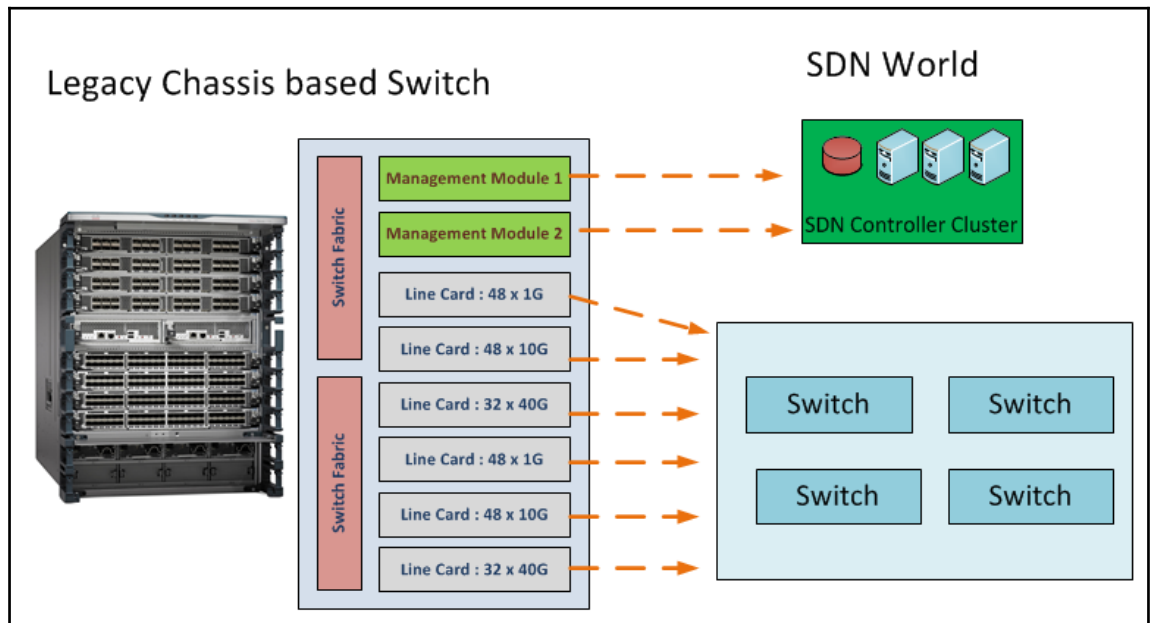
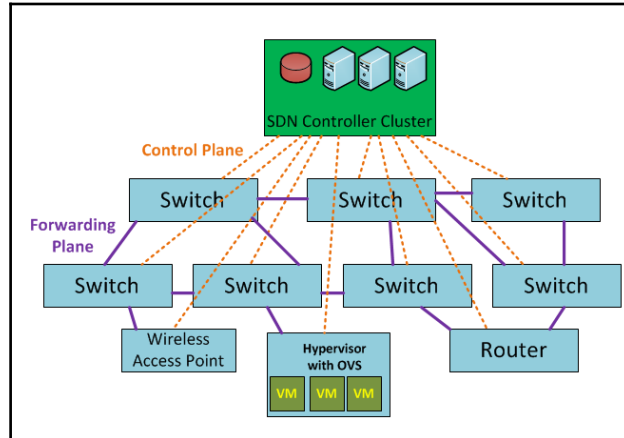
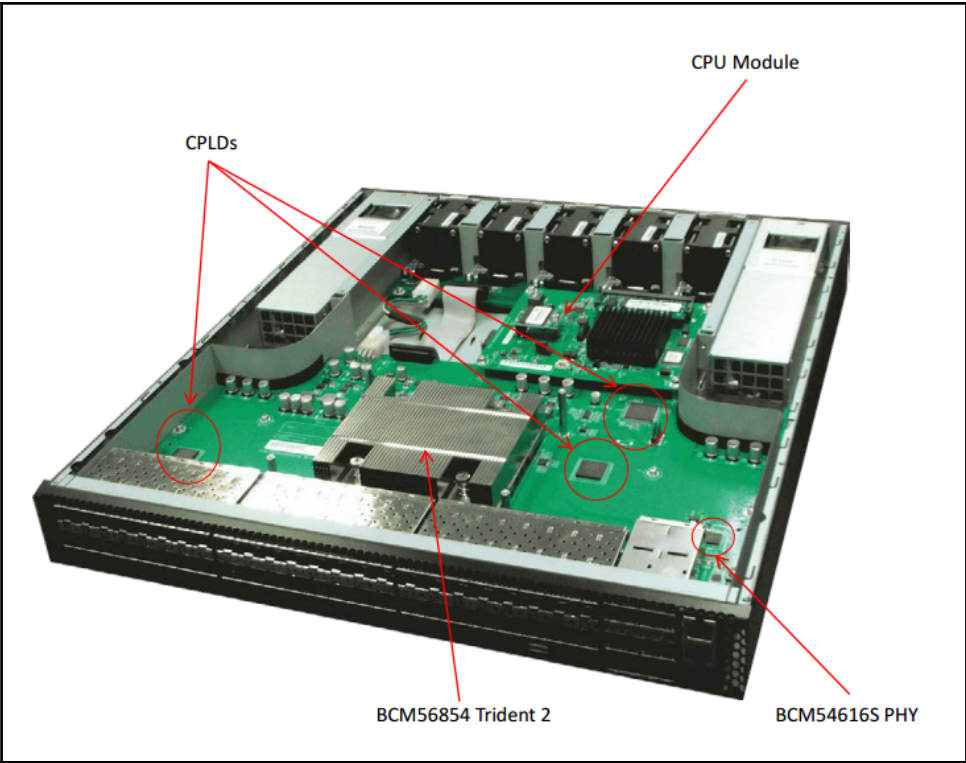
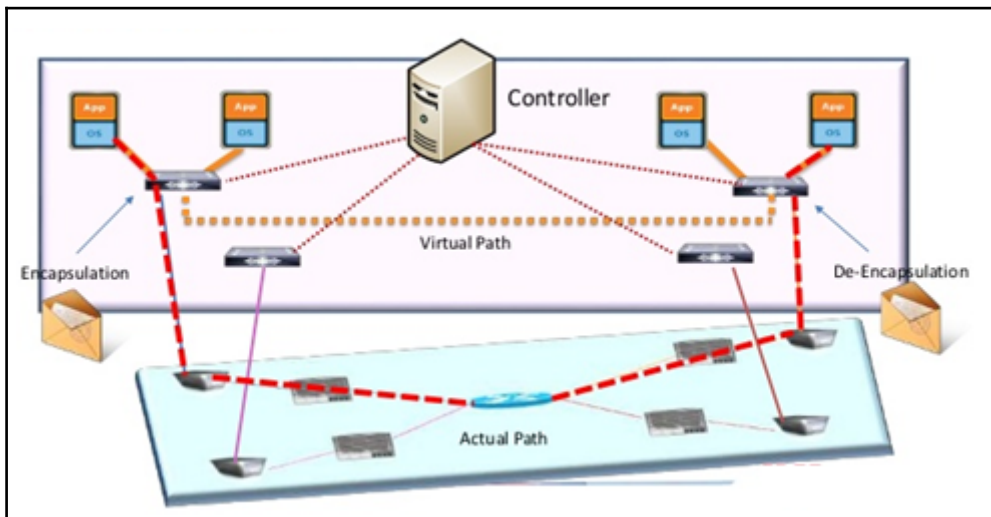
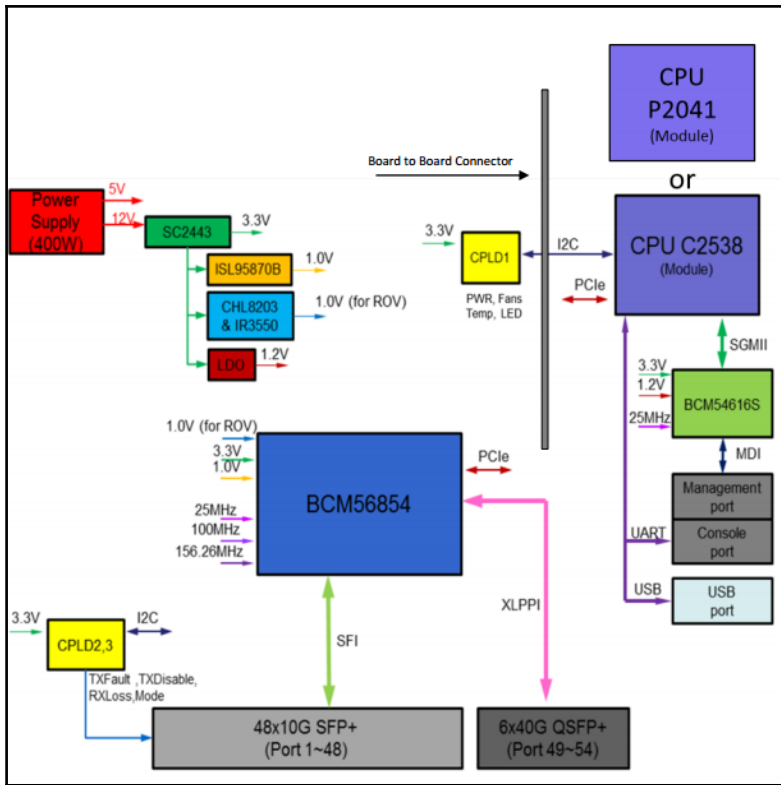
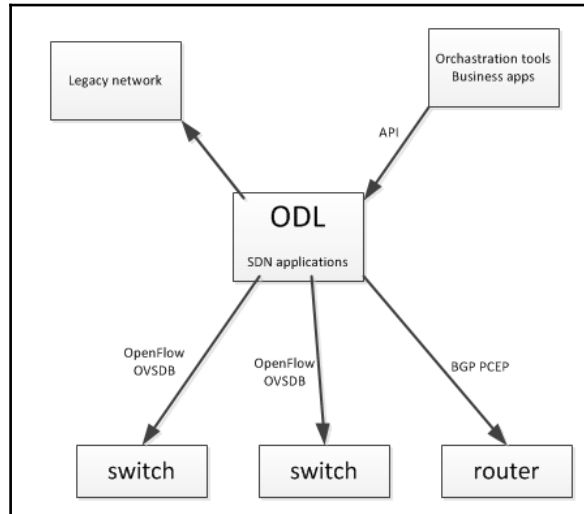
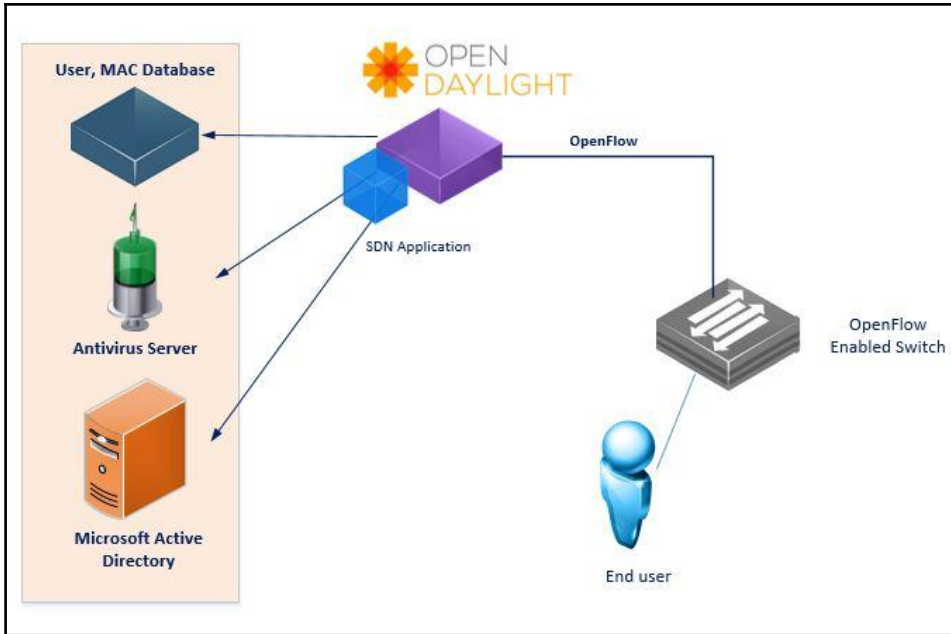


Chapter 1: Introduction to SDN - Transformation from Legacy to SDN



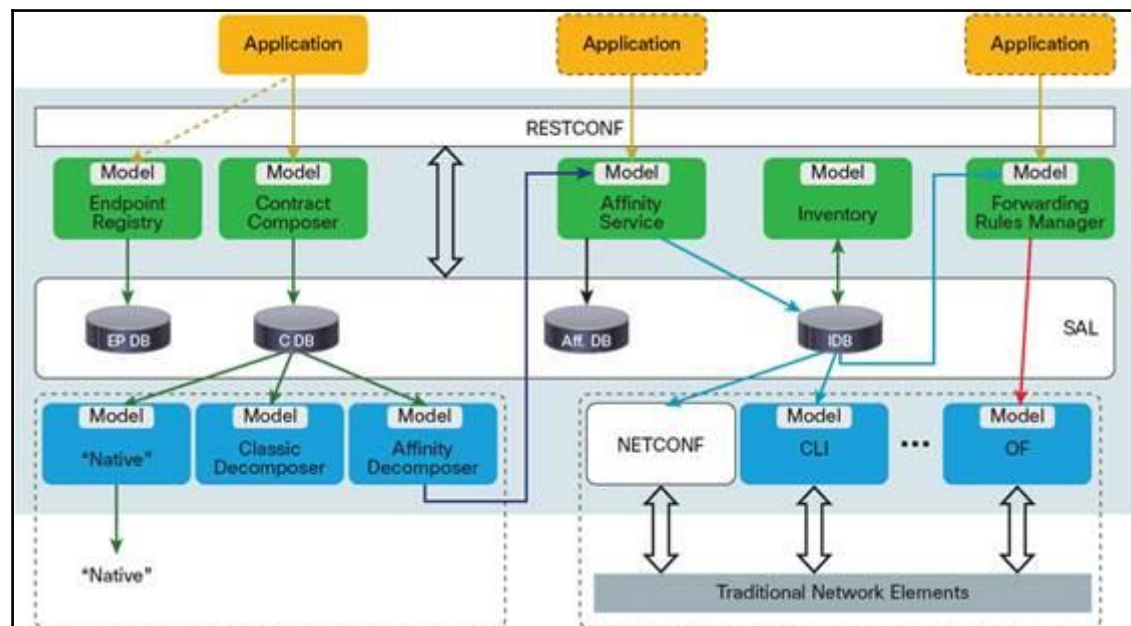
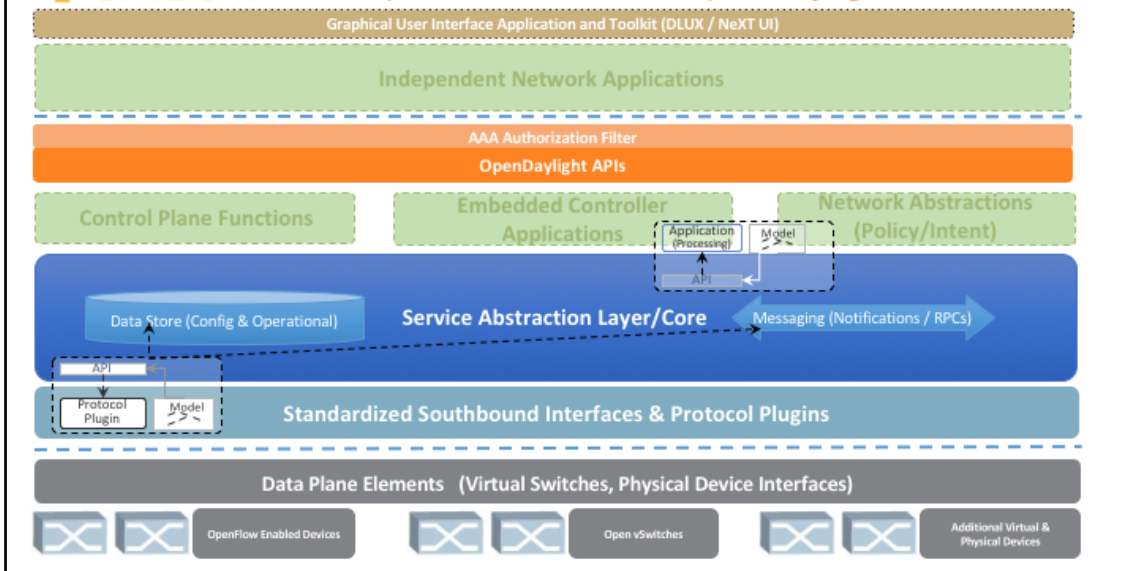




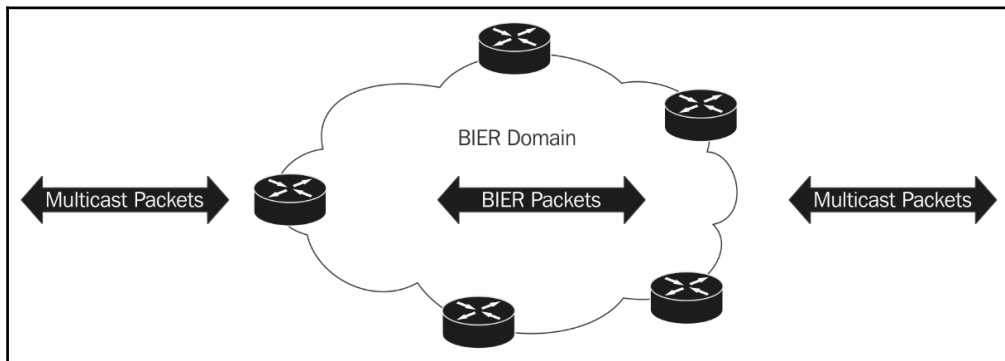
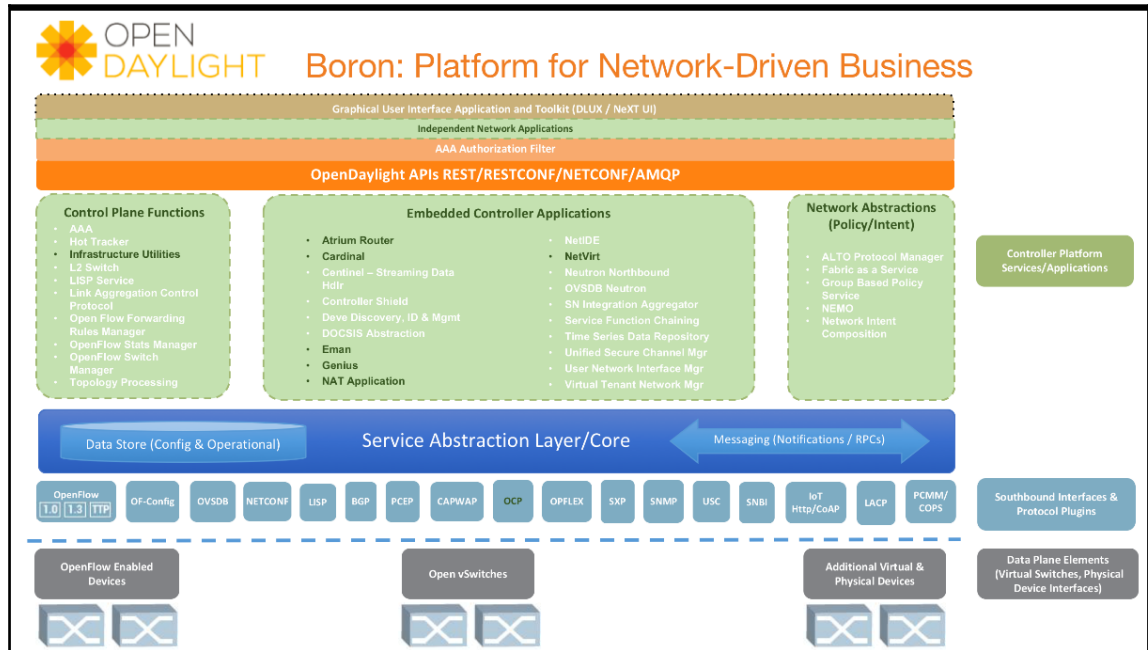


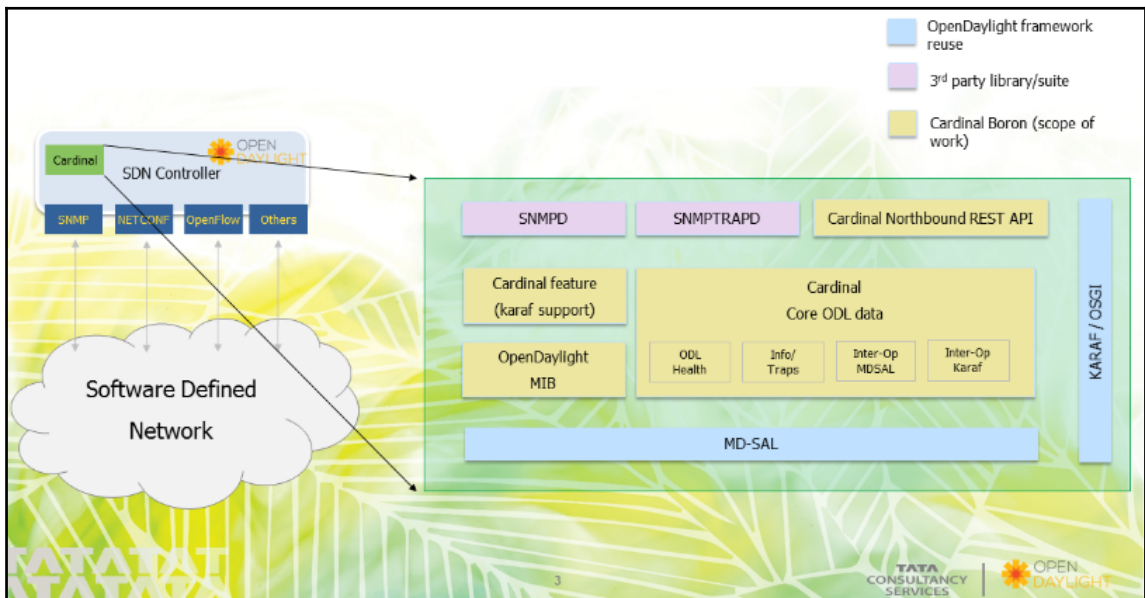
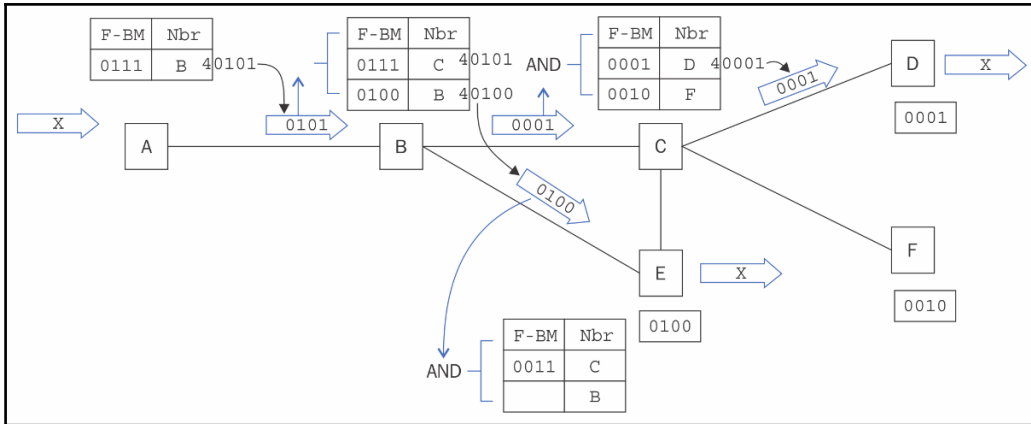


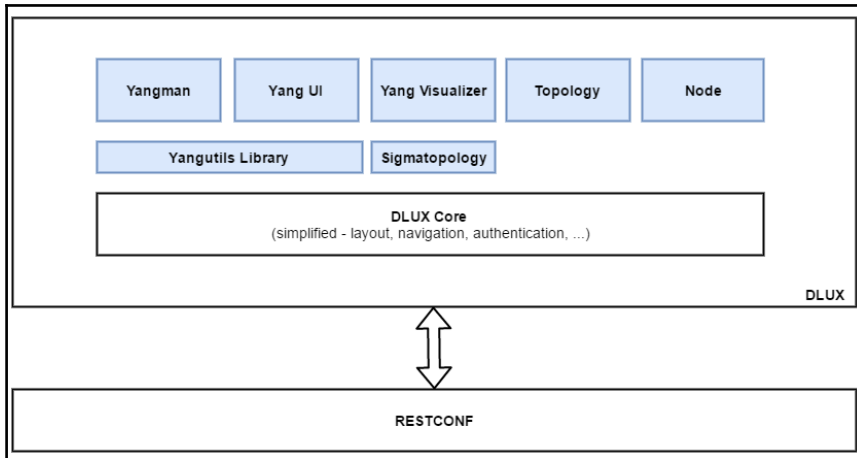
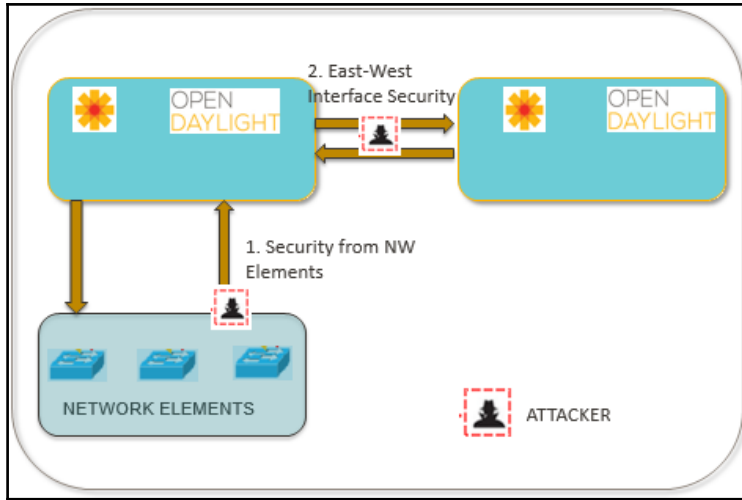
An Operational View of OpenDaylight

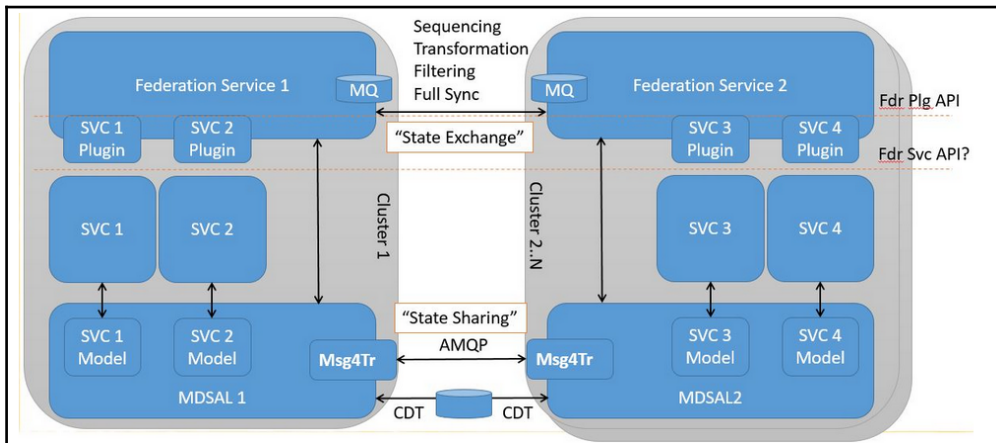
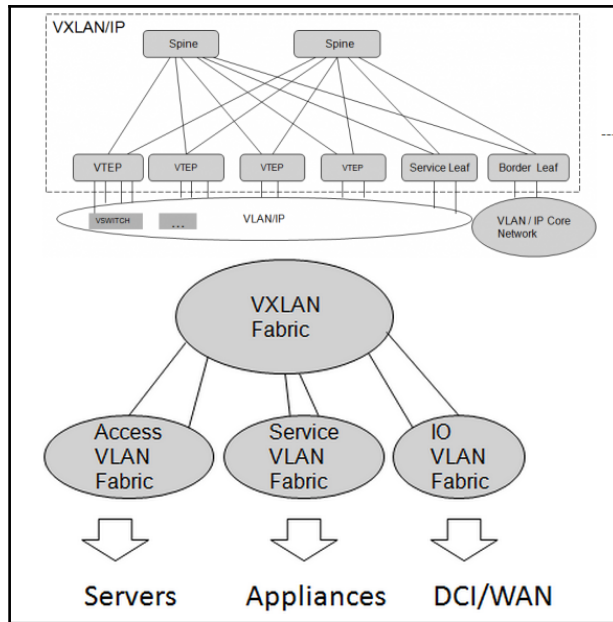


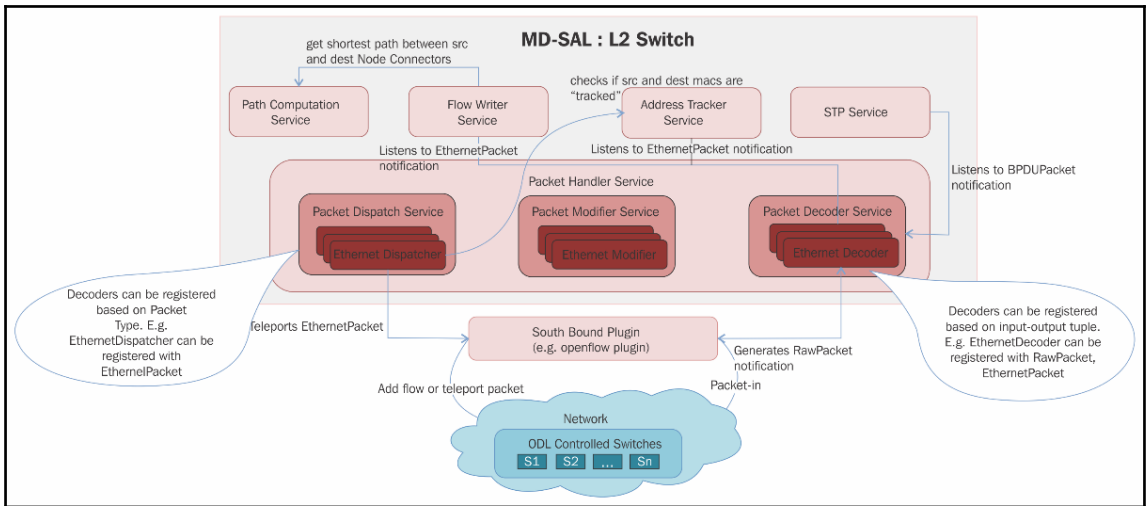
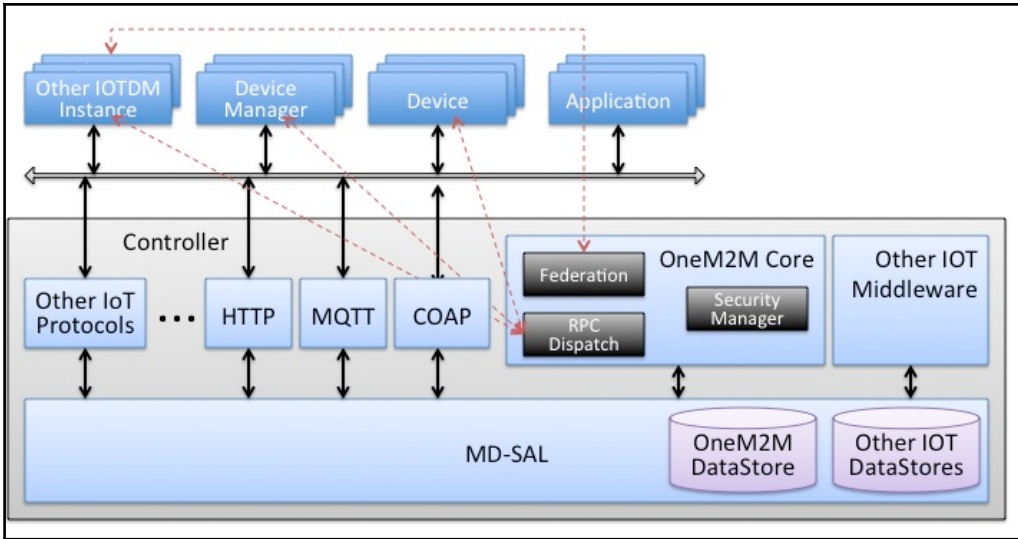
Chapter 2: Overview of OpenDaylight



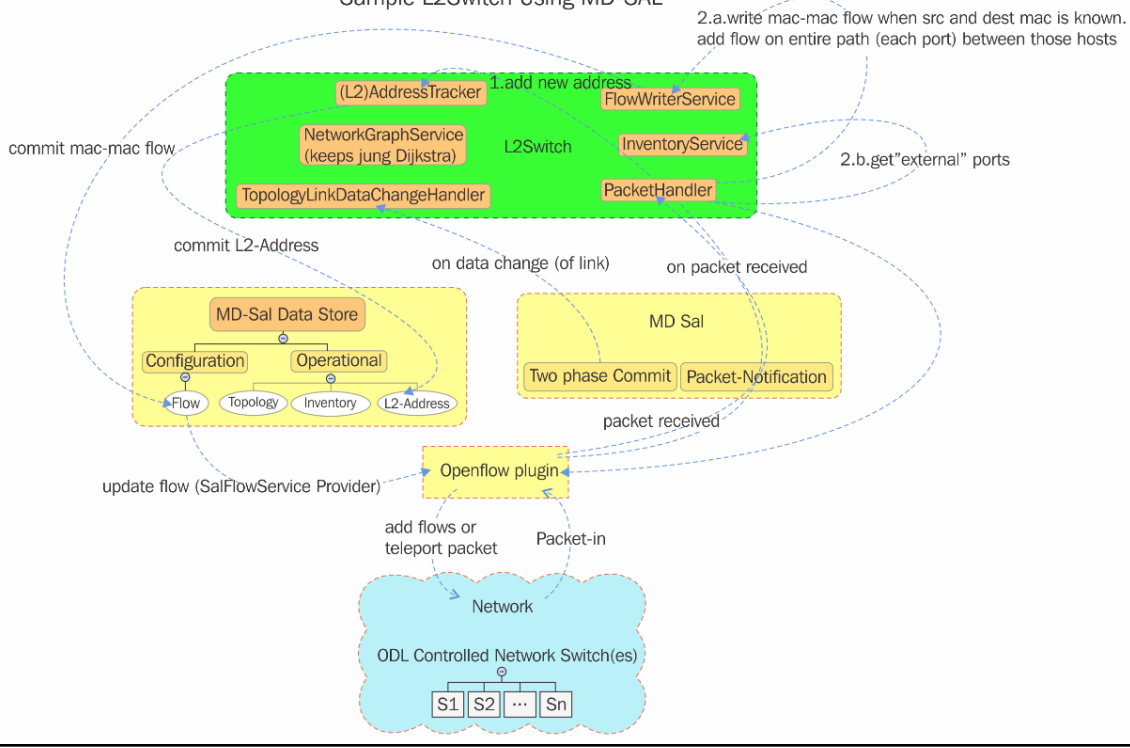


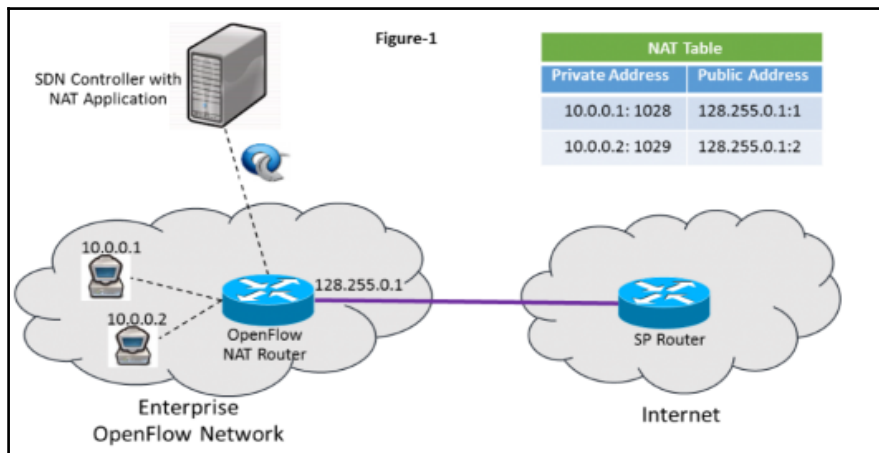
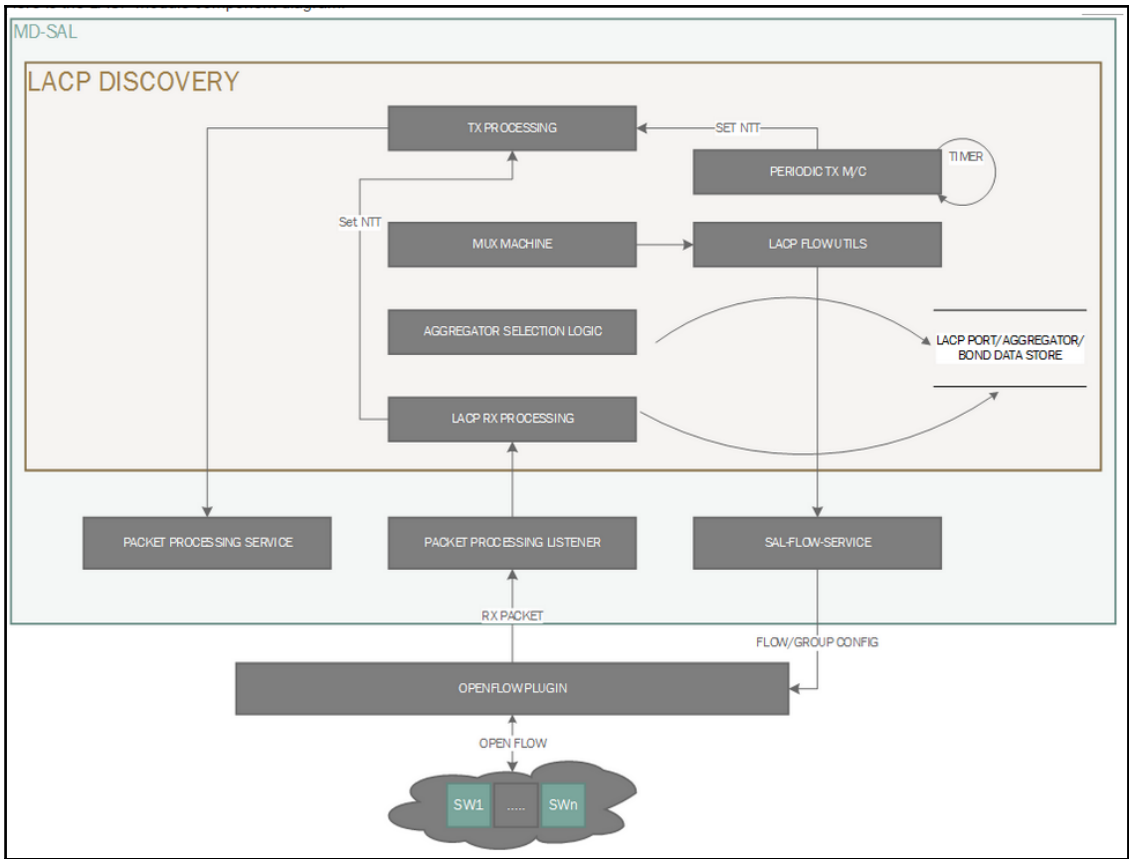


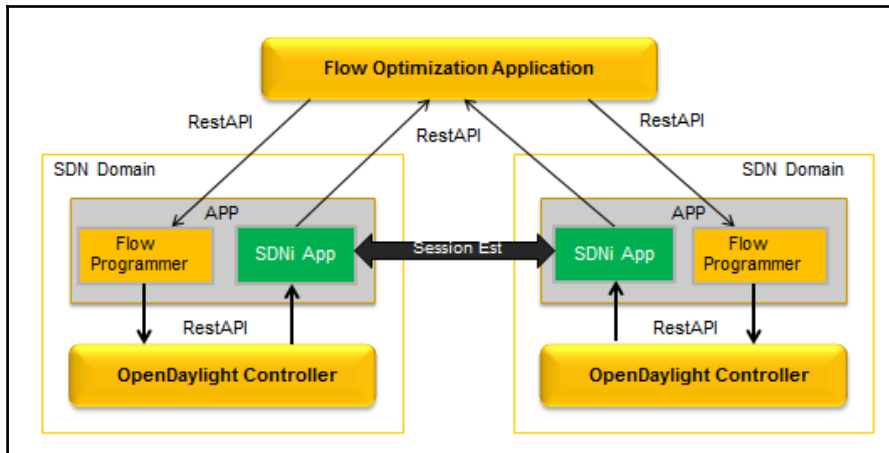
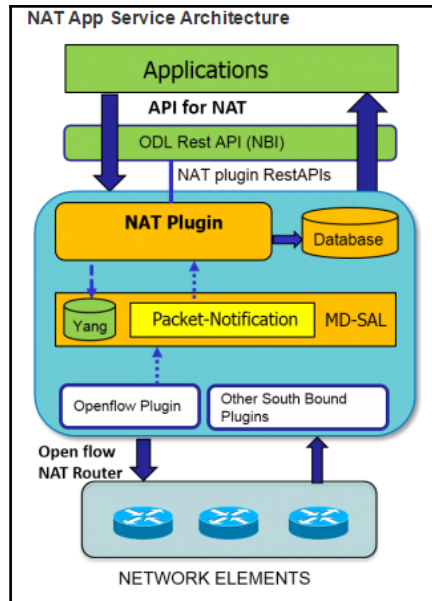


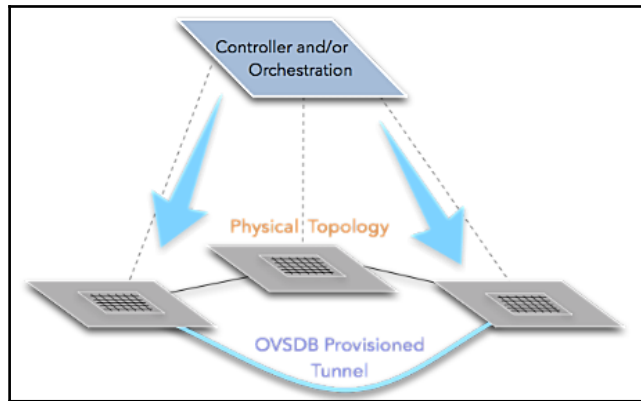
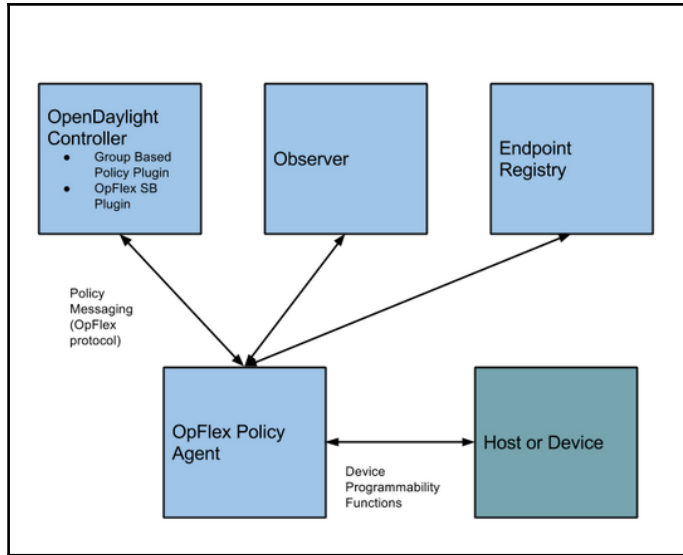


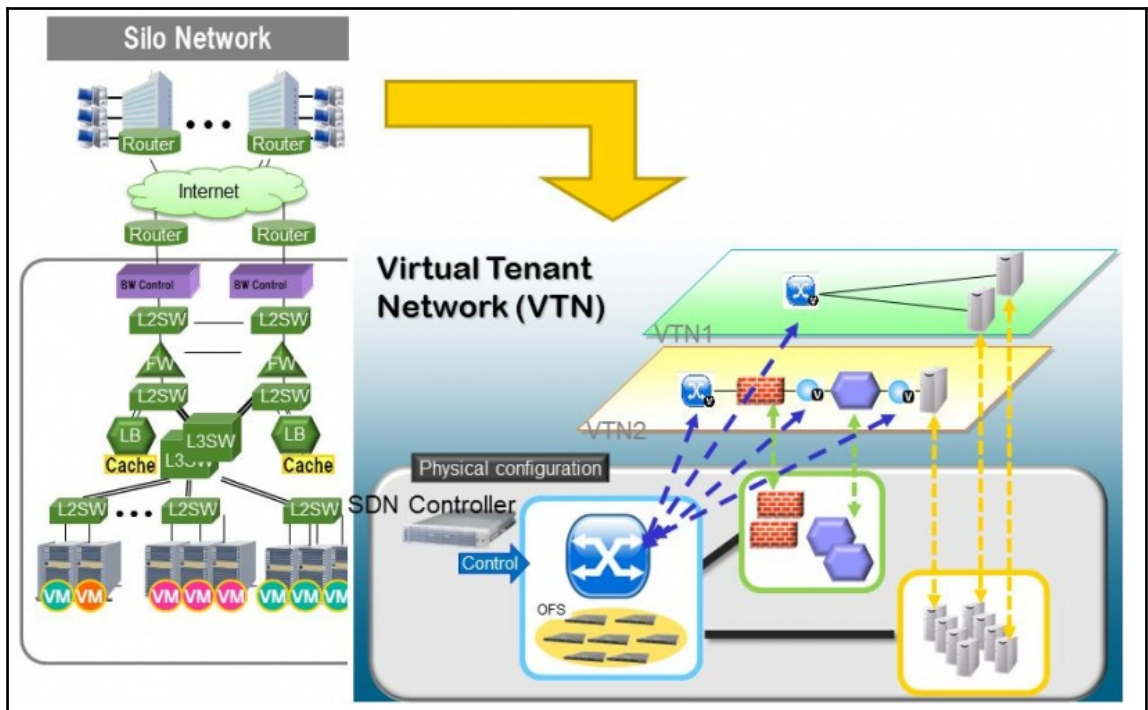
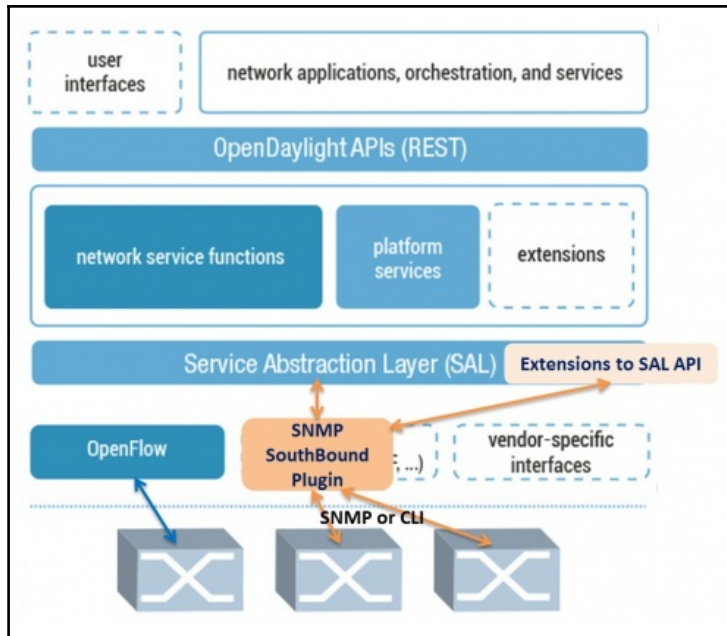
Sample L2Switch Using MD-SAL











OpenDaylight GUI - YangUI

localhost:9000/index.html#/yangui/index

Nodes
Topology
Connection Manager
Flows
Container
Networks
Yang UI

Module

- Expand all Collapse others
- + config rev 2013-04-05
- network-topology rev 2013-07-12
 - + config
 - operational
 - network-topology
 - network-topology rev 2013-10-21
 - opendaylight-action-types rev 2013-10-21
 - opendaylight-inventory rev 2013-08-21
 - openflow-action rev 2013-07-31
 - openflow-extensible-match rev 2013-07-31
 - openflow-instruction rev 2013-07-31
 - toaster rev 2009-11-20

/operational/network-topology GET

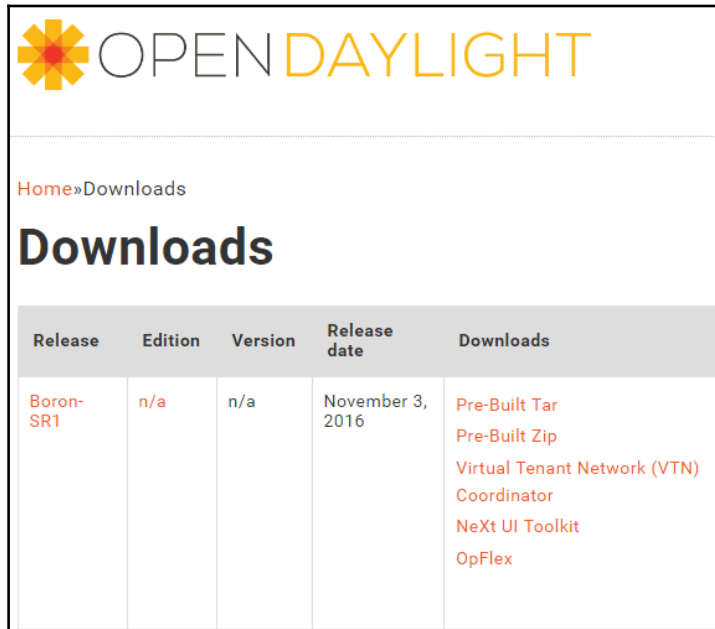
Request sent successfully

network-topology

- topology list topology <name>=network-topology
- topology-id flow:1
- node list node <node-id openflow 5> node <node-id openflow 4> node <node-id openflow 6>
- node-id openflow:1
- termination-point list

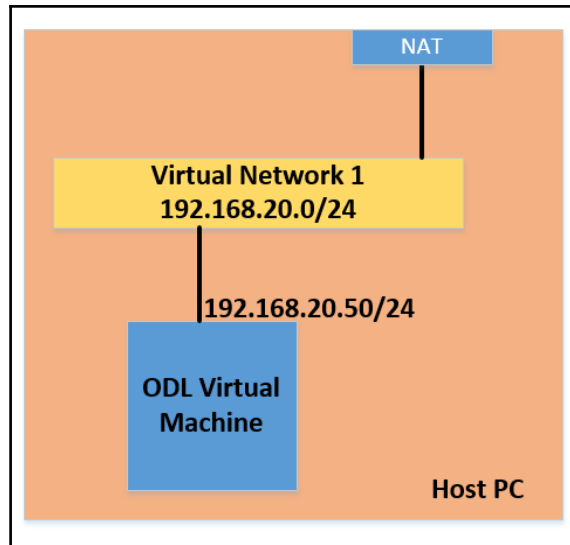
```
graph TD;
  n3[openflow:3] --- n2[openflow:2];
  n3 --- n4[openflow:4];
  n2 --- n1[openflow:1];
  n2 --- n5[openflow:5];
  n4 --- n1;
  n1 --- n6[openflow:6];
  n5 --- n6;
```


Chapter 3: OpenDaylight Installation and Deployment



Release	Edition	Version	Release date	Downloads
Boron-SR1	n/a	n/a	November 3, 2016	Pre-Built Tar Pre-Built Zip Virtual Tenant Network (VTN) Coordinator NeXt UI Toolkit OpFlex

```
learningod1@ODL01:/$ cat /etc/issue
Ubuntu 16.04.1 LTS \n \l
learningod1@ODL01:/$ █
```



```
# This file describes the network interfaces available on your system
# and how to activate them. For more information, see interfaces(5).

source /etc/network/interfaces.d/*

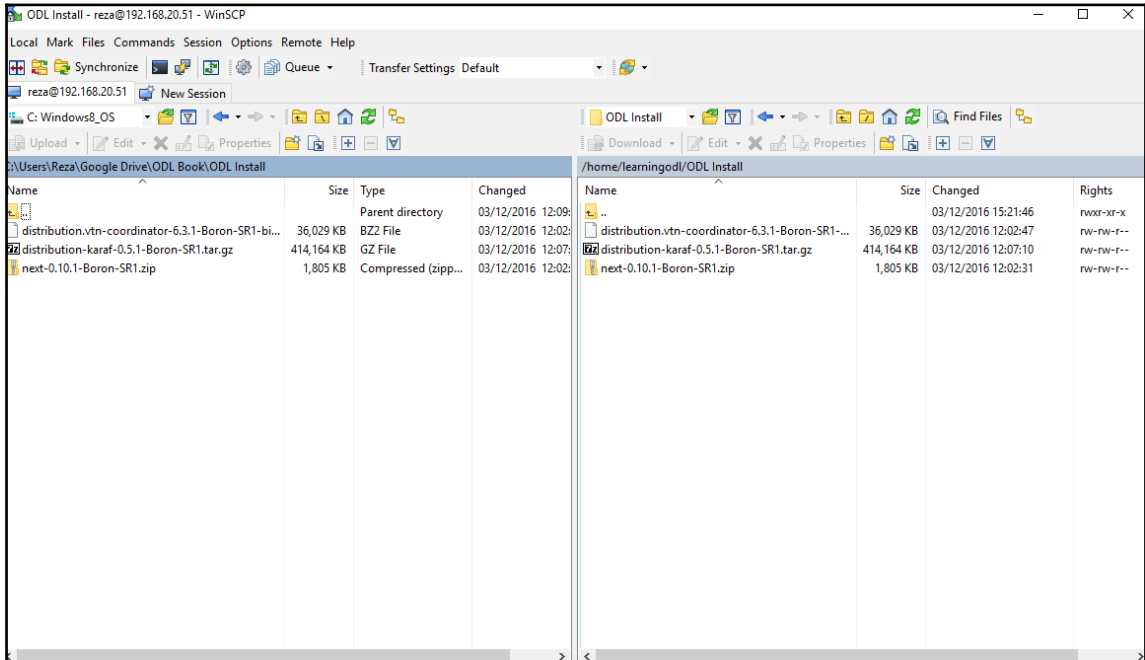
# The loopback network interface
auto lo
iface lo inet loopback

# The primary network interface
auto ens33
iface ens33 inet static
    address 192.168.20.51
    netmask 255.255.255.0
    gateway 192.168.20.2
    dns-nameservers 4.2.2.4 8.8.8.8
```

```
learningodl@ODL01: ~
learningodl@ODL01:~$ java -version
openjdk version "1.8.0_111"
OpenJDK Runtime Environment (build 1.8.0_111-8u111-b14-2ubuntu0.16.04.2-b14)
openjdk 64-bit Server VM (build 25.111-b14, mixed mode)
learningodl@ODL01:~$
```

```
learningodl@ODL01:~$ sudo update-alternatives --config java
There is only one alternative in link group java (providing /usr/bin/java):
/usr/lib/jvm/java-8-openjdk-amd64/jre/bin/java
Nothing to configure.
learningodl@ODL01:~$
```

```
GNU nano 2.5.3 File: /etc/environment
PATH="/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr
JAVA_HOME="/usr/lib/jvm/java-8-openjdk-amd64/jre"
```



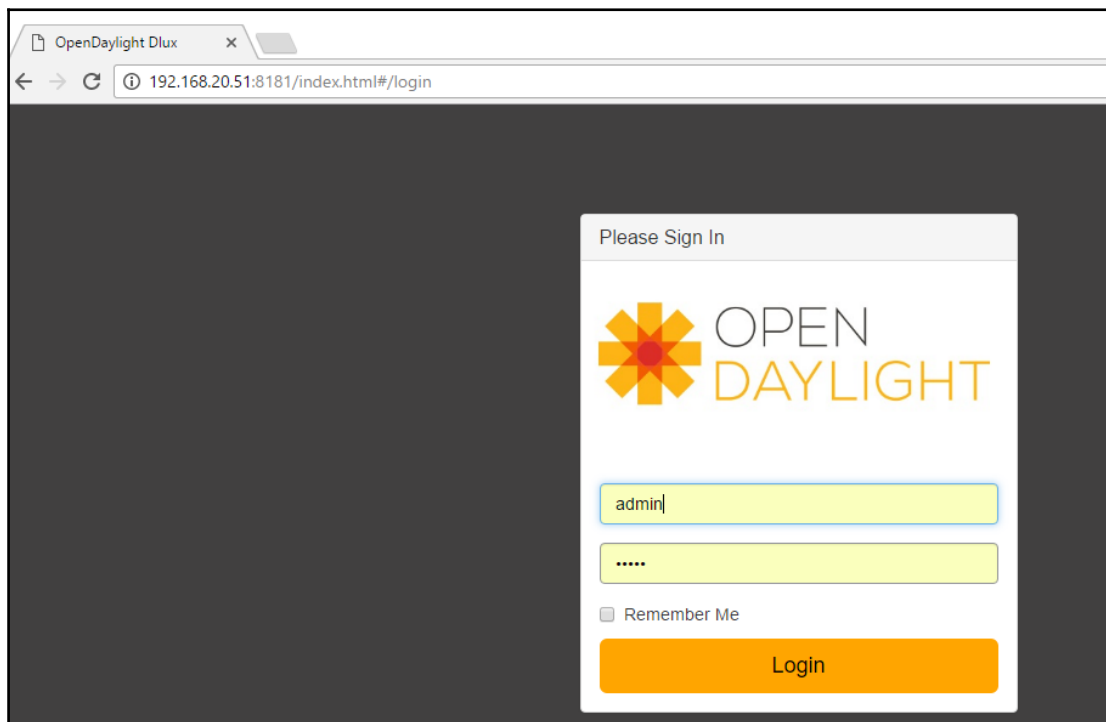
```
learningodl@ODL01:/opt/odl$ ll
total 414176
drwxr-xr-x  3 root root    4096 Dec 10 05:54 ./
drwxr-xr-x  3 root root    4096 Dec  3 07:23 ../
lrwxrwxrwx  1 root root     34 Dec 10 05:54 boron -> distribution-karaf-0.5.1-Boron-SR1/
drwxr-xr-x 10 root root    4096 Dec 10 05:53 distribution-karaf-0.5.1-Boron-SR1/
-rw-rw-r--  1 reza reza 424102999 Dec  3 04:07 distribution-karaf-0.5.1-Boron-SR1.tar.gz
learningodl@ODL01:/opt/odl$
```

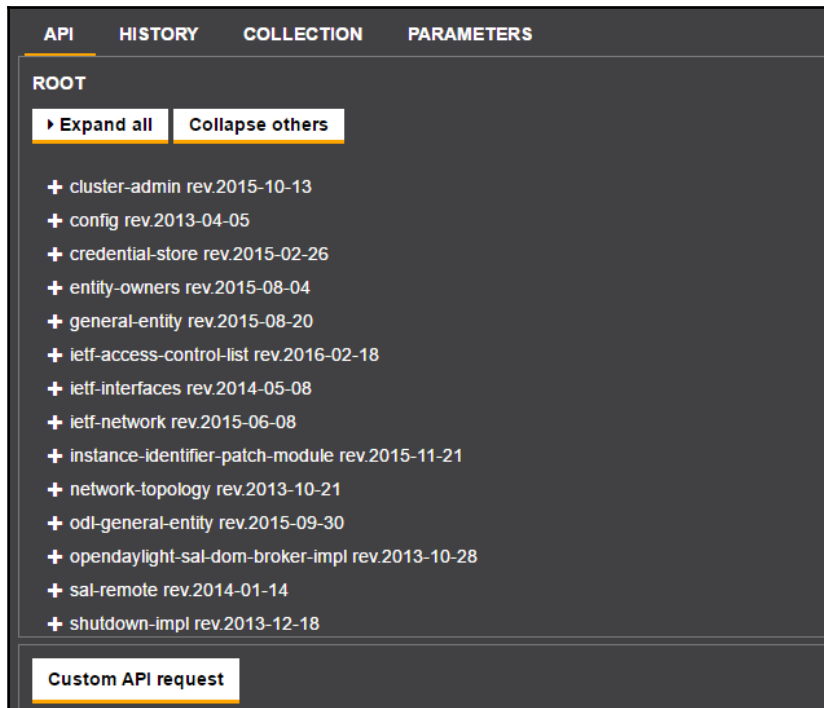
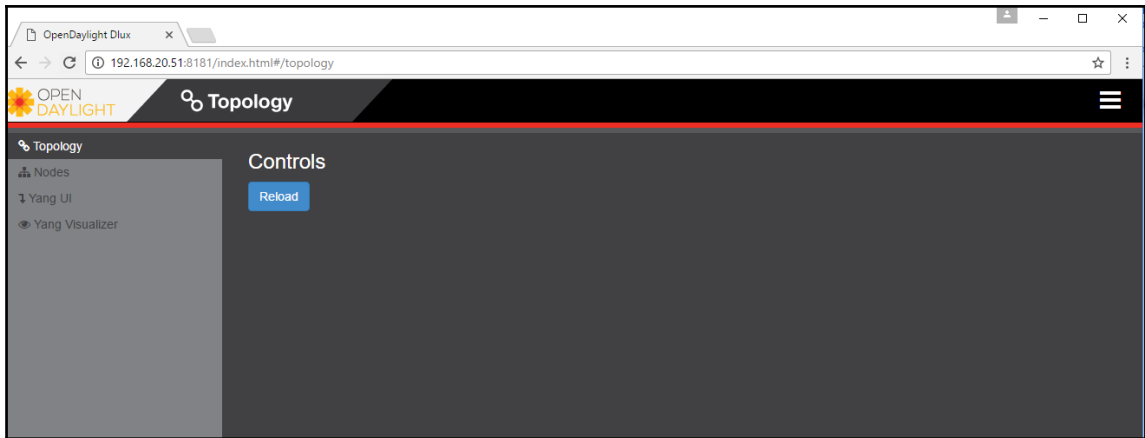
```
karaf: JAVA_HOME not set; results may vary
```

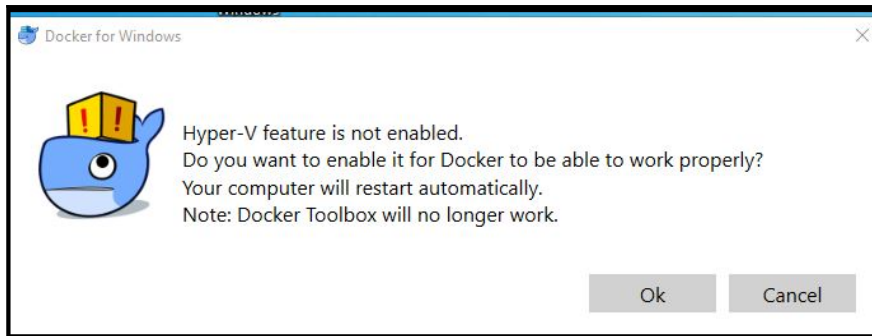


```
Hit '<tab>' for a list of available commands  
and '[cmd] --help' for help on a specific command.  
Hit '<ctrl-d>' or type 'system:shutdown' or 'logout' to shutdown OpenDaylight.
```

```
opendaylight-user@root>
```







```
PS C:\Users\Reza> docker version
Client:
Version:      17.03.0-ce
API version:  1.26
Go version:   go1.7.5
Git commit:   60ccb22
Built:        Thu Feb 23 10:40:59 2017
OS/Arch:      windows/amd64

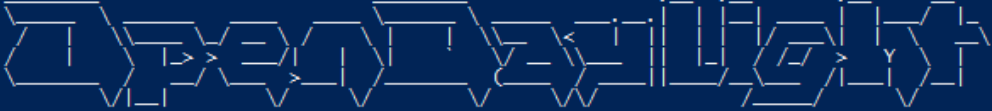
Server:
Version:      17.03.0-ce
API version:  1.26 (minimum version 1.12)
Go version:   go1.7.5
Git commit:   3a232c8
Built:        Tue Feb 28 07:52:04 2017
OS/Arch:      linux/amd64
Experimental: true
```

```
PS C:\Users\Reza> docker pull learningopendaylight/boron
Using default tag: latest
latest: Pulling from learningopendaylight/boron
d54efb8db41d: Pull complete
f8b845f45a87: Pull complete
e8db7bf7c39f: Pull complete
9654c40e9079: Pull complete
6d9ef359eaaa: Pull complete
62effac8c946: Pull complete
71278939a794: Pull complete
6cd3d1c61611: Pull complete
4ca4da3f9e8b: Pull complete
58939183c122: Pull complete
Digest: sha256:f704534b8a5cb203bf0786037f02af66314a022e7c5ad8a48455ed9e62cfd3bb
Status: Downloaded newer image for learningopendaylight/boron:latest
PS C:\Users\Reza>
```

```
PS C:\Users\Reza> docker images
REPOSITORY          TAG         IMAGE ID      CREATED      SIZE
learningopendaylight/boron  latest     08a356afd986  3 hours ago  1.88 GB
PS C:\Users\Reza>
```

```
PS C:\Users\Reza> docker run -it -p 8181:8181 learningopendaylight/boron
karaf: JAVA_HOME not set; results may vary
Apache Karaf starting up. Press Enter to open the shell now...
100% [=====]

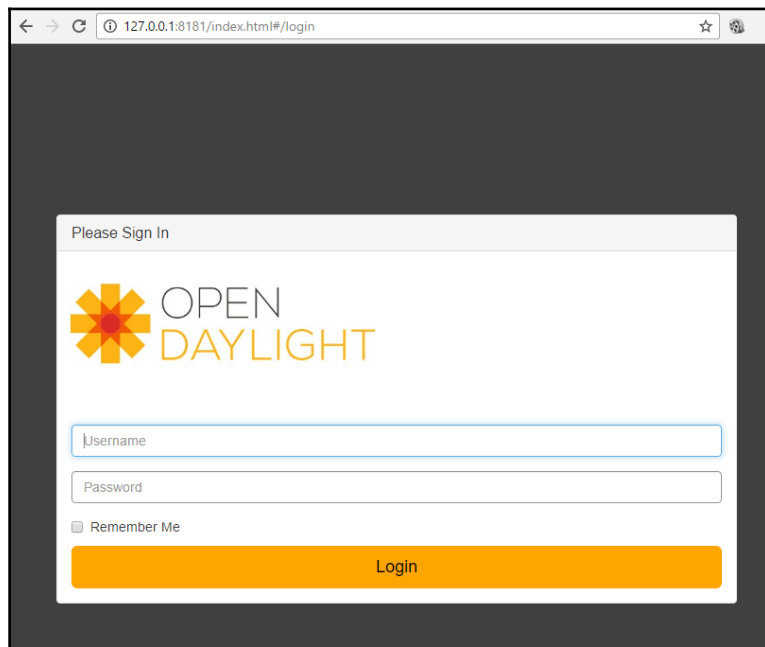
Karaf started in 3s. Bundle stats: 64 active, 64 total




Hit '<tab>' for a list of available commands
and '[cmd] --help' for help on a specific command.
Hit '<ctrl-d>' or type 'system:shutdown' or 'logout' to shutdown OpenDaylight.

opendaylight-user@odl>
```

```
opendaylight-user@odl>feature:install odl-dlux-all
opendaylight-user@odl>
```



Please Sign In

 OPEN DAYLIGHT

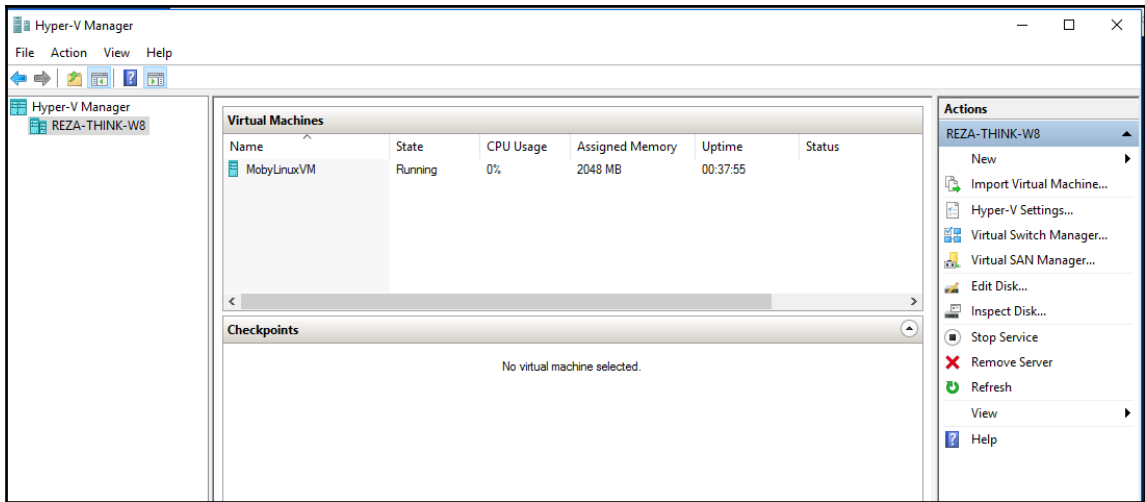
Username

Password

Remember Me

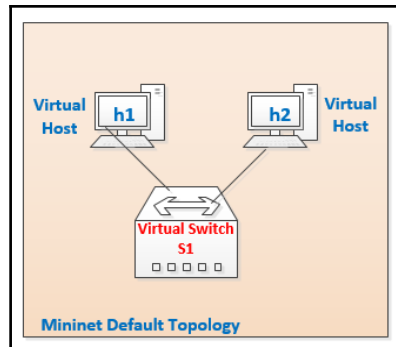
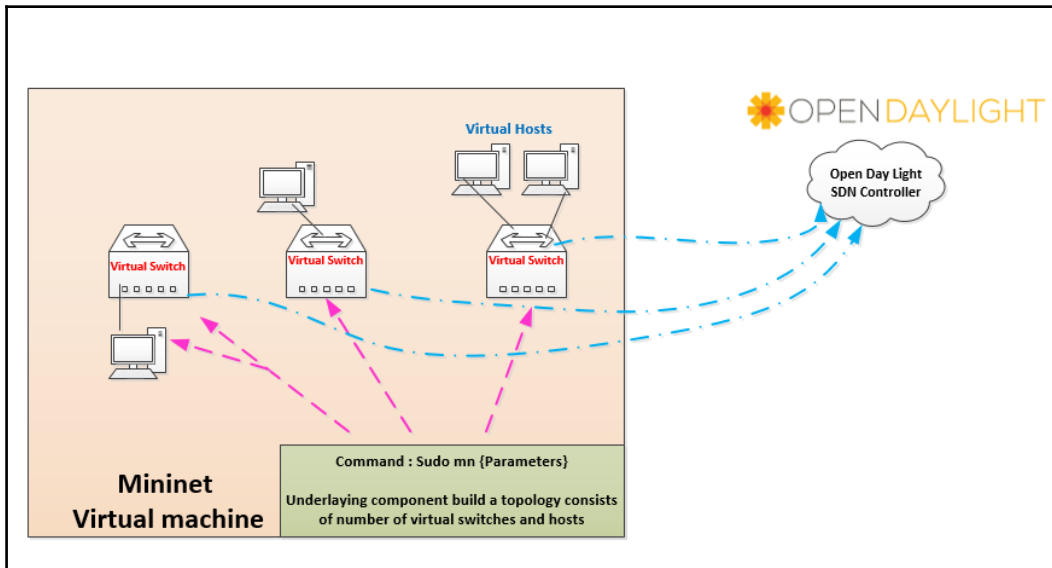
Login

```
opendaylight-user@odl>shutdown
Confirm: halt instance root (yes/no): yes
opendaylight-user@odl>
PS C:\Users\Reza>
```



Line	Command
1	FROM ubuntu:16.04
2	RUN apt-get -y update && apt-get install -y openjdk-8-jre wget
3	RUN mkdir /opt/od1
4	RUN wget -O /opt/od1/od1.tar.gz https://nexus.opendaylight.org/content/repositories/opendaylight.release/org.opendaylight/integration/distribution-karaf/0.5.2-Boron-SR2/distribution-karaf-0.5.2-Boron-SR2.tar.gz
5	RUN tar -xzf /opt/od1/od1.tar.gz -C /opt/od1/
6	RUN mv /opt/od1/dist* /opt/od1/boron
7	CMD /opt/od1/boron/bin/karaf

Chapter 4: Building a Virtual SDN Test Lab with Virtual Switches



```
mininet@mininet-vm:/$ sudo mn
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2
*** Adding switches:
s1
*** Adding links:
(h1, s1) (h2, s1)
*** Configuring hosts
h1 h2
*** Starting controller
c0
*** Starting 1 switches
s1 ...
*** Starting CLI:
mininet>
mininet>
```

```
mininet> net
h1 h1-eth0:s1-eth1
h2 h2-eth0:s1-eth2
s1 lo: s1-eth1:h1-eth0 s1-eth2:h2-eth0
c0
mininet> █
```

```
mininet> h1 ifconfig
h1-eth0  Link encap:Ethernet  HWaddr aa:58:44:58:97:74
         inet addr:10.0.0.1  Bcast:10.255.255.255  Mask:255.0.0.0
         UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo       Link encap:Local Loopback
         inet addr:127.0.0.1  Mask:255.0.0.0
         UP LOOPBACK RUNNING  MTU:65536  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:0
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

mininet> h2 ifconfig
h2-eth0  Link encap:Ethernet  HWaddr 5e:80:93:72:8b:d2
         inet addr:10.0.0.2  Bcast:10.255.255.255  Mask:255.0.0.0
         UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo       Link encap:Local Loopback
         inet addr:127.0.0.1  Mask:255.0.0.0
         UP LOOPBACK RUNNING  MTU:65536  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:0
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

mininet> █
```

```
mininet> h2 cat /etc/issue
Ubuntu 14.04 LTS \n \l
mininet> █
```

```
mininet> h1 bash
root@mininet-vm:~#
root@mininet-vm:~#
root@mininet-vm:~#
root@mininet-vm:~# ls /
bin  dev  home  lib  lost+found  mnt  proc  run  srv  tmp  var
boot  etc  initrd.img  lib64  media  opt  root /sbin  sys  usr  vmlinuz
root@mininet-vm:~# █
```

← → ↻ mininet.org/download/#option-1-mininet-vm-installation-easy-recommended

Download/Get Started With Mininet

The easiest way to get started is to **download a pre-packaged Mininet/Ubuntu VM**. This VM includes Mininet itself, all OpenFlow binaries and tools pre-installed, and tweaks to the kernel configuration to support larger Mininet networks.

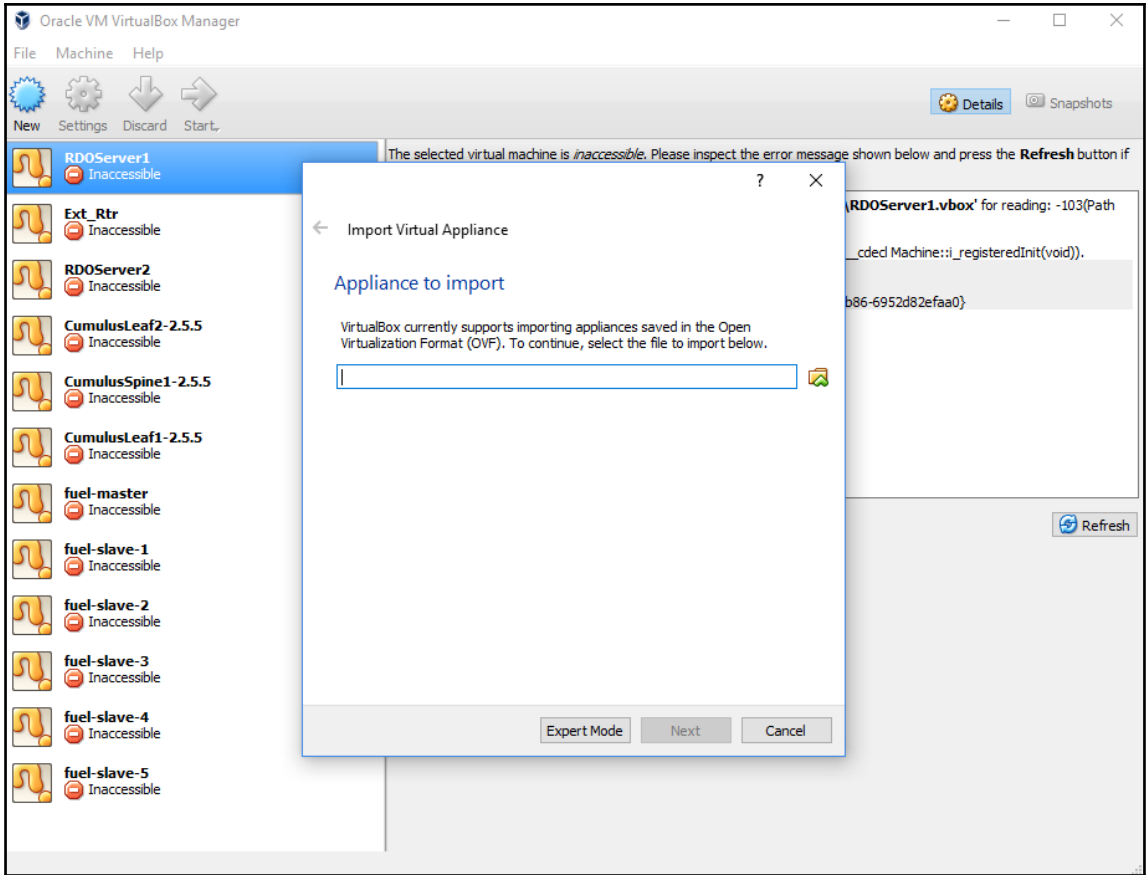
- [Option 1: Mininet VM Installation \(easy, recommended\)](#)
- [Option 2: Native Installation from Source](#)
- [Option 3: Installation from Packages](#)
- [Option 4: Upgrading an existing Mininet Installation](#)

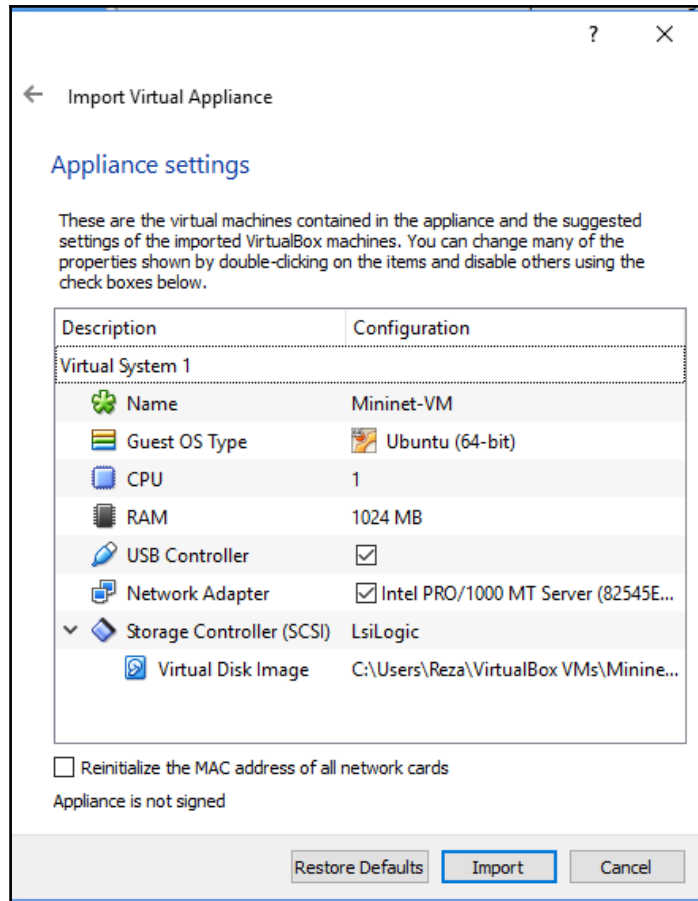
Option 1: Mininet VM Installation (easy, recommended)

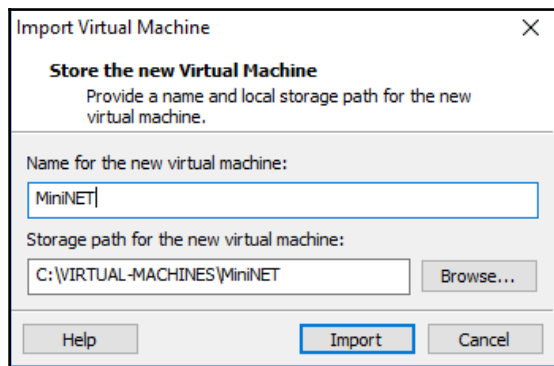
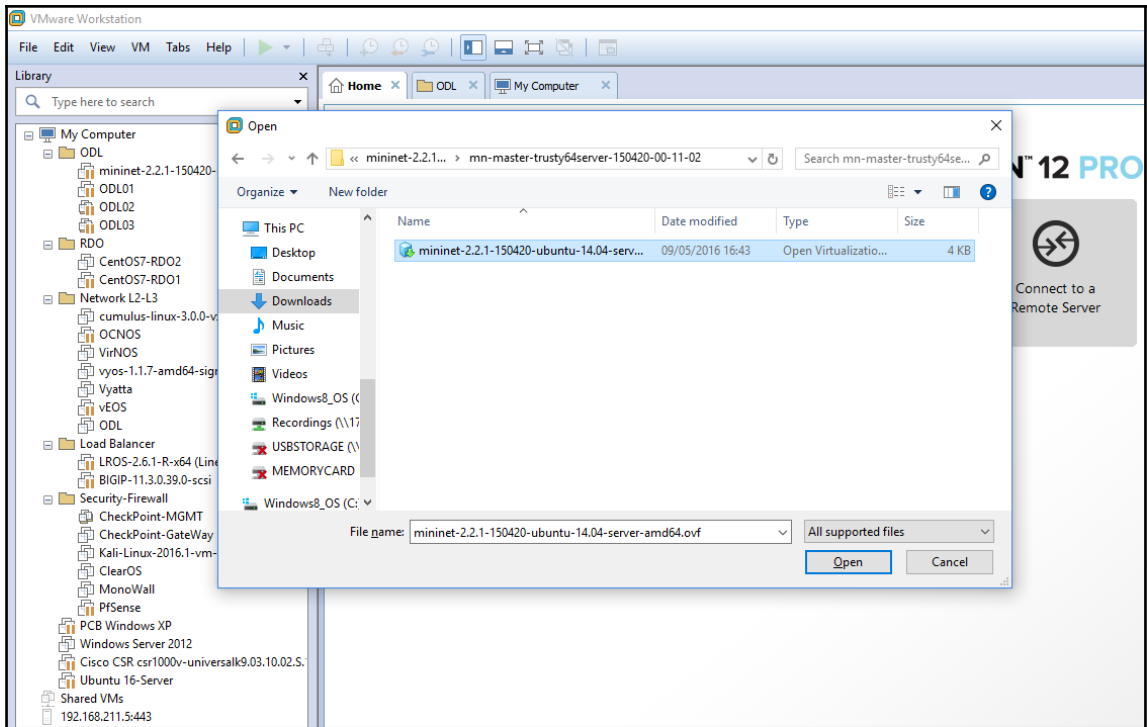
VM installation is the **easiest and most foolproof** way of installing Mininet, so it's what we recommend to start with.

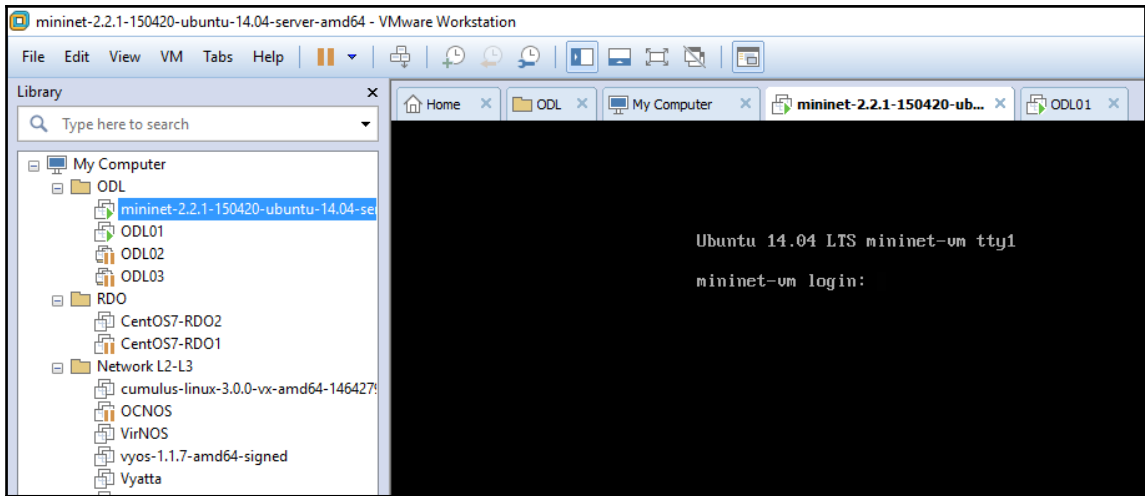
Follow these steps for a VM install:

1. Download the [Mininet VM image](#).
2. Download and install a virtualization system. We recommend [VirtualBox](#) (free, GPL) because it is **free** and works on OS X, Windows, and Linux (though it's slightly slower than VMware in our tests.) You can also use [Qemu](#) for any platform, [VMware Workstation](#) for Windows or Linux, [VMware Fusion](#) for Mac, or [KVM](#) (free, GPL) for Linux.
3. Sign up for the [mininet-discuss mailing list](#). This is the source for Mininet **support** and discussion with the friendly Mininet community. ;-)
4. Run through the [VM Setup Notes](#) to log in to the VM and customize it as desired.
5. Follow the [Walkthrough](#) to get familiar with Mininet commands and typical usage.





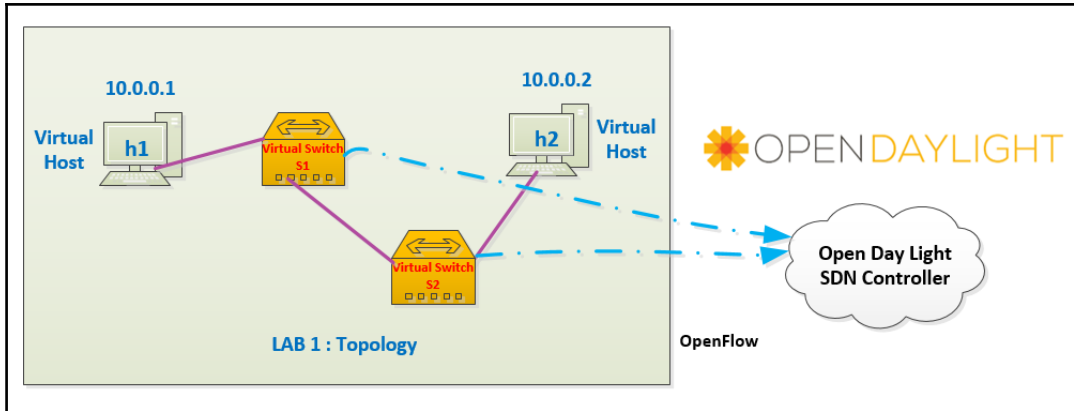




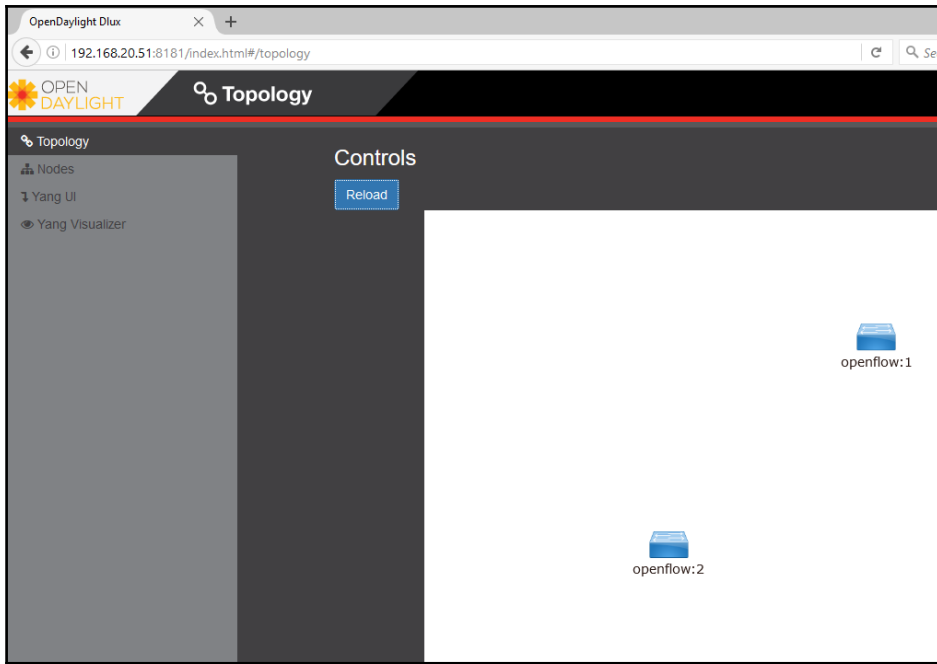
```
mininet@mininet-vm:/$ ping 192.168.20.51 -c 5
PING 192.168.20.51 (192.168.20.51) 56(84) bytes of data:
64 bytes from 192.168.20.51: icmp_seq=1 ttl=64 time=0.443 ms
64 bytes from 192.168.20.51: icmp_seq=2 ttl=64 time=0.442 ms
64 bytes from 192.168.20.51: icmp_seq=3 ttl=64 time=0.372 ms
64 bytes from 192.168.20.51: icmp_seq=4 ttl=64 time=0.385 ms
64 bytes from 192.168.20.51: icmp_seq=5 ttl=64 time=0.358 ms

--- 192.168.20.51 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4000ms
rtt min/avg/max/mdev = 0.358/0.400/0.443/0.035 ms
```

192.168.20.55	192.168.20.51	TCP	74	37654→6633	[SYN]	Seq=0	Win=29200	Len=0	MSS=1460
192.168.20.55	192.168.20.51	TCP	74	37655→6633	[SYN]	Seq=0	Win=29200	Len=0	MSS=1460
192.168.20.51	192.168.20.55	TCP	60	6633→37654	[RST, ACK]	Seq=1	Ack=1	Win=0	Len=0
192.168.20.51	192.168.20.55	TCP	60	6633→37655	[RST, ACK]	Seq=1	Ack=1	Win=0	Len=0



```
mininet@mininet-vm:/$ sudo mn --controller=remote,ip=192.168.20.51 --topo=linear,2 --mac
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2
*** Adding switches:
s1 s2
*** Adding links:
(h1, s1) (h2, s2) (s2, s1)
*** Configuring hosts
h1 h2
*** Starting controller
c0
*** Starting 2 switches
s1 s2 ...
*** Starting CLI:
mininet> █
```



*VMware Network Adapter VMnet8

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openflow_v1

No.	Time	Source	Destination	Protocol	Length	Info
78	8.605941	192.168.20.55	192.168.20.51	OpenFlow	74	Type: OFPT_HELLO
79	8.605941	192.168.20.55	192.168.20.51	OpenFlow	74	Type: OFPT_HELLO
82	8.609917	192.168.20.51	192.168.20.55	OpenFlow	74	Type: OFPT_HELLO
84	8.611761	192.168.20.51	192.168.20.55	OpenFlow	74	Type: OFPT_HELLO
86	8.611762	192.168.20.51	192.168.20.55	OpenFlow	74	Type: OFPT_FEATURES_REQUEST
87	8.611763	192.168.20.51	192.168.20.55	OpenFlow	74	Type: OFPT_FEATURES_REQUEST
90	8.634942	192.168.20.55	192.168.20.51	OpenFlow	242	Type: OFPT_FEATURES_REPLY
91	8.634943	192.168.20.55	192.168.20.51	OpenFlow	242	Type: OFPT_FEATURES_REPLY
92	8.635537	192.168.20.51	192.168.20.55	OpenFlow	74	Type: OFPT_BARRIER_REQUEST
93	8.635538	192.168.20.51	192.168.20.55	OpenFlow	74	Type: OFPT_BARRIER_REQUEST
94	8.636451	192.168.20.55	192.168.20.51	OpenFlow	74	Type: OFPT_BARRIER_REPLY
95	8.646973	192.168.20.55	192.168.20.51	OpenFlow	74	Type: OFPT_BARRIER_REPLY
96	8.646974	192.168.20.51	192.168.20.55	OpenFlow	78	Type: OFPT_STATS_REQUEST
97	8.646974	192.168.20.55	192.168.20.51	OpenFlow	1134	Type: OFPT_STATS_REPLY
99	8.648586	192.168.20.51	192.168.20.55	OpenFlow	78	Type: OFPT_STATS_REQUEST
112	8.661994	192.168.20.55	192.168.20.51	OpenFlow	406	Type: OFPT_STATS_REPLY
114	8.661996	192.168.20.51	192.168.20.55	OpenFlow	122	Type: OFPT_STATS_REQUEST

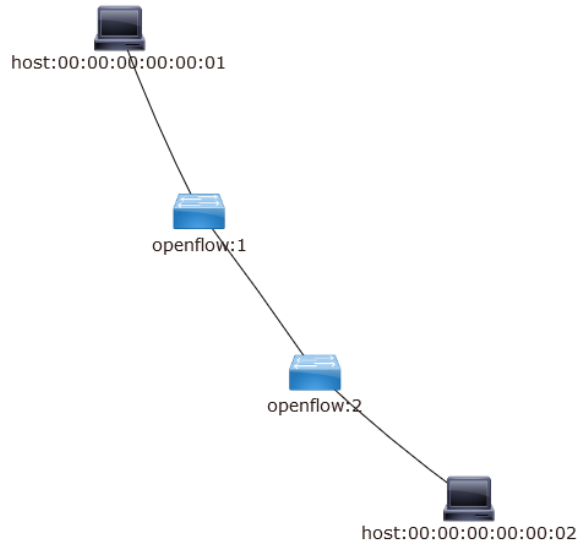
```
Wireshark · Packet 78 · wireshark_28B0CB8F-F843-4526-953D-49773024E253_20170107163529_a64456
> Frame 78: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface 0
> Ethernet II, Src: Vmware_69:36:bc (00:0c:29:69:36:bc), Dst: Vmware_44:f0:0c (00:0c:29:44:f0:0c)
> Internet Protocol Version 4, Src: 192.168.20.55, Dst: 192.168.20.51
> Transmission Control Protocol, Src Port: 37568, Dst Port: 6633, Seq: 1, Ack: 1, Len: 8
▼ OpenFlow 1.0
  .000 0001 = Version: 1.0 (0x01)
  Type: OFPT_HELLO (0)
  Length: 8
  Transaction ID: 63
```

```
Wireshark · Packet 84 · wireshark_28B0CB8F-F843-4526-953D-49773024E253_20170107163529_a64456
> Frame 84: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface 0
> Ethernet II, Src: Vmware_44:f0:0c (00:0c:29:44:f0:0c), Dst: Vmware_69:36:bc (00:0c:29:69:36:bc)
> Internet Protocol Version 4, Src: 192.168.20.51, Dst: 192.168.20.55
> Transmission Control Protocol, Src Port: 6633, Dst Port: 37569, Seq: 1, Ack: 9, Len: 8
▼ OpenFlow 1.0
  .000 0001 = Version: 1.0 (0x01)
  Type: OFPT_HELLO (0)
  Length: 8
  Transaction ID: 65
```

```
mininet> h1 ping h2
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data:
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=0.280 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.168 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.178 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.197 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.159 ms
64 bytes from 10.0.0.2: icmp_seq=6 ttl=64 time=0.161 ms
64 bytes from 10.0.0.2: icmp_seq=7 ttl=64 time=0.148 ms
^C
--- 10.0.0.2 ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6001ms
rtt min/avg/max/mdev = 0.148/0.184/0.280/0.043 ms
mininet>
```

Controls

Reload

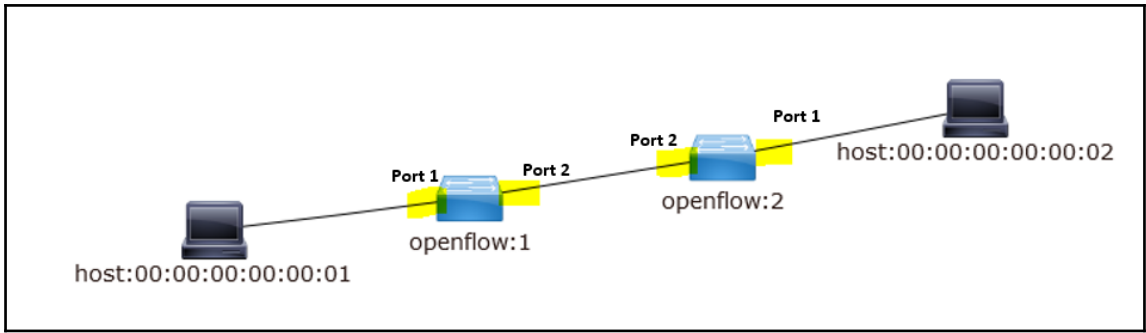


```

> Ethernet II, Src: Vmware_69:36:bc (00:0c:29:69:36:bc), Dst: Vmware_44:f0:0c (00:0c:29:44:f0:0c)
> Internet Protocol Version 4, Src: 192.168.20.55, Dst: 192.168.20.51
> Transmission Control Protocol, Src Port: 38116, Dst Port: 6633, Seq: 34999, Ack: 1192, Len: 60
▼ OpenFlow 1.0
  .000 0001 = Version: 1.0 (0x01)
  Type: OFPT_PACKET_IN (10)
  Length: 60
  Transaction ID: 0
  Buffer Id: 0xffffffff
  Total length: 42
  In port: 1
  Reason: Action explicitly output to controller (1)
  Pad: 00
  > Ethernet II, Src: 00:00:00_00:00:01 (00:00:00:00:00:01), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
  ▼ Address Resolution Protocol (request)
    Hardware type: Ethernet (1)
    Protocol type: IPv4 (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: request (1)
    Sender MAC address: 00:00:00_00:00:01 (00:00:00:00:00:01)
    Sender IP address: 10.0.0.1
    Target MAC address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Target IP address: 10.0.0.2

```

245	7.031988	192.168.20.51	192.168.20.55	OpenFlow	74	Type: OFPT_BARRIER_REQUEST
246	7.032310	192.168.20.55	192.168.20.51	OpenFlow	74	Type: OFPT_BARRIER_REPLY
251	7.521639	192.168.20.51	192.168.20.55	OpenFlow	146	Type: OFPT_FLOW_MOD
252	7.521659	192.168.20.51	192.168.20.55	OpenFlow	154	Type: OFPT_FLOW_MOD
254	7.522124	192.168.20.51	192.168.20.55	OpenFlow	154	Type: OFPT_FLOW_MOD
255	7.522342	192.168.20.51	192.168.20.55	OpenFlow	146	Type: OFPT_FLOW_MOD
257	7.532086	192.168.20.51	192.168.20.55	OpenFlow	74	Type: OFPT_BARRIER_REQUEST
258	7.532302	192.168.20.55	192.168.20.51	OpenFlow	74	Type: OFPT_BARRIER_REPLY



```
> Ethernet II, Src: Vmware_44:f0:0c (00:0c:29:44:f0:0c), Dst: Vmware_69:36:bc (00:0c:29:69:36:bc)
> Internet Protocol Version 4, Src: 192.168.20.51, Dst: 192.168.20.55
> Transmission Control Protocol, Src Port: 6633, Dst Port: 38116, Seq: 1016, Ack: 34991, Len: 80
▼ OpenFlow 1.0
  .000 0001 = Version: 1.0 (0x01)
  Type: OFPT_FLOW_MOD (14)
  Length: 80
  Transaction ID: 20
  Wildcards: 3678462
  In port: 2
  Ethernet source address: 00:00:00_00:00:00 (00:00:00:00:00:00)
  Ethernet destination address: 00:00:00_00:00:00 (00:00:00:00:00:00)
  Input VLAN id: 65535
  Input VLAN priority: 0
  Pad: 00
  Dl type: 0
  IP ToS: 0
  IP protocol: 0
  Pad: 0000
  Source Address: 0.0.0.0
  Destination Address: 0.0.0.0
  Source Port: 0
  Destination Port: 0
  Cookie: 0x2b00000000000010
  Command: New flow (0)
  Idle time-out: 0
  hard time-out: 0
  Priority: 2
  Buffer Id: 0xffffffff
  Out port: 65535
  Flags: 0
```

```
> Ethernet II, Src: Vmware_44:f0:0c (00:0c:29:44:f0:0c), Dst: Vmware_69:36:bc (00:0c:29:69:36:bc)
> Internet Protocol Version 4, Src: 192.168.20.51, Dst: 192.168.20.55
> Transmission Control Protocol, Src Port: 6633, Dst Port: 38116, Seq: 1096, Ack: 34991, Len: 88
  OpenFlow 1.0
    .000 0001 = Version: 1.0 (0x01)
    Type: OFPT_FLOW_MOD (14)
    Length: 88
    Transaction ID: 21
    Wildcards: 3678462
    In port: 1
    Ethernet source address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Ethernet destination address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Input VLAN id: 65535
    Input VLAN priority: 0
    Pad: 00
    D1 type: 0
    IP ToS: 0
    IP protocol: 0
    Pad: 0000
    Source Address: 0.0.0.0
    Destination Address: 0.0.0.0
    Source Port: 0
    Destination Port: 0
    Cookie: 0x2b00000000000011
    Command: New flow (0)
    Idle time-out: 0
    hard time-out: 0
    Priority: 2
    Buffer Id: 0xffffffff
    Out port: 65535
    Flags: 0
```

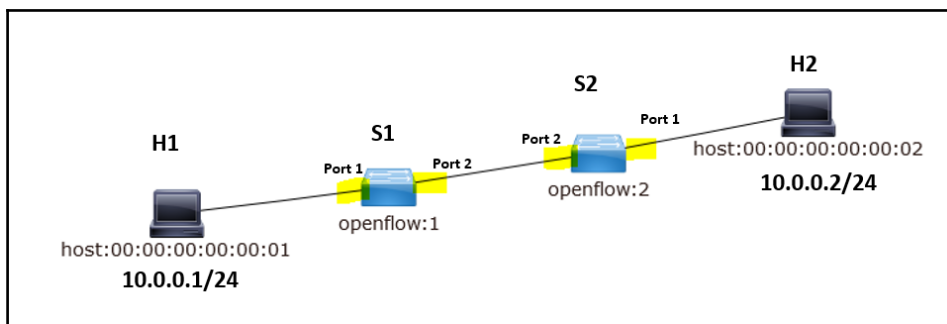
```
> Ethernet II, Src: Vmware_44:f0:0c (00:0c:29:44:f0:0c), Dst: Vmware_69:36:bc (00:0c:29:69:36:bc)
> Internet Protocol Version 4, Src: 192.168.20.51, Dst: 192.168.20.55
> Transmission Control Protocol, Src Port: 6633, Dst Port: 38115, Seq: 1101, Ack: 34899, Len: 88
  OpenFlow 1.0
    .000 0001 = Version: 1.0 (0x01)
    Type: OFPT_FLOW_MOD (14)
    Length: 88
    Transaction ID: 20
    Wildcards: 3678462
    In port: 1
    Ethernet source address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Ethernet destination address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Input VLAN id: 65535
    Input VLAN priority: 0
    Pad: 00
    Dl type: 0
    IP ToS: 0
    IP protocol: 0
    Pad: 0000
    Source Address: 0.0.0.0
    Destination Address: 0.0.0.0
    Source Port: 0
    Destination Port: 0
    Cookie: 0x2b00000000000012
    Command: New flow (0)
    Idle time-out: 0
    hard time-out: 0
    Priority: 2
    Buffer Id: 0xffffffff
    Out port: 65535
    Flags: 0
```



```

> Ethernet II, Src: Vmware_44:f0:0c (00:0c:29:44:f0:0c), Dst: Vmware_69:36:bc (00:0c:29:69:36:bc)
> Internet Protocol Version 4, Src: 192.168.20.51, Dst: 192.168.20.55
> Transmission Control Protocol, Src Port: 6633, Dst Port: 38115, Seq: 1189, Ack: 34899, Len: 80
  OpenFlow 1.0
    .000 0001 = Version: 1.0 (0x01)
    Type: OFPT_FLOW_MOD (14)
    Length: 80
    Transaction ID: 21
    Wildcards: 3678462
    In port: 2
    Ethernet source address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Ethernet destination address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Input VLAN id: 65535
    Input VLAN priority: 0
    Pad: 00
    D1 type: 0
    IP ToS: 0
    IP protocol: 0
    Pad: 0000
    Source Address: 0.0.0.0
    Destination Address: 0.0.0.0
    Source Port: 0
    Destination Port: 0
    Cookie: 0x2b00000000000013
    Command: New flow (0)
    Idle time-out: 0
    hard time-out: 0
    Priority: 2
    Buffer Id: 0xffffffff
    Out port: 65535
    Flags: 0

```



```
mininet> net
h1 h1-eth0:s1-eth1
h2 h2-eth0:s2-eth1
s1 lo: s1-eth1:h1-eth0 s1-eth2:s2-eth2
s2 lo: s2-eth1:h2-eth0 s2-eth2:s1-eth2
c0
mininet> █
```

```
mininet> links
h1-eth0<->s1-eth1 (OK OK)
h2-eth0<->s2-eth1 (OK OK)
s2-eth2<->s1-eth2 (OK OK)
mininet> █
```

```
mininet> nodes
available nodes are:
c0 h1 h2 s1 s2
mininet> █
```

```
mininet> dump
<Host h1: h1-eth0:10.0.0.1 pid=19436>
<Host h2: h2-eth0:10.0.0.2 pid=19439>
<OVSSwitch s1: lo:127.0.0.1,s1-eth1:None,s1-eth2:None pid=19444>
<OVSSwitch s2: lo:127.0.0.1,s2-eth1:None,s2-eth2:None pid=19447>
<RemoteController{'ip': '192.168.20.51'} c0: 192.168.20.51:6633 pid=19430>
mininet> █
```

```
mininet> h1 ifconfig
*** errRun: ['stty', '-icanon', 'min', '1']
0h1-eth0  Link encap:Ethernet  HWaddr 00:00:00:00:00:01
          inet addr:10.0.0.1  Bcast:10.255.255.255  Mask:255.0.0.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo       Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

mininet> █
```

```
mininet> h1 ping h2
*** errRun: ['stty', '-icanon', 'min', '1']
  OPING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=0.169 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.155 ms
^CsendInt: writing chr(3)
```

```
--- 10.0.0.2 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 0.155/0.162/0.169/0.007 ms
mininet> █
```

```
Omininet> pingall
*** Ping: testing ping reachability
h1 -> *** h1: ('ping -c1 10.0.0.2',)
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=0.268 ms

--- 10.0.0.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.268/0.268/0.268/0.000 ms
h2
h2 -> *** h2: ('ping -c1 10.0.0.1',)
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.
64 bytes from 10.0.0.1: icmp_seq=1 ttl=64 time=0.144 ms

--- 10.0.0.1 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.144/0.144/0.144/0.000 ms
h1
*** Results: 0% dropped (2/2 received)
mininet> █
```

```
mininet> pingpair
h1 -> *** h1: ('ping -c1 10.0.0.2',)
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=0.383 ms

--- 10.0.0.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.383/0.383/0.383/0.000 ms
h2
h2 -> *** h2: ('ping -c1 10.0.0.1',)
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.
64 bytes from 10.0.0.1: icmp_seq=1 ttl=64 time=0.127 ms

--- 10.0.0.1 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.127/0.127/0.127/0.000 ms
h1
*** Results: 0% dropped (2/2 received)
mininet> █
```

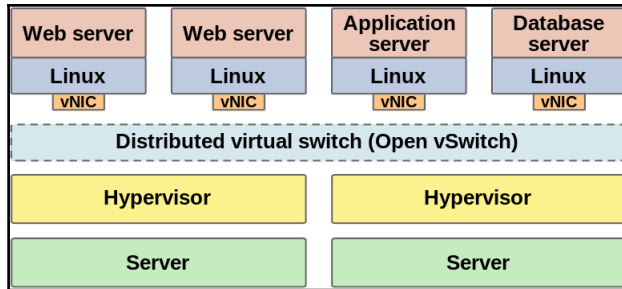
```
mininet> h1 python -m SimpleHTTPServer 80 &
mininet> h2 wget -O - -h1
--2016-12-19 19:23:46-- http://10.0.0.1/
Connecting to 10.0.0.1:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 802 [text/html]
Saving to: 'STDOUT'

 0% [          ] 0           --.-K/s
<title>Directory listing for /</title>
<body>
<h2>Directory listing for /</h2>
<hr>
<ul>
<li><a href=".bash_history">.bash_history</a>
<li><a href=".bash_logout">.bash_logout</a>
<li><a href=".bashrc">.bashrc</a>
<li><a href=".cache/">.cache/</a>
<li><a href=".gitconfig">.gitconfig</a>
<li><a href=".mininet_history">.mininet_history</a>
<li><a href=".profile">.profile</a>
<li><a href=".rnd">.rnd</a>
<li><a href=".wireshark/">.wireshark/</a>
<li><a href="install-mininet-vm.sh">install-mininet-vm.sh</a>
<li><a href="loxigen/">loxigen/</a>
<li><a href="mininet/">mininet/</a>
<li><a href="oflops/">oflops/</a>
<li><a href="oftest/">oftest/</a>
<li><a href="openflow/">openflow/</a>
<li><a href="pox/">pox/</a>
</ul>
<hr>
</body>
</html>
100%[=====] 802           --.-K/s   in 0s
2016-12-19 19:23:46 (171 MB/s) - written to stdout [802/802]
mininet> █
```

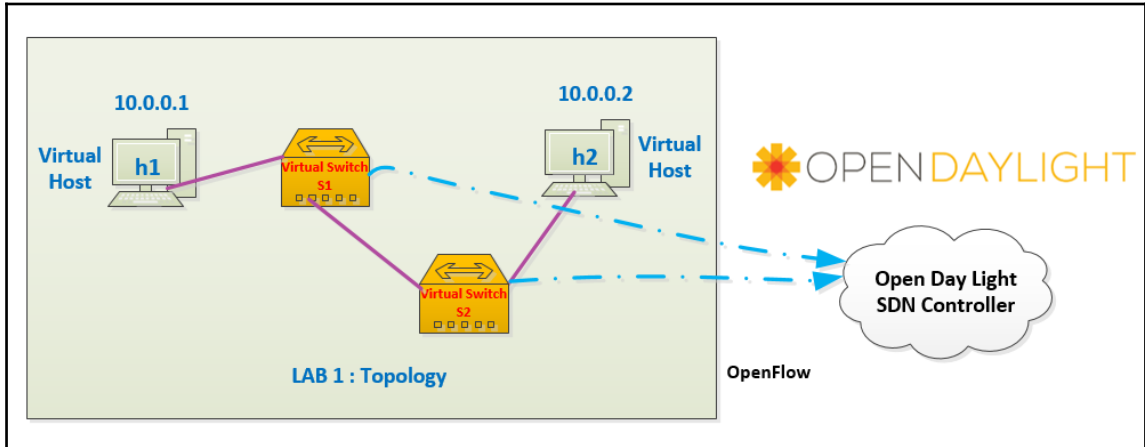
```

mininet> dpctl dump-flows
*** s1 : ('ovs-ofctl', 'dump-flows', <OVSSwitch s1: lo:127.0.0.1,s1-eth1:None,s1-eth2:None pid=20685> )
NXST_FLOW reply (xid=0x4):
  cookie=0x2b0000000000000b, duration=927.436s, table=0, n_packets=4, n_bytes=280, idle_age=920, priority=2,in_port=1 actions=output:2,CONTRO
R:65535
  cookie=0x2b0000000000000a, duration=927.436s, table=0, n_packets=4, n_bytes=280, idle_age=920, priority=2,in_port=2 actions=output:1
  cookie=0x2b00000000000006, duration=930.441s, table=0, n_packets=186, n_bytes=15810, idle_age=1, priority=100,d1_type=0x88cc actions=CONTRO
R:65535
  cookie=0x2b00000000000006, duration=930.441s, table=0, n_packets=0, n_bytes=0, idle_age=930, priority=0 actions=drop
  cookie=0x2b0000000000000b, duration=927.436s, table=0, n_packets=4, n_bytes=280, idle_age=920, priority=2,in_port=1 actions=output:2,CONTRO
R:65535
  cookie=0x2b0000000000000a, duration=927.436s, table=0, n_packets=4, n_bytes=280, idle_age=920, priority=2,in_port=2 actions=output:1
  cookie=0x2b00000000000006, duration=930.441s, table=0, n_packets=186, n_bytes=15810, idle_age=1, priority=100,d1_type=0x88cc actions=CONTRO
R:65535
  cookie=0x2b00000000000006, duration=930.441s, table=0, n_packets=0, n_bytes=0, idle_age=930, priority=0 actions=drop
*** s2 : ('ovs-ofctl', 'dump-flows', <OVSSwitch s2: lo:127.0.0.1,s2-eth1:None,s2-eth2:None pid=20688> )
NXST_FLOW reply (xid=0x4):
  cookie=0x2b0000000000000c, duration=927.439s, table=0, n_packets=4, n_bytes=280, idle_age=920, priority=2,in_port=1 actions=output:2,CONTRO
R:65535
  cookie=0x2b0000000000000d, duration=927.439s, table=0, n_packets=4, n_bytes=280, idle_age=920, priority=2,in_port=2 actions=output:1
  cookie=0x2b00000000000005, duration=933.378s, table=0, n_packets=187, n_bytes=15895, idle_age=1, priority=100,d1_type=0x88cc actions=CONTRO
R:65535
  cookie=0x2b00000000000005, duration=933.376s, table=0, n_packets=0, n_bytes=0, idle_age=933, priority=0 actions=drop
  cookie=0x2b0000000000000c, duration=927.439s, table=0, n_packets=4, n_bytes=280, idle_age=920, priority=2,in_port=1 actions=output:2,CONTRO
R:65535
  cookie=0x2b0000000000000d, duration=927.439s, table=0, n_packets=4, n_bytes=280, idle_age=920, priority=2,in_port=2 actions=output:1
  cookie=0x2b00000000000005, duration=933.378s, table=0, n_packets=187, n_bytes=15895, idle_age=1, priority=100,d1_type=0x88cc actions=CONTRO
R:65535
  cookie=0x2b00000000000005, duration=933.376s, table=0, n_packets=0, n_bytes=0, idle_age=933, priority=0 actions=drop
mininet>

```

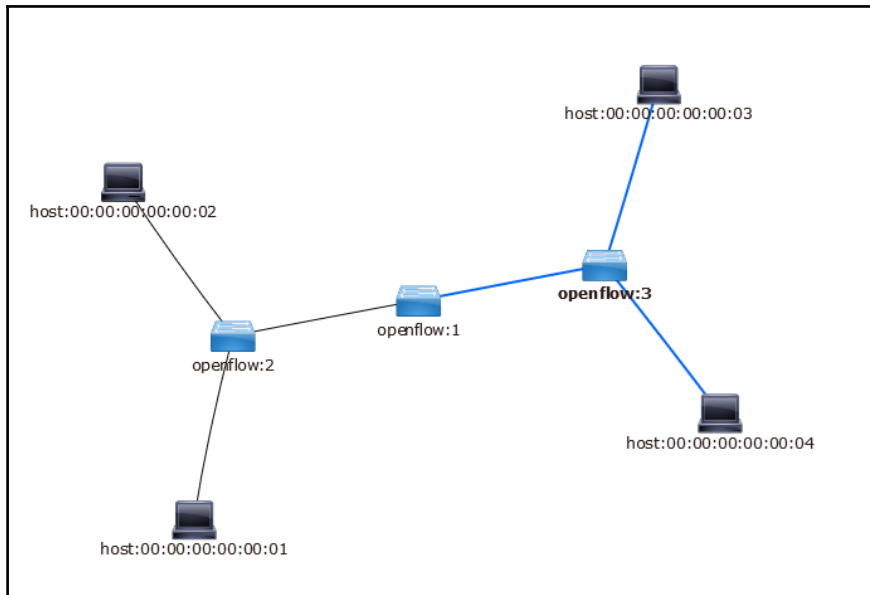
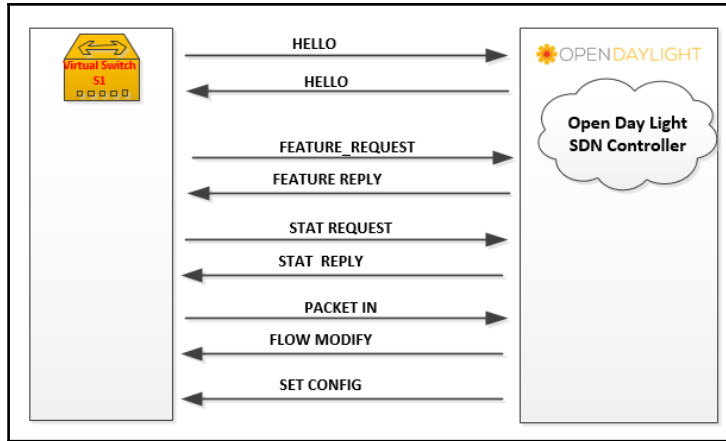


Chapter 5: Basic Networking with OpenDaylight



```

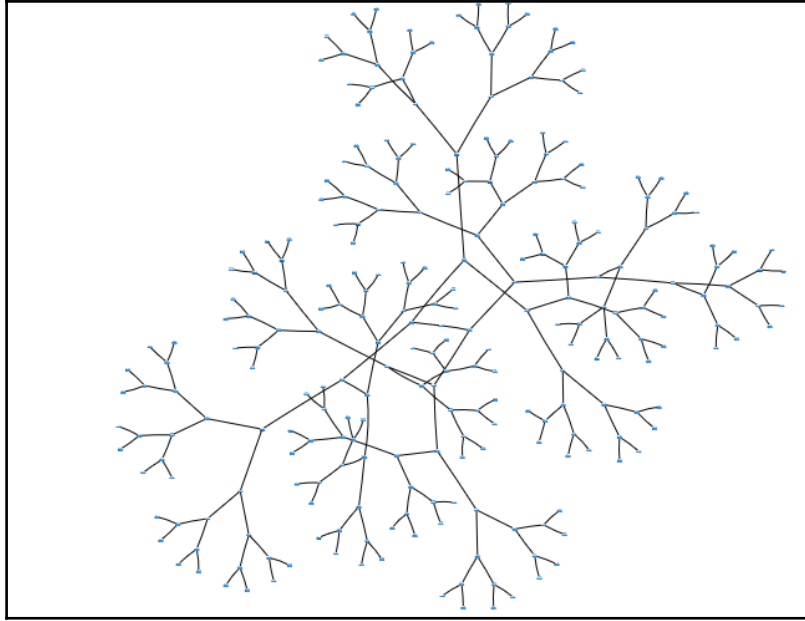
tearningod1@ODL01:~$ netstat -ln
Active Internet connections (only servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 0.0.0.0:22              0.0.0.0:*               LISTEN
tcp6       0      0 :::8080                  :::*                     LISTEN
tcp6       0      0 :::8181                  :::*                     LISTEN
tcp6       0      0 :::22                    :::*                     LISTEN
tcp6       0      0 127.0.0.1:2550          :::*                     LISTEN
tcp6       0      0 :::8185                  :::*                     LISTEN
tcp6       0      0 :::44378                 :::*                     LISTEN
tcp6       0      0 :::44444                 :::*                     LISTEN
tcp6       0      0 :::6653                  :::*                     LISTEN
tcp6       0      0 :::42719                 :::*                     LISTEN
tcp6       0      0 127.0.0.1:42655        :::*                     LISTEN
tcp6       0      0 :::8101                  :::*                     LISTEN
tcp6       0      0 0:::6633                 :::*                     LISTEN
tcp6       0      0 :::1099                  :::*                     LISTEN
Active UNIX domain sockets (only servers)
Proto RefCnt Flags               Type           State         I-Node      Path
unix   2      [ ACC ]                STREAM        LISTENING     14323       /run/user/1001/systemd/private
unix   2      [ ACC ]                SEQPACKET    LISTENING     11180       /run/udev/control
unix   2      [ ACC ]                STREAM        LISTENING     11174       /run/systemd/private
unix   2      [ ACC ]                STREAM        LISTENING     11191       /run/systemd/journal/stdout
unix   2      [ ACC ]                STREAM        LISTENING     11204       /run/systemd/ftsck.progress
unix   2      [ ACC ]                STREAM        LISTENING     13768       /run/uidm/request
unix   2      [ ACC ]                STREAM        LISTENING     16563       /var/run/dbus/system_bus_socket
unix   2      [ ACC ]                STREAM        LISTENING     13767       /var/lib/1xd/unix.socket
tearningod1@ODL01:~$
  
```

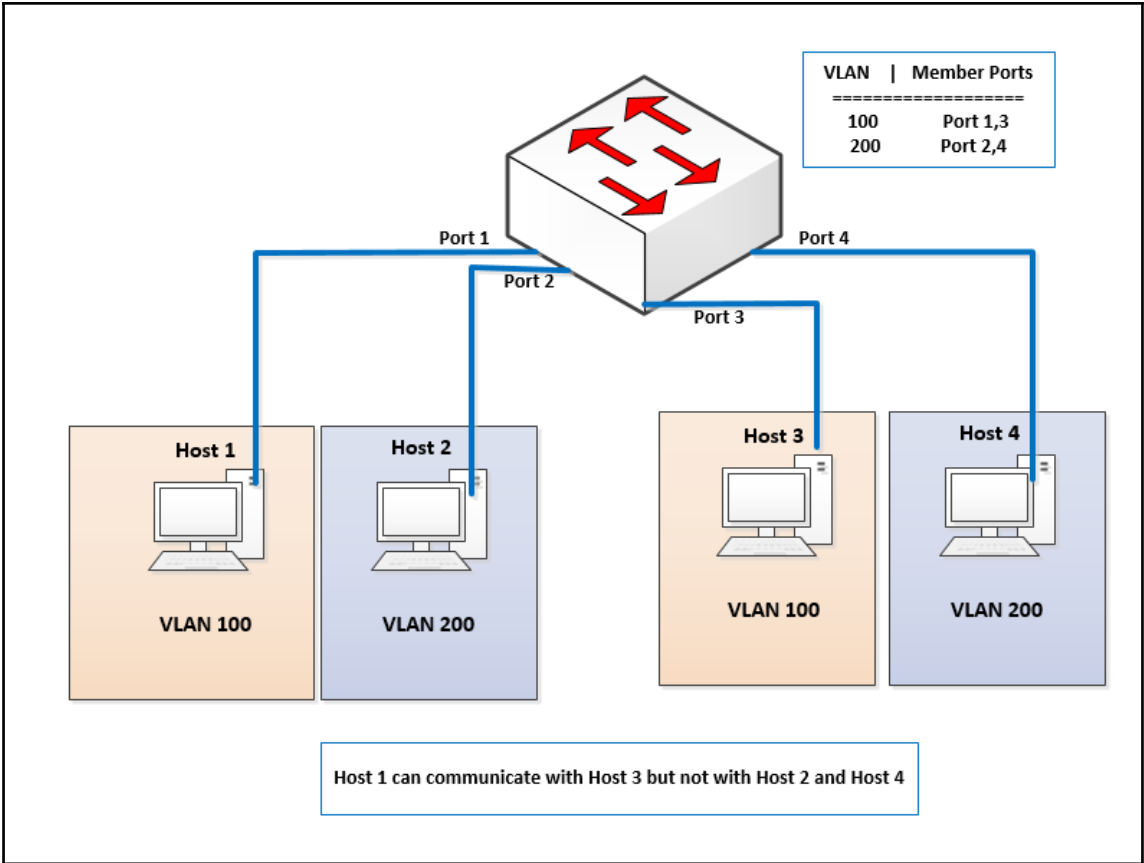


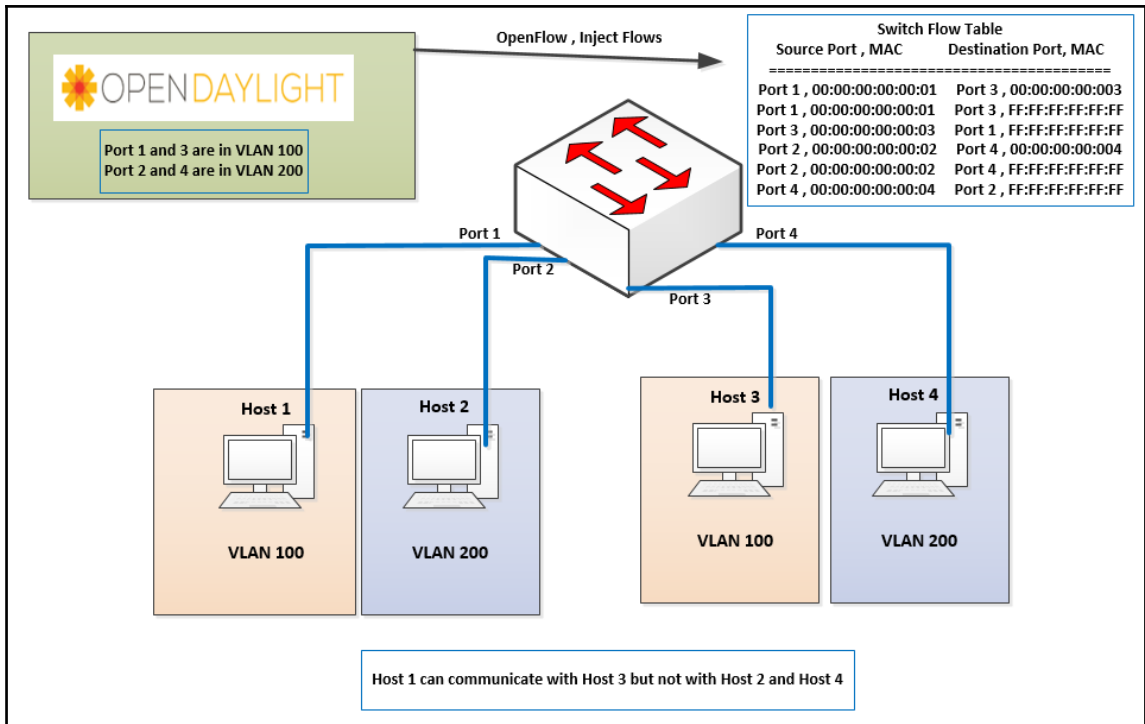
```

mininet> pingall
*** Ping: testing ping reachability
h1 -> h2 h3 h4
h2 -> h1 h3 h4
h3 -> h1 h2 h4
h4 -> h1 h2 h3
*** Results: 0% dropped (12/12 received)
mininet> █
  
```

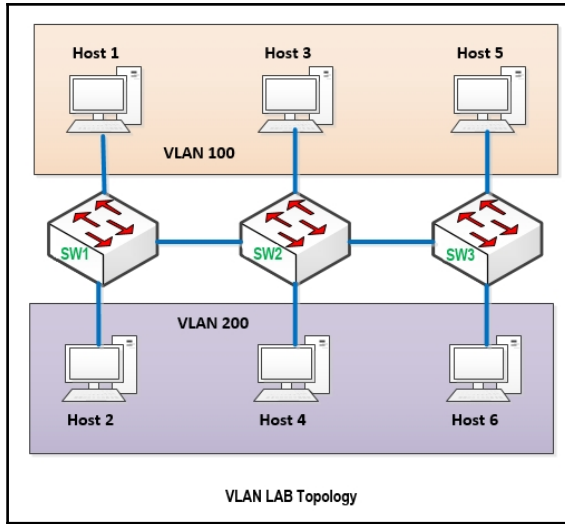
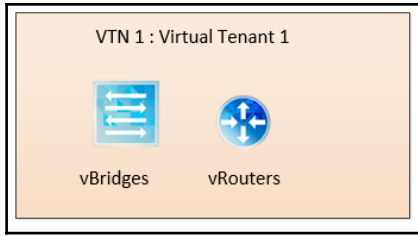
```
> Ethernet II, Src: Vmware_44:f0:0c (00:0c:29:44:f0:0c), Dst: Vmware_69:36:bc (00:0c:29:69:36:bc)
> Internet Protocol Version 4, Src: 192.168.20.51, Dst: 192.168.20.55
> Transmission Control Protocol, Src Port: 6633, Dst Port: 36652, Seq: 1399, Ack: 19955, Len: 160
  OpenFlow 1.0
    .000 0001 = Version: 1.0 (0x01)
    Type: OFPT_FLOW_MOD (14)
    Length: 80
    Transaction ID: 21
    Wildcards: 3678451
    In port: 0
    Ethernet source address: 00:00:00_00:00:03 (00:00:00:00:00:03)
    Ethernet destination address: 00:00:00_00:00:04 (00:00:00:00:00:04)
    Input VLAN id: 65535
    Input VLAN priority: 0
    Pad: 00
    D1 type: 0
    IP ToS: 0
    IP protocol: 0
    Pad: 0000
    Source Address: 0.0.0.0
    Destination Address: 0.0.0.0
    Source Port: 0
    Destination Port: 0
    Cookie: 0x2a000000000000c8
    Command: New flow (0)
    Idle time-out: 1800
    hard time-out: 3600
    Priority: 10
    Buffer Id: 0xffffffff
    Out port: 65535
    Flags: 0
```

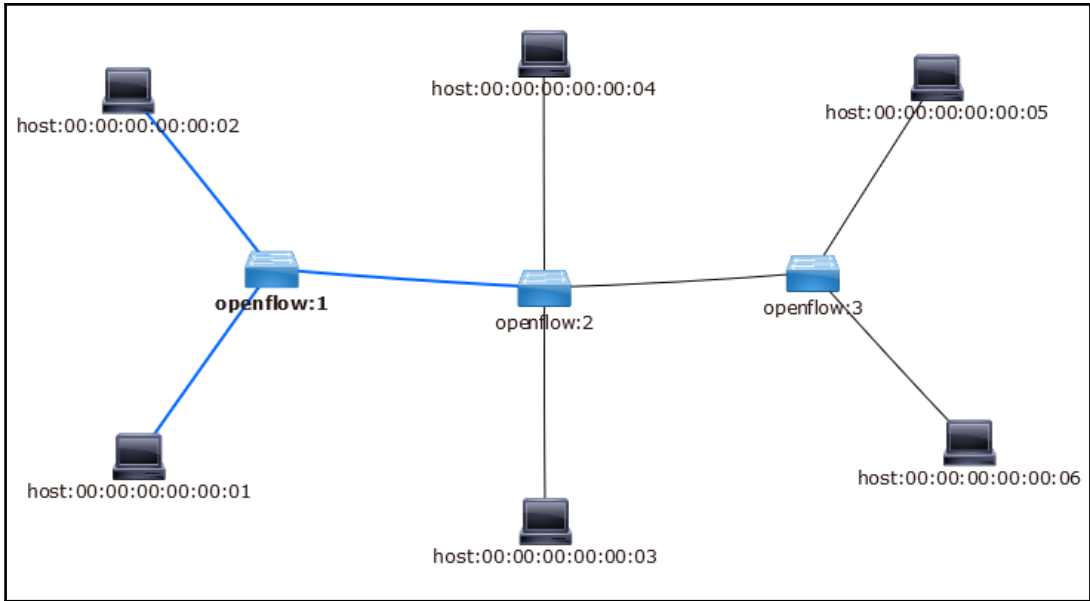







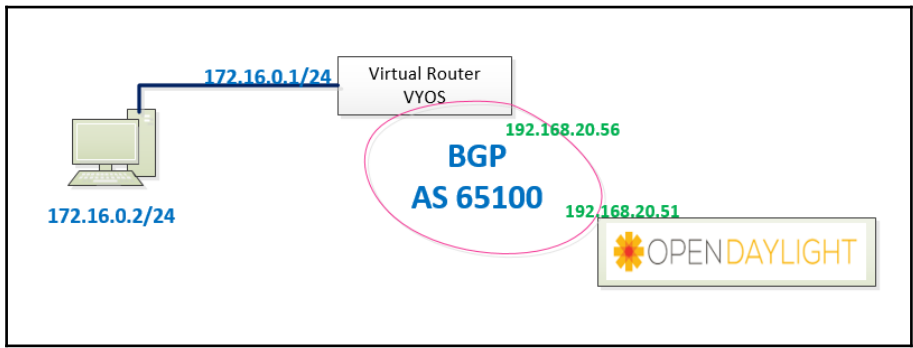
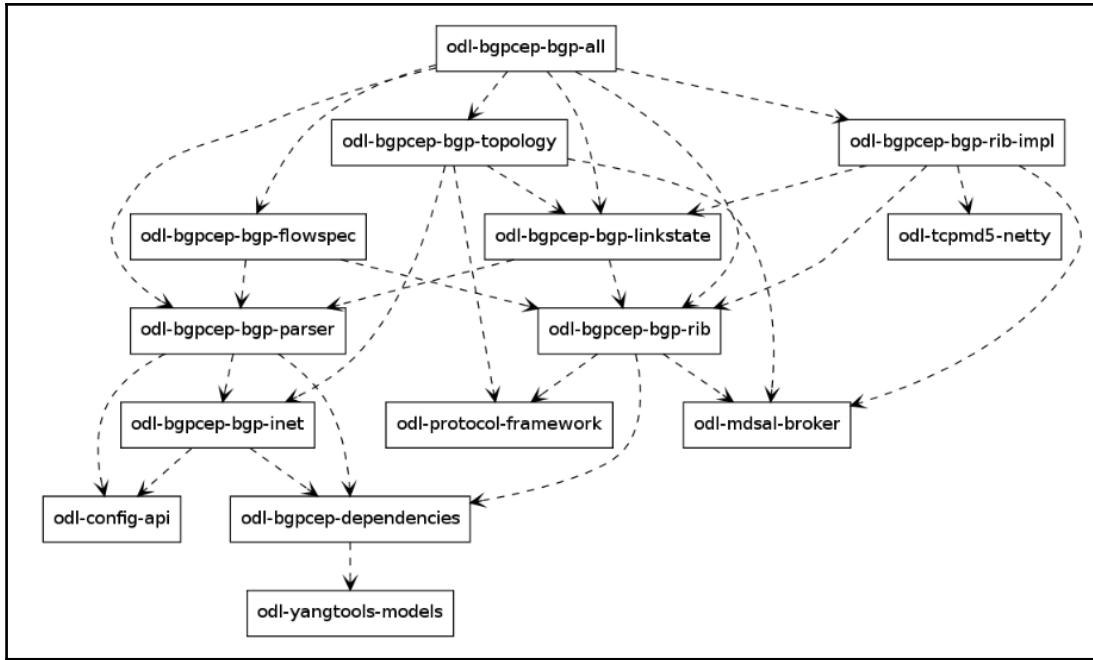
Name of element	Description	
Virtual node	vBridge	Logical representation of an L2 switch function
	vRouter	Logical representation of a router function
	vTep	Logical representation of Tunnel End Point (TEP)
	vTunnel	Logical representation of Tunnel
	vBypass	Logical representation of the connectivity between controlled networks
Virtual interface	interface	Representation of an endpoint on the virtual node
Virtual link	vLink	Logical representation of L1 connectivity between virtual interfaces





The screenshot shows the Postman Builder interface. The top bar includes 'Runner', 'Import', and 'Builder' tabs. The main area displays a REST client request configuration. The request is a GET to `http://192.168.20.51:8181/restconf/operations/vtn-version:get-manager-version`. The 'Authorization' tab is active, showing 'Basic Auth' with 'Username' 'admin' and 'Password' '*****'. The 'Body' tab shows a JSON error response:

```
1- {
2-   "errors": {
3-     "error": {
4-       "error-type": "protocol",
5-       "error-tag": "invalid-value",
6-       "error-message": "URI has bad format. If operations behind mount point should be showed, URI has to end with yang-ext:mount"
7-     }
8-   }
9- }
10-
11- }
```



Builder Team Library

controller

GET `http://192.168.20.51:8181/r/`

GET `http://192.168.20.51:8181/r/example-bgp-rib`

Params Send Save

Body Cookies Headers (6) Tests Status: 200 OK Time: 82 ms

Pretty Raw Preview JSON Save Response

```

191     "afi": "bgp-types:ipv4-address-family",
192     "safI": "bgp-types:unicast-subsequent-address-family",
193     "bgp-inet-ipv4-routes": {},
194     "attributes": {}
195   },
196   },
197   },
198   "peer-role": "ibgp",
199   "adj-rtb-tn": {
200     "tables": [
201       {
202         "afi": "bgp-types:ipv4-address-family",
203         "safI": "bgp-types:unicast-subsequent-address-family",
204         "bgp-inet-ipv4-routes": {
205           "ipv4-route": [
206             {
207               "path-id": 0,
208               "prefix": "192.16.0.0/24",
209               "attributes": {
210                 "ipv4-next-hop": {
211                   "global": "192.168.20.56"
212                 },
213                 "origin": {
214                   "value": "igp"
215                 },
216                 "multi-exit-disc": {
217                   "med": 1
218                 },
219                 "as-path": {},
220                 "local-pref": {
221                   "pref": 100
222                 }
223               }
224             }
225           ]
226         }
227       }
228     ],
229     "attributes": {
230       "update": true
231     }
232   }
233 ]

```

GET `http://192.168.20.51:8181/auth/v1/users`

Params Send

Authorization Headers (1) Body Pre-request Script Tests

Authorization Basic YWRtaW46YWRtaW4= Bulk Edit

key value

Body Cookies Headers (4) Tests Status: 200 OK

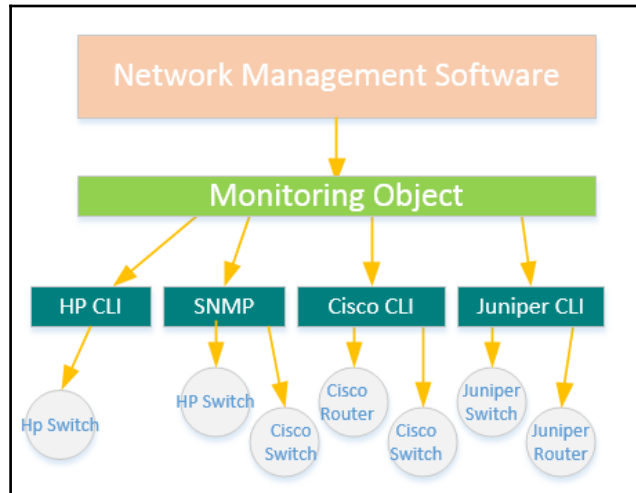
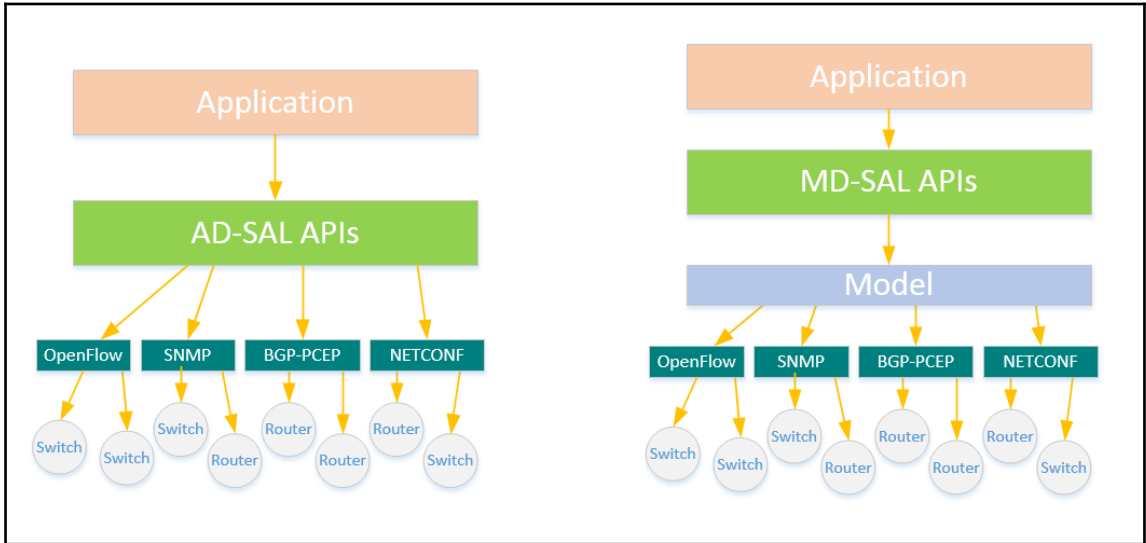
Pretty Raw Preview JSON

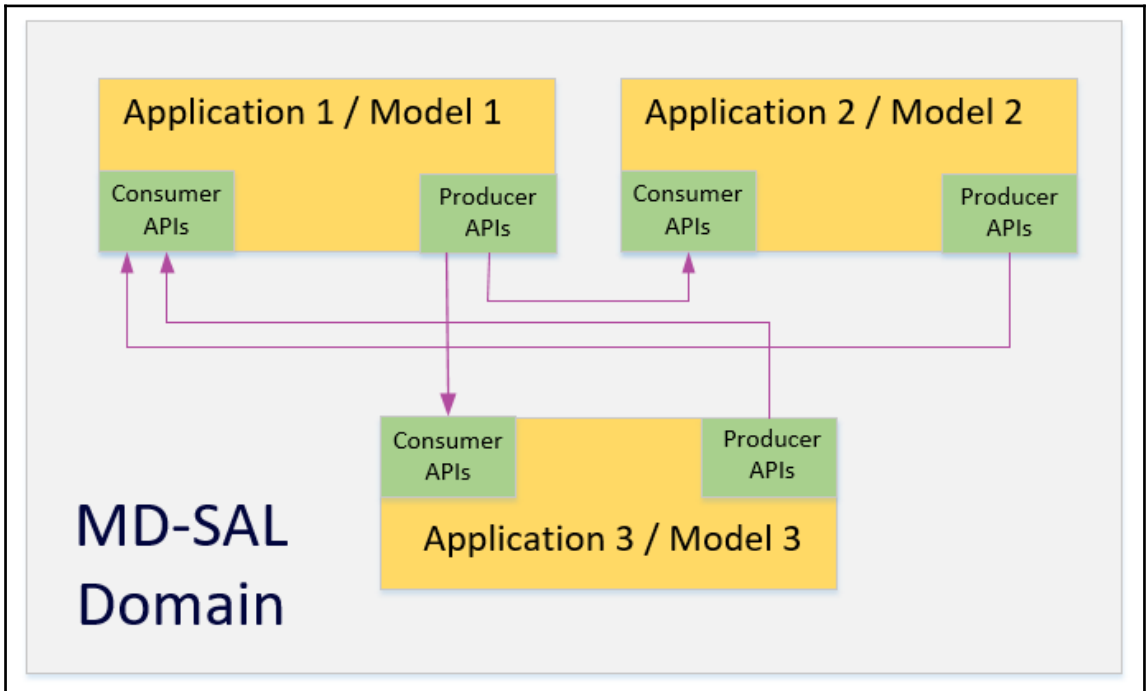
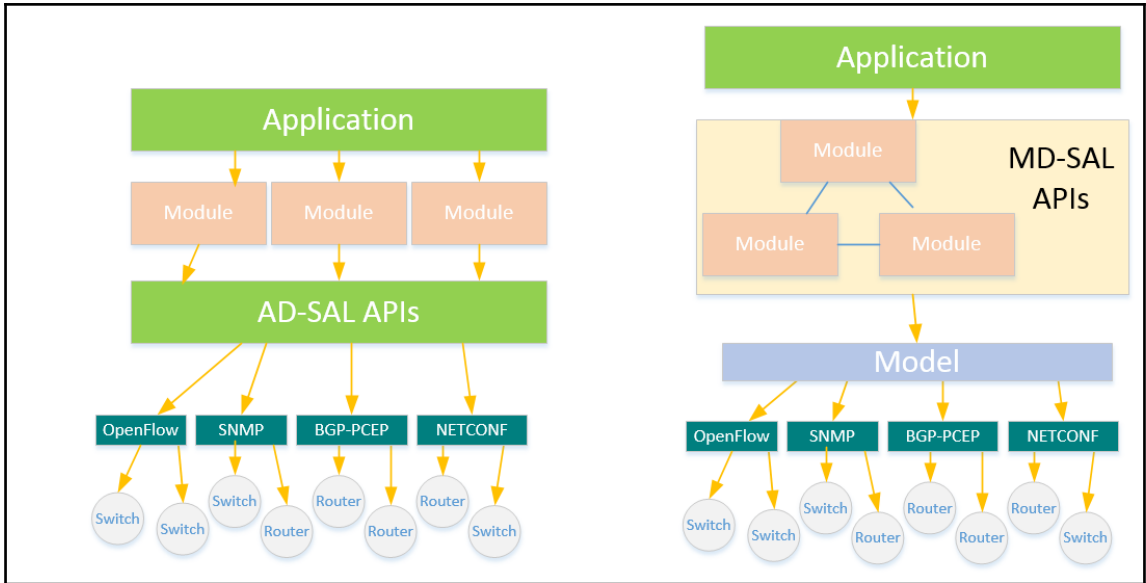
```

1  [
2  {
3  {
4    "userid": "admtngsdn",
5    "name": "admtng",
6    "description": "admin user",
7    "enabled": true,
8    "email": "",
9    "password": "*****",
10   "salt": "*****",
11   "domainid": "sdn"
12   },
13   {
14     "userid": "user@sdn",
15     "name": "user",
16     "description": "user user",
17     "enabled": true,
18     "email": "",
19     "password": "*****",
20     "salt": "*****",
21     "domainid": "sdn"
22   }
23   }
24 ]

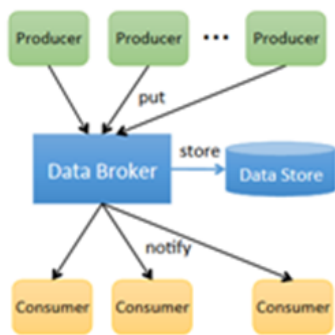
```

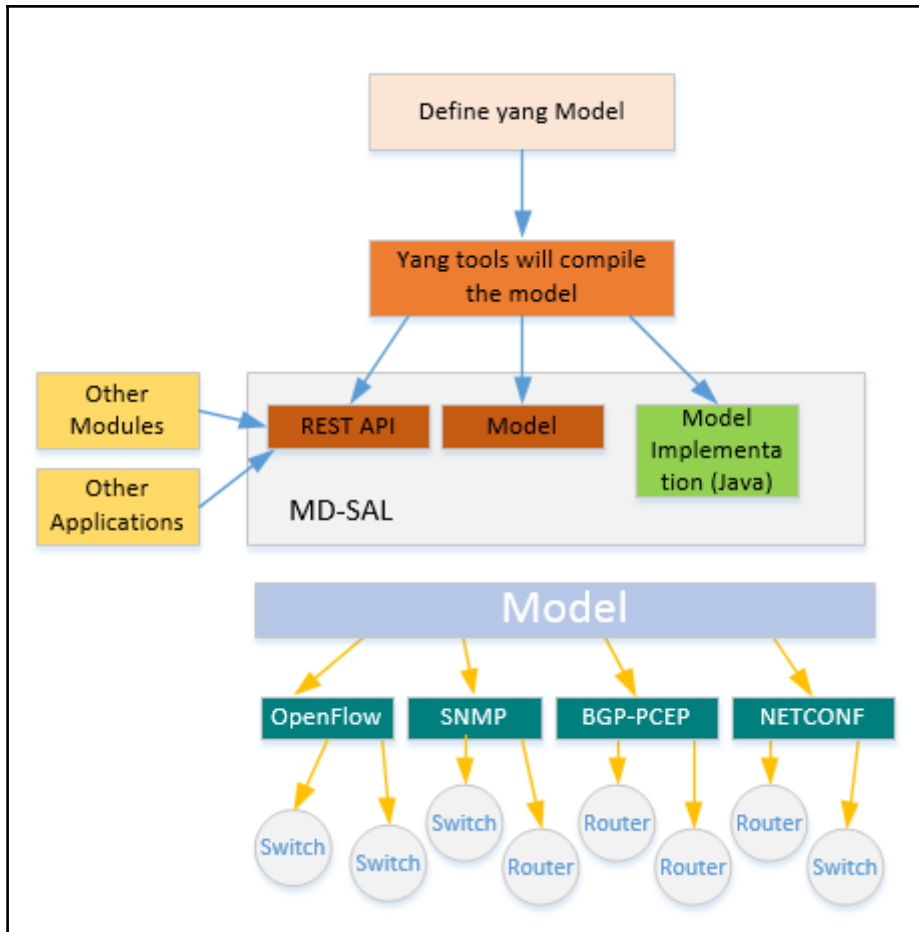
Chapter 6: Overview of OpenDaylight Applications





MD-SAL: The Brokers





```

learningodl@ODL01:~$ mvn archetype:generate "-DarchetypeGroupId=org.opendaylight.controller" "-Da
tps://nexus.opendaylight.org/content/repositories/public/" "-DarchetypeCatalog=https://nexus.open
Version=1.2.0-Boron"
[INFO] Scanning for projects...
[INFO] -----
[INFO] Building Maven Stub Project (No POM) 1
[INFO] -----
[INFO] >>> maven-archetype-plugin:3.0.0:generate (default-cli) > generate-sources @ standalone-po
[INFO] <<< maven-archetype-plugin:3.0.0:generate (default-cli) < generate-sources @ standalone-po
[INFO] --- maven-archetype-plugin:3.0.0:generate (default-cli) @ standalone-pom ---
[INFO] Generating project in Interactive mode
[INFO] No catalog defined. Using internal catalog
[WARNING] Archetype not found in any catalog. Falling back to central repository (http://repo.mav
[WARNING] Use -DarchetypeRepository=<your repository> if archetype's repository is elsewhere.
Define value for property 'groupId': org.opendaylight.example
Define value for property 'artifactId': example
[INFO] Using property: version = 0.1.0-SNAPSHOT
Define value for property 'package' org.opendaylight.example: ;
Define value for property 'classPrefix' Example: : ${artifactId.substring(0,1).toUpperCase()}${ar
Define value for property 'copyright': learningodl
[INFO] Using property: copyrightYear = 2016
Confirm properties configuration:
groupId: org.opendaylight.example
artifactId: example
version: 0.1.0-SNAPSHOT
package: org.opendaylight.example
classPrefix: ${artifactId.substring(0,1).toUpperCase()}${artifactId.substring(1)}
copyright: learningodl
copyrightYear: 2016
Y: : Y

```

```

[INFO] -----
[INFO] Using following parameters for creating project from Archetype:.opendaylight
[INFO] -----
[INFO] Parameter: groupId, Value: org.opendaylight.example
[INFO] Parameter: artifactId, Value: example
[INFO] Parameter: version, Value: 0.1.0-SNAPSHOT
[INFO] Parameter: package, Value: org.opendaylight.example
[INFO] Parameter: packageInPathFormat, Value: org/opendaylight/example
[INFO] Parameter: classPrefix, Value: Example
[INFO] Parameter: package, Value: org.opendaylight.example
[INFO] Parameter: version, Value: 0.1.0-SNAPSHOT
[INFO] Parameter: copyright, Value: learningodl
[INFO] Parameter: groupId, Value: org.opendaylight.example
[INFO] Parameter: artifactId, Value: example
[INFO] Parameter: copyrightYear, Value: 2016
[WARNING] Don't override file /home/learningodl/example/pom.xml
[INFO] Project created from Archetype in dir: /home/learningodl/example
[INFO] -----
[INFO] BUILD SUCCESS
[INFO] -----
[INFO] Total time: 31.502 s
[INFO] Finished at: 2017-05-18T14:01:17-07:00
[INFO] Final Memory: 16M/167M
[INFO] -----
learningodl@ODL01:~$ █


```

```
learningodl@ODL01:~$ cd example
learningodl@ODL01:~/example$ ls
api artifacts cli deploy-site.xml features impl it karaf pom.xml src
learningodl@ODL01:~/example$
```

```
ender er/resources/default-site=macros.vm
[INFO]
[INFO] --- maven-site-plugin:3.5.1:attach-descriptor (generate-site) @ example-aggregator ---
[INFO]
[INFO] Reactor Summary:
[INFO]
[INFO] example-api ..... SUCCESS [01:22 min]
[INFO] example-impl ..... SUCCESS [ 36.386 s]
[INFO] example-cli ..... SUCCESS [ 36.794 s]
[INFO] example-features ..... SUCCESS [07:29 min]
[INFO] example-karaf ..... SUCCESS [01:39 min]
[INFO] example-artifacts ..... SUCCESS [ 3.384 s]
[INFO] example-it ..... SUCCESS [03:23 min]
[INFO] example ..... SUCCESS [01:13 min]
[INFO]
[INFO] BUILD SUCCESS
[INFO]
[INFO] Total time: 16:35 min
[INFO] Finished at: 2017-05-18T14:21:43-07:00
[INFO] Final Memory: 226M/721M
[INFO]
learningodl@ODL01:~/example$
```

```
learningodl@ODL01:~/example/karaf/target/assembly/bin$ ./karaf
Apache Karaf starting up. Press Enter to open the shell now...
100% [=====]

Karaf started in 51s. Bundle stats: 284 active, 284 total



Hit '<tab>' for a list of available commands
and '[cmd] --help' for help on a specific command.
Hit '<ctrl-d>' or type 'system:shutdown' or 'logout' to shutdown OpenDaylight.

opendaylight-user@root>log:display | grep Example
2017-05-18 14:23:43,640 | INFO | rint Extender: 2 | ExampleProvider | 169 - org
opendaylight.example.impl - 0.1.0.SNAPSHOT | ExampleProvider Session Initiated
```

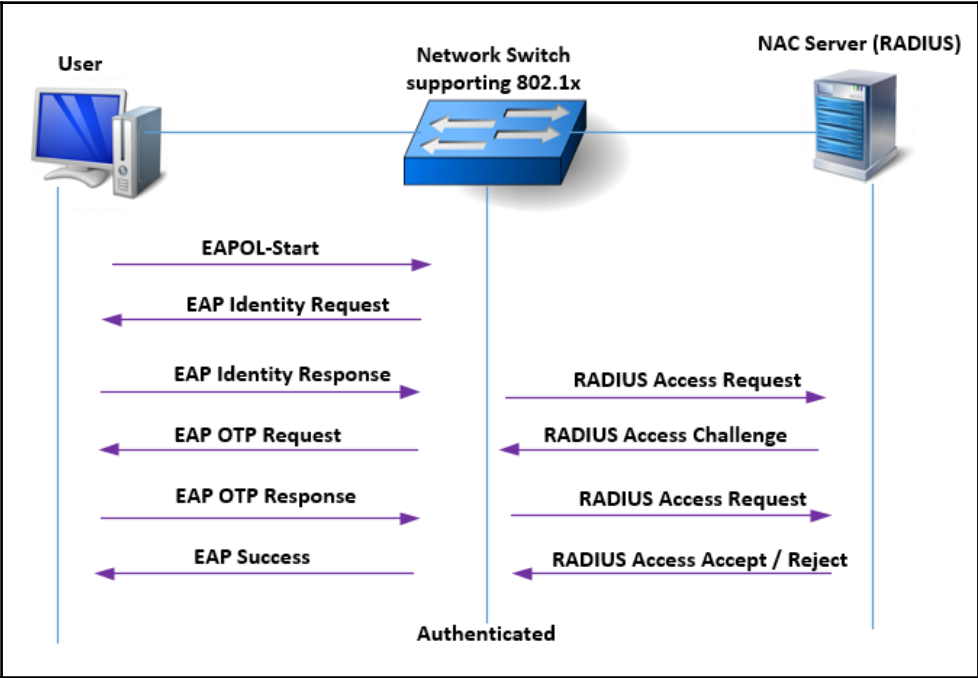
```
Karaf started in 19s. Bundle stats: 284 active, 284 total
```

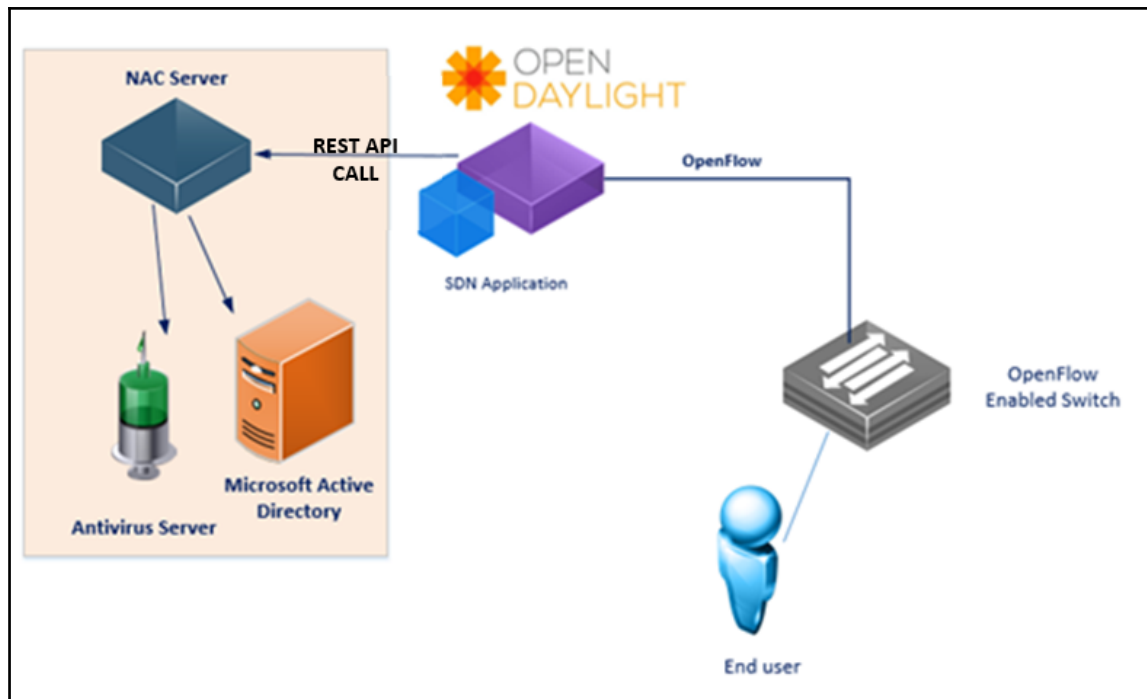


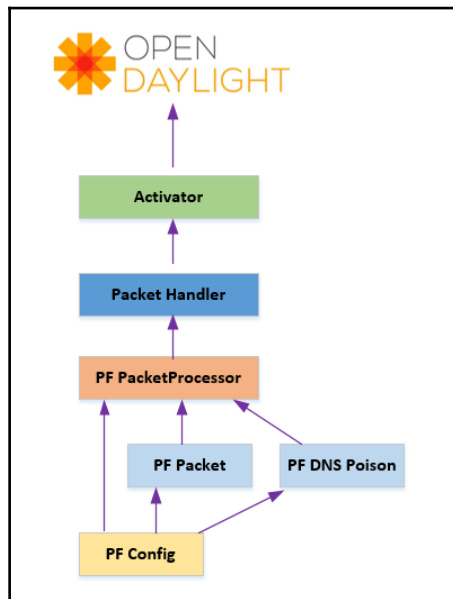
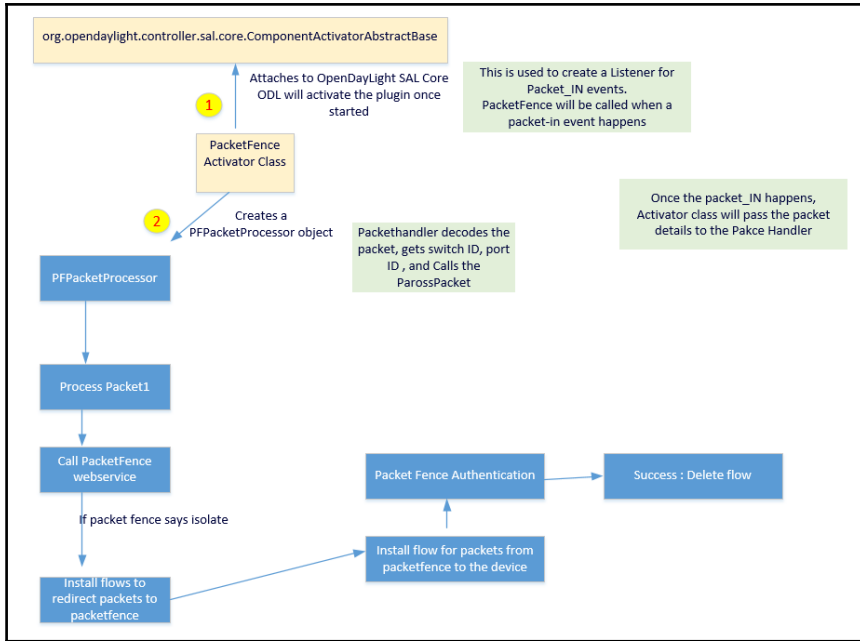
```
Hit '<tab>' for a list of available commands  
and '[cmd] --help' for help on a specific command.  
Hit '<ctrl-d>' or type 'system:shutdown' or 'logout' to shutdown OpenDaylight.
```

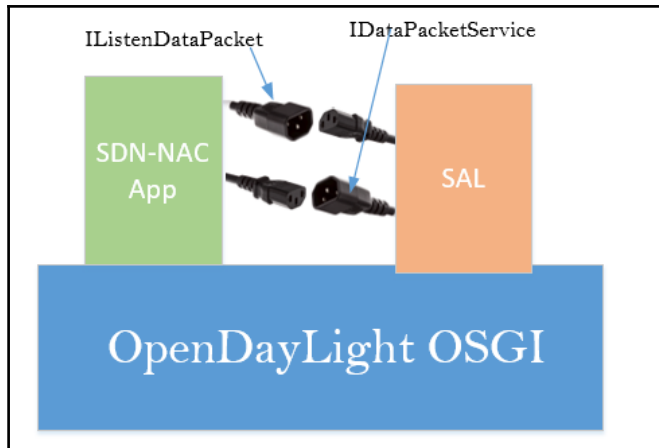
```
opendaylight-user@root>log:display | grep Example  
2017-03-21 15:16:49.435 | INFO | rint Extender: 2 | ExampleProvider | 169 - org.opendaylight.example.impl - 0.1.0.SNAPSHOT |  
ExampleProvider Session Initiated  
opendaylight-user@root>
```

Chapter 7: Building SDN Applications for OpenDaylight

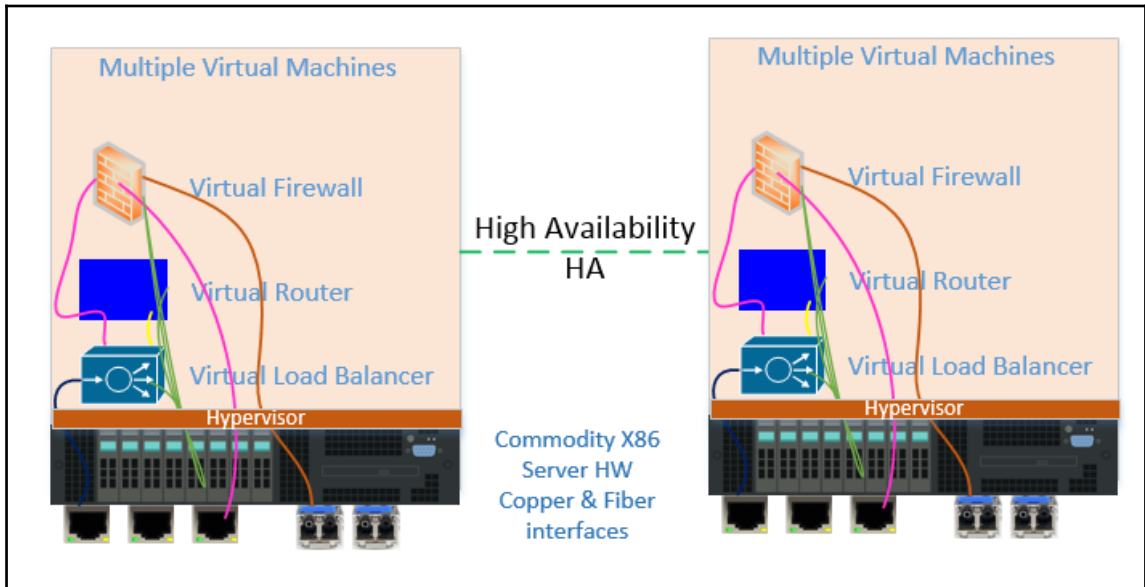


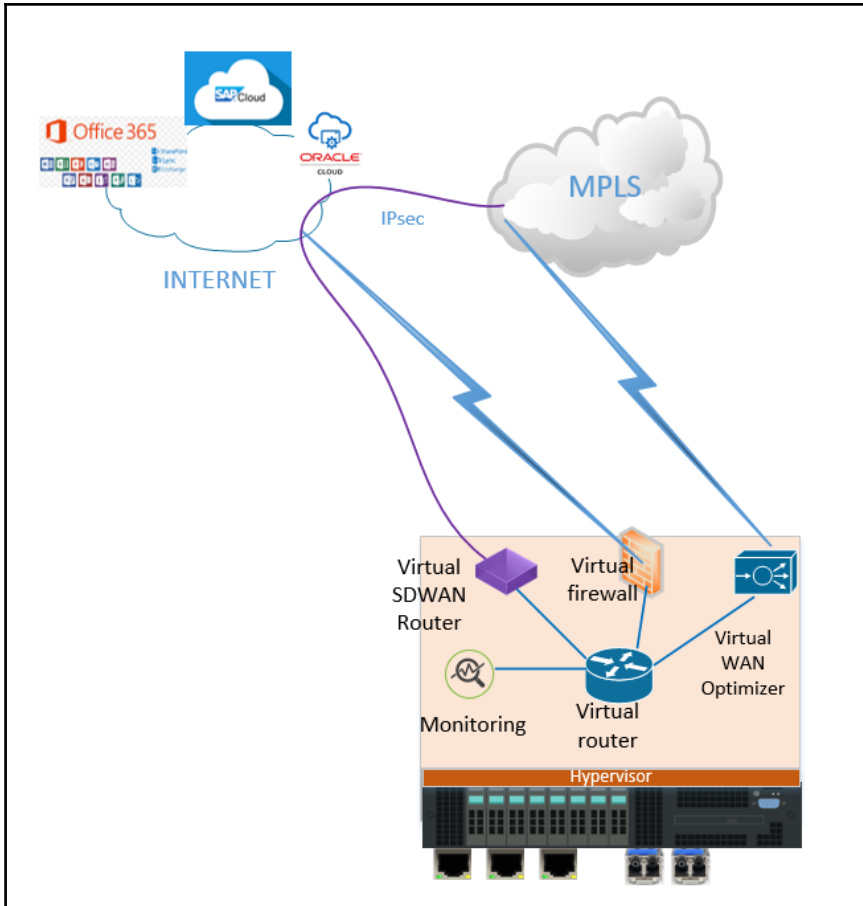


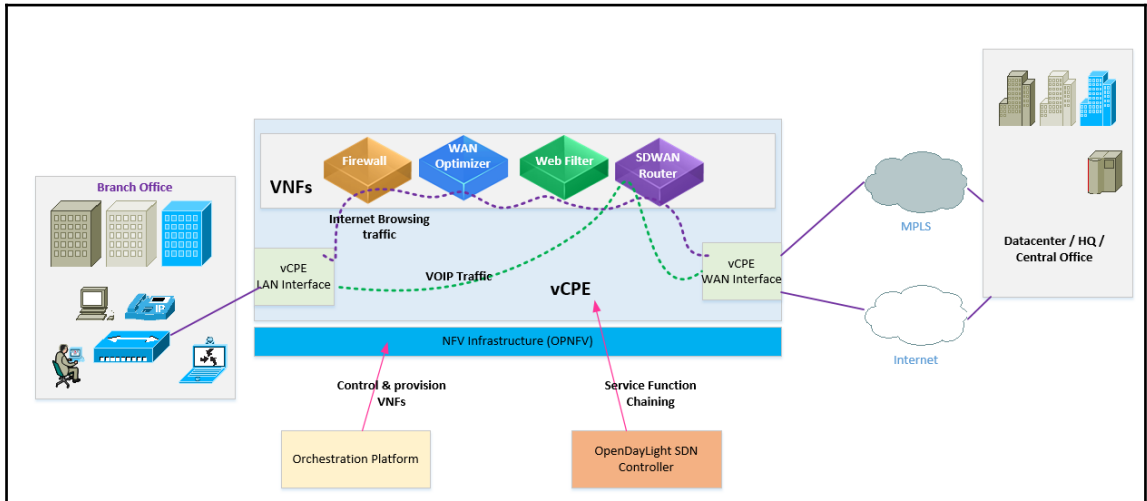
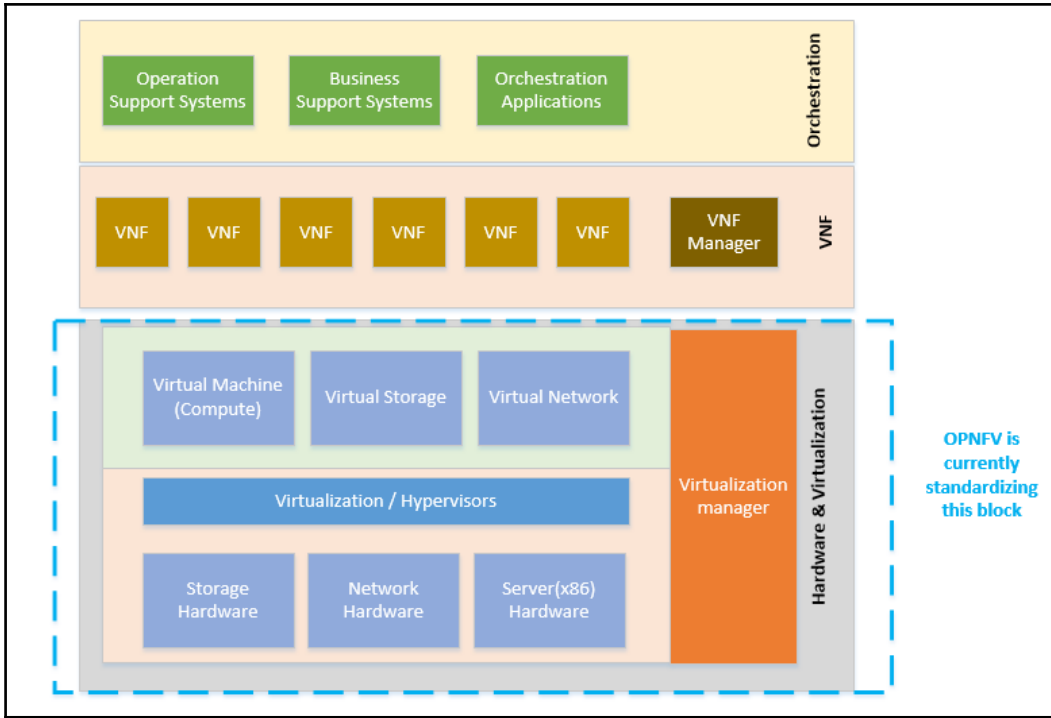


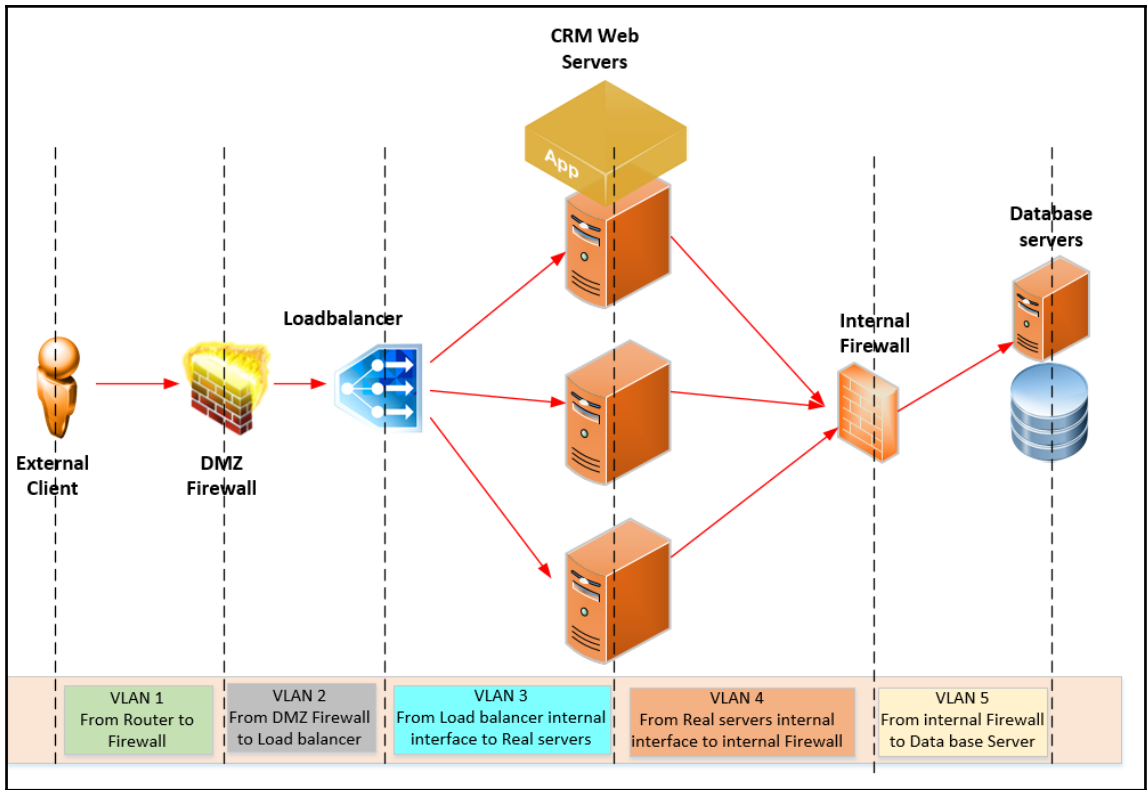


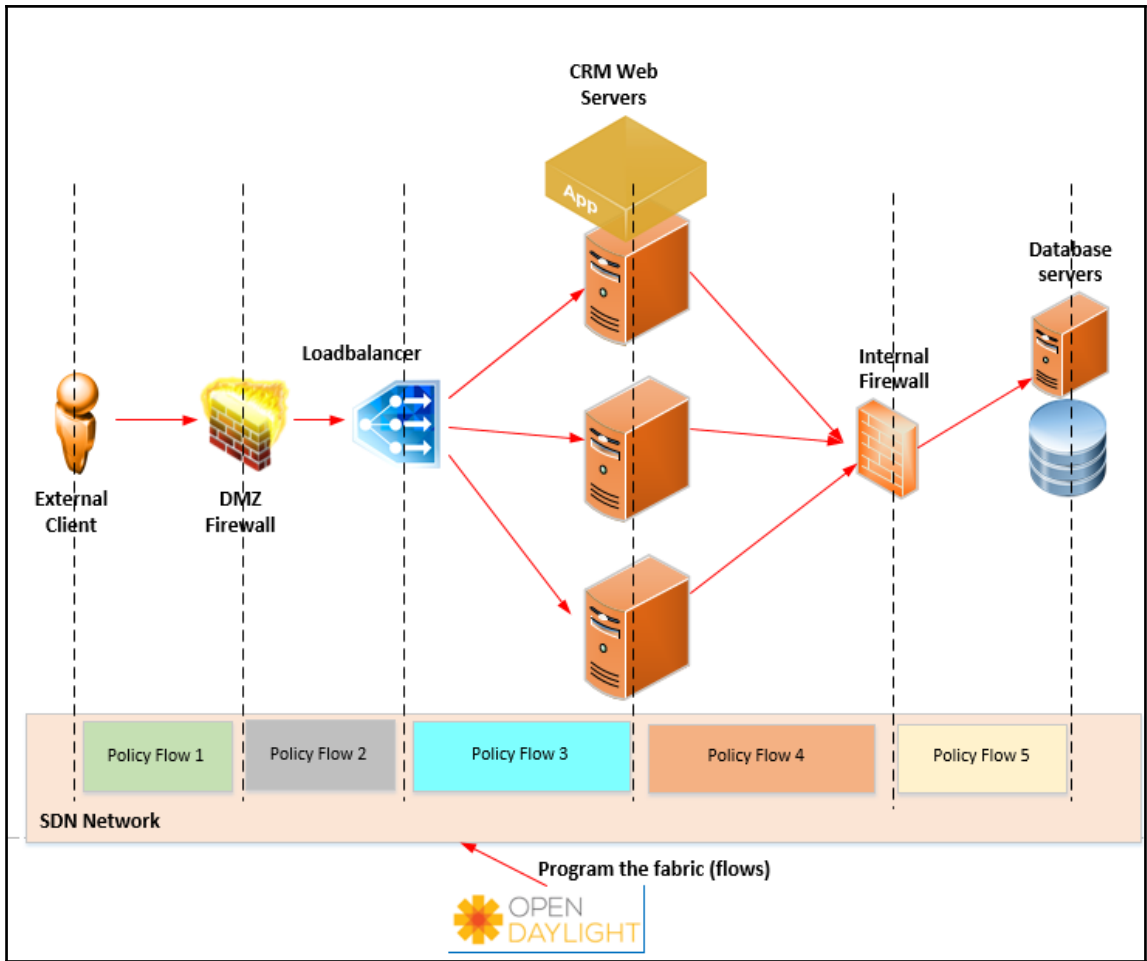
Chapter 8: Network Function Virtualization NFV

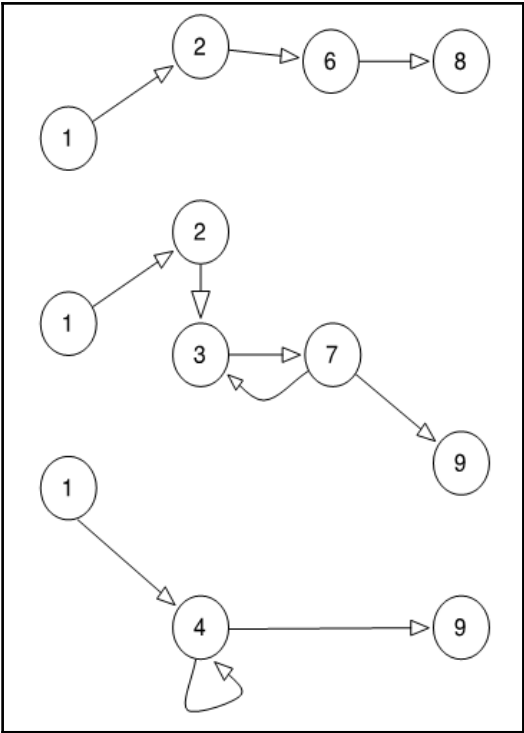


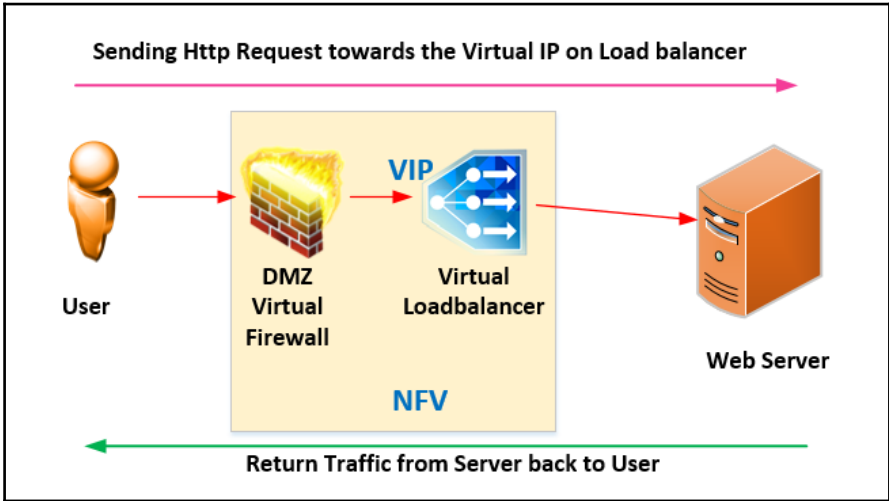
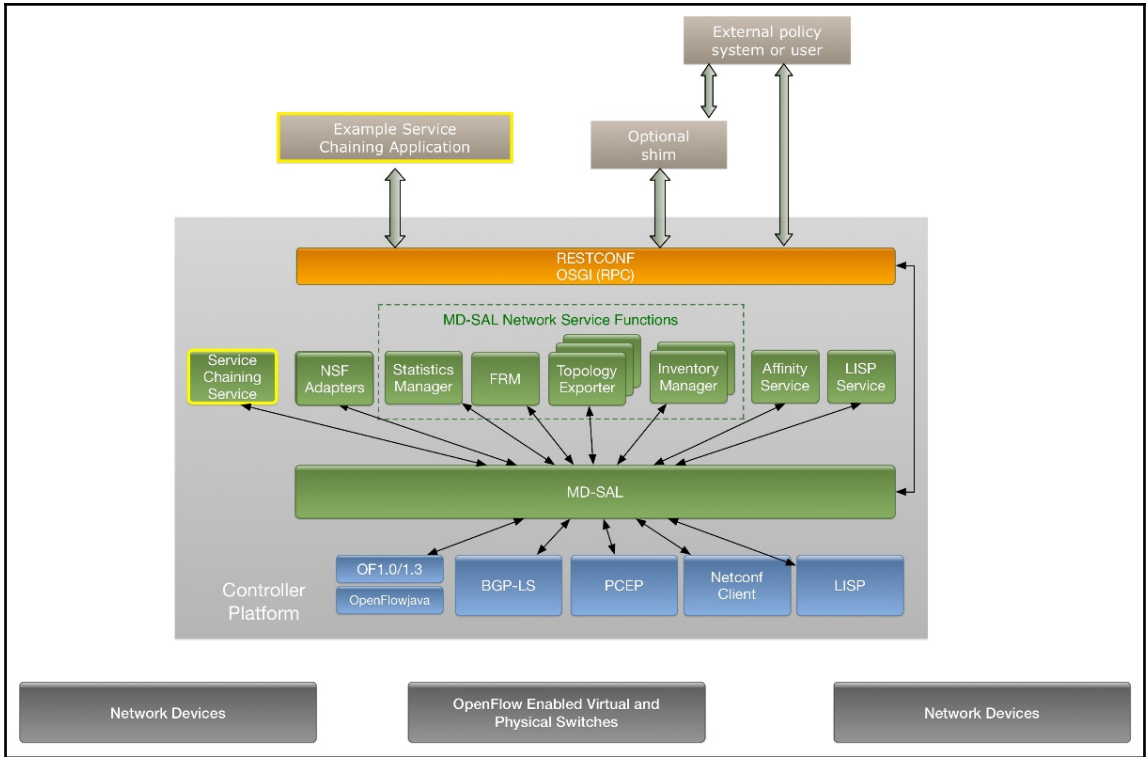


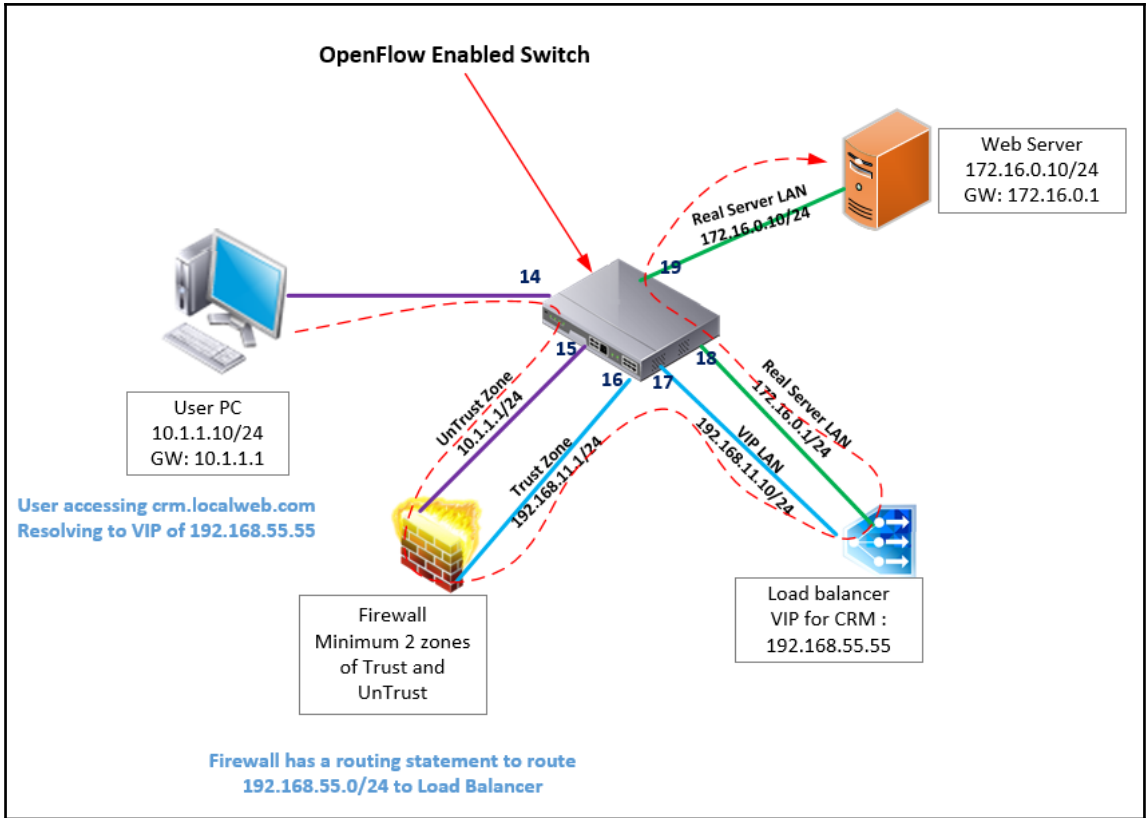


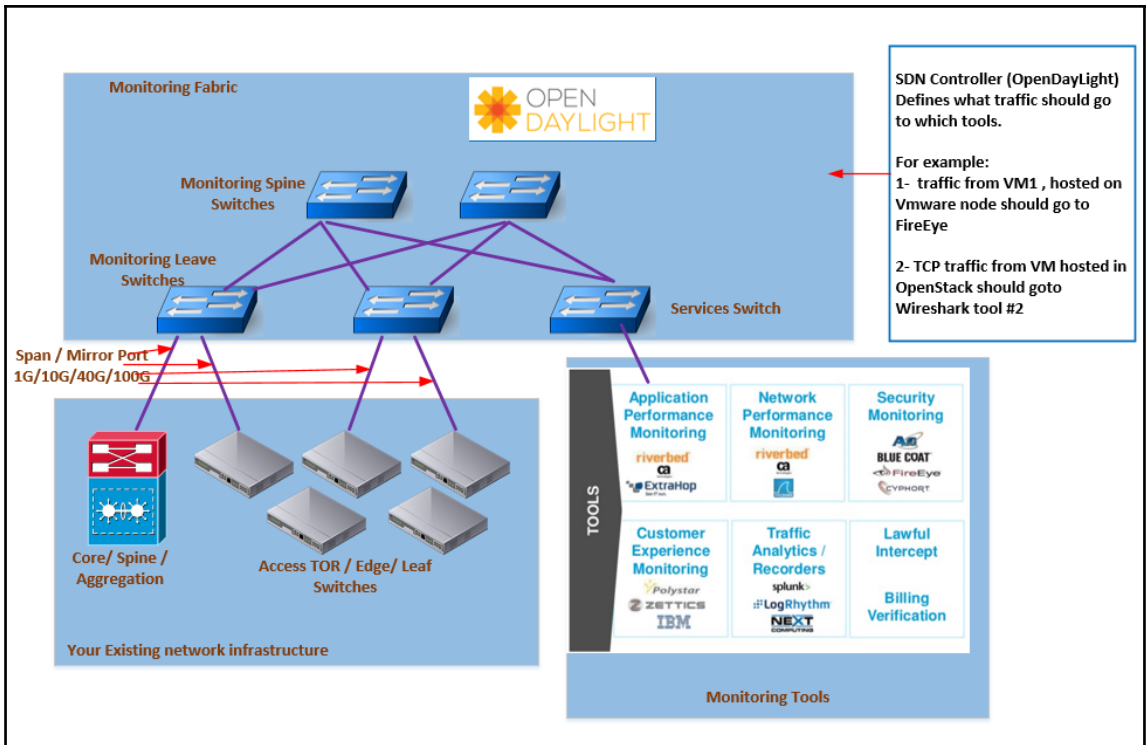




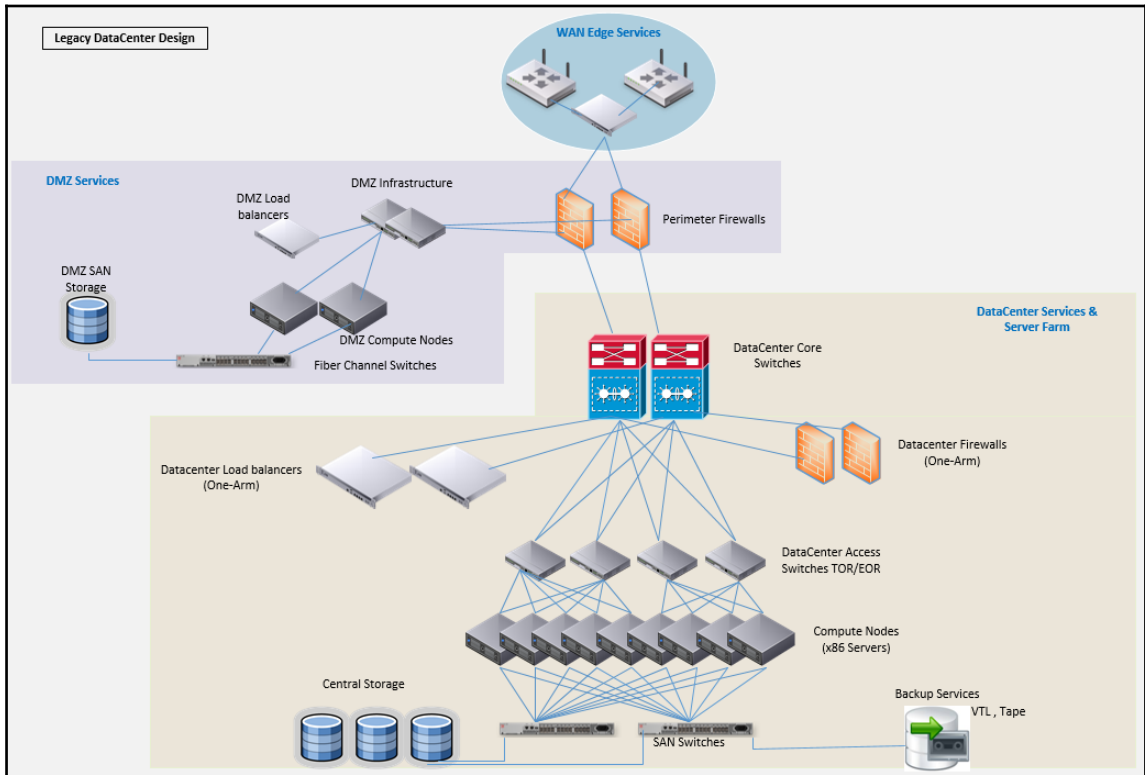








Chapter 9: Building a Software-Driven Data Center with OpenDaylight



**Hyper Converged
DataCenter Design**

