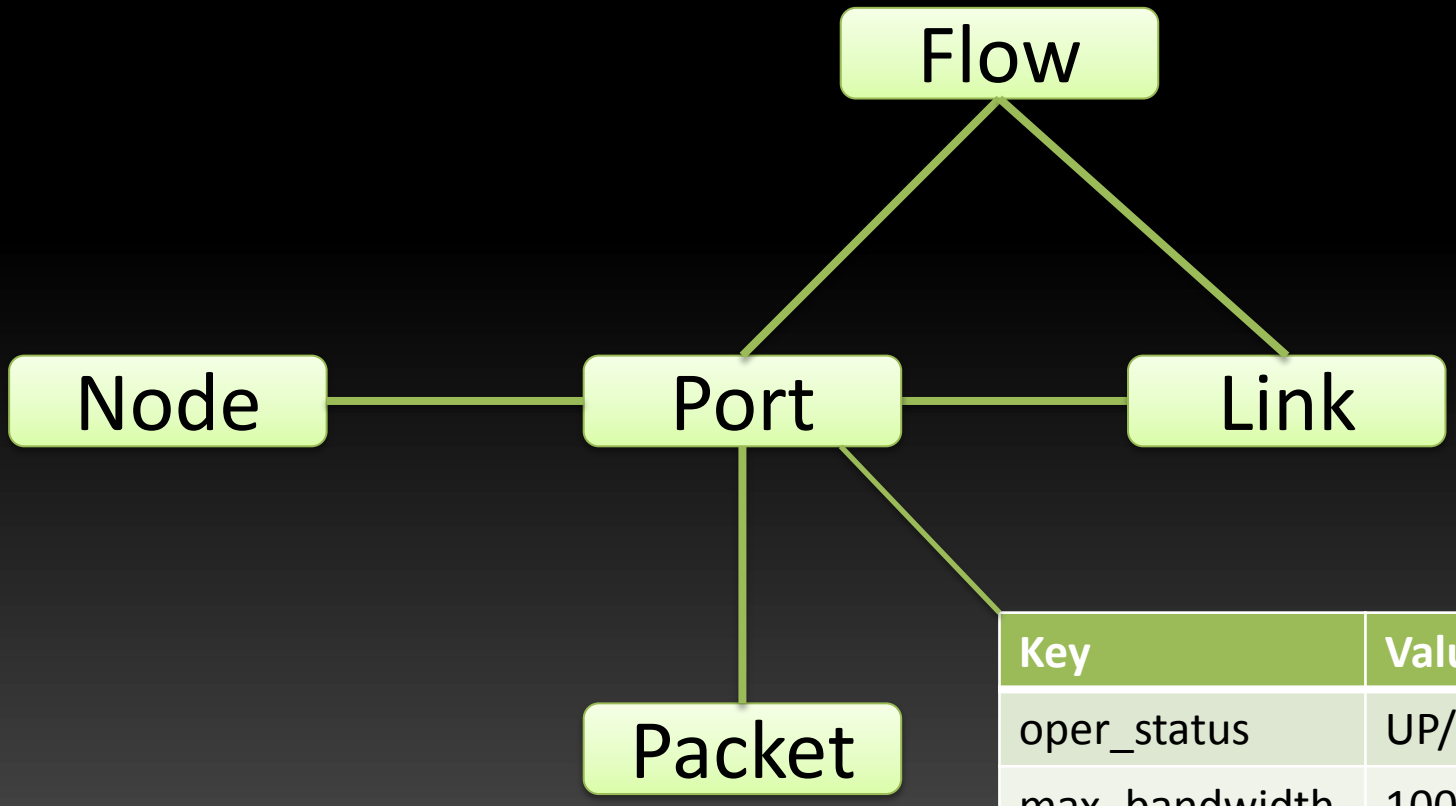
Slicer : A Logic Component



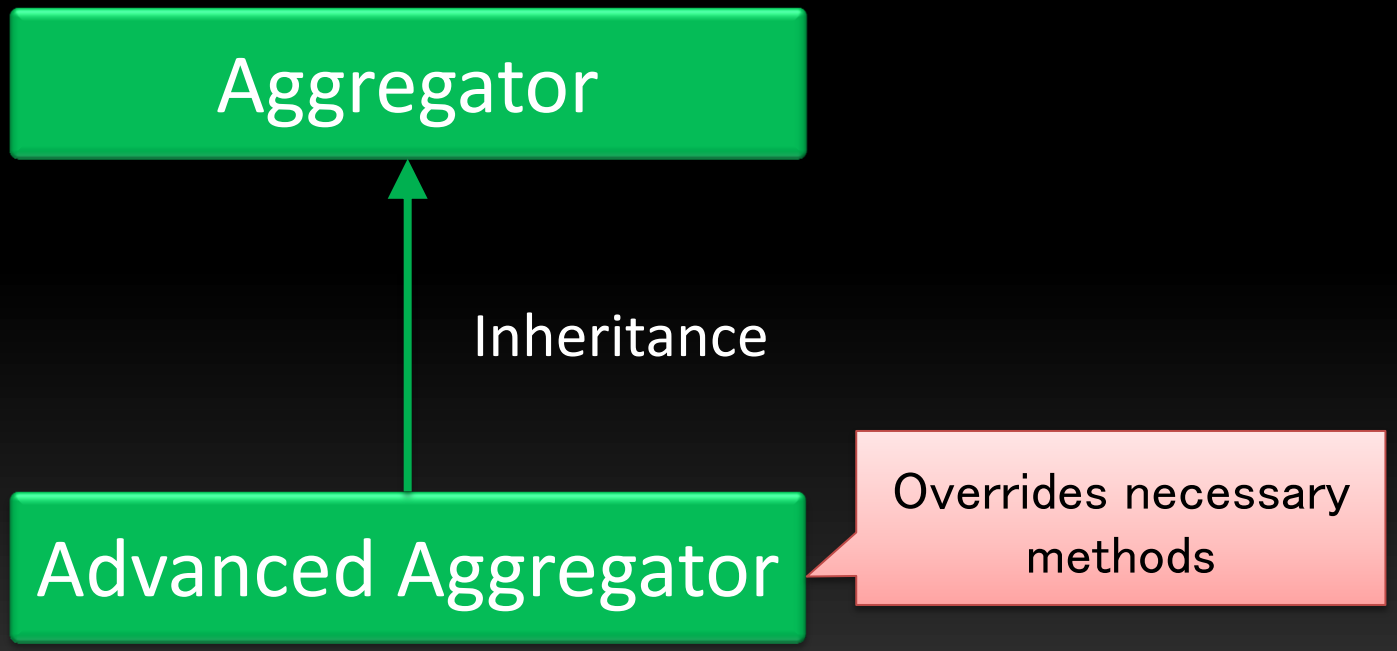
Q. Can I expand models or operators?

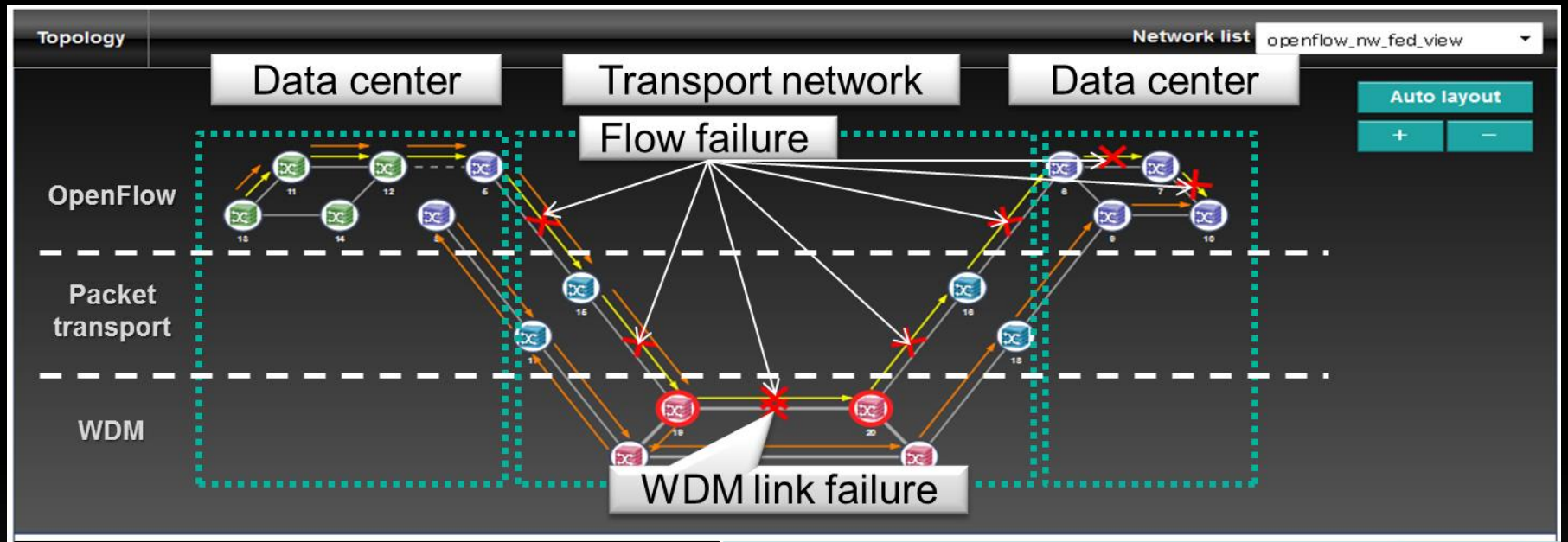
A. Yes, it's possible.

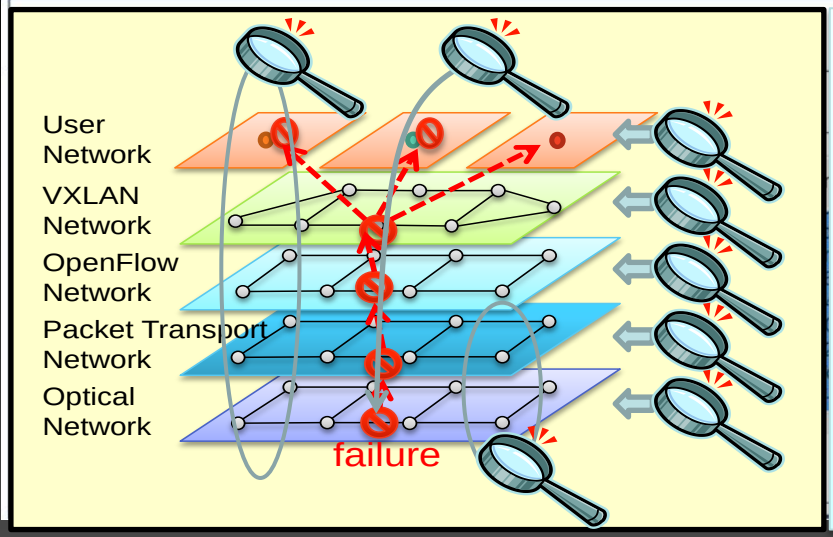
Network Model



Key	Value
oper_status	UP/DOWN
max_bandwidth	1000 Mbps


Aggregator
Inheritance
Advanced Aggregator
Overrides necessary methods





- Multi-layer topology visualization from logical network instances
- Inter-layer correlation mapping through operators
- Trouble shooting, failure analysis, etc.