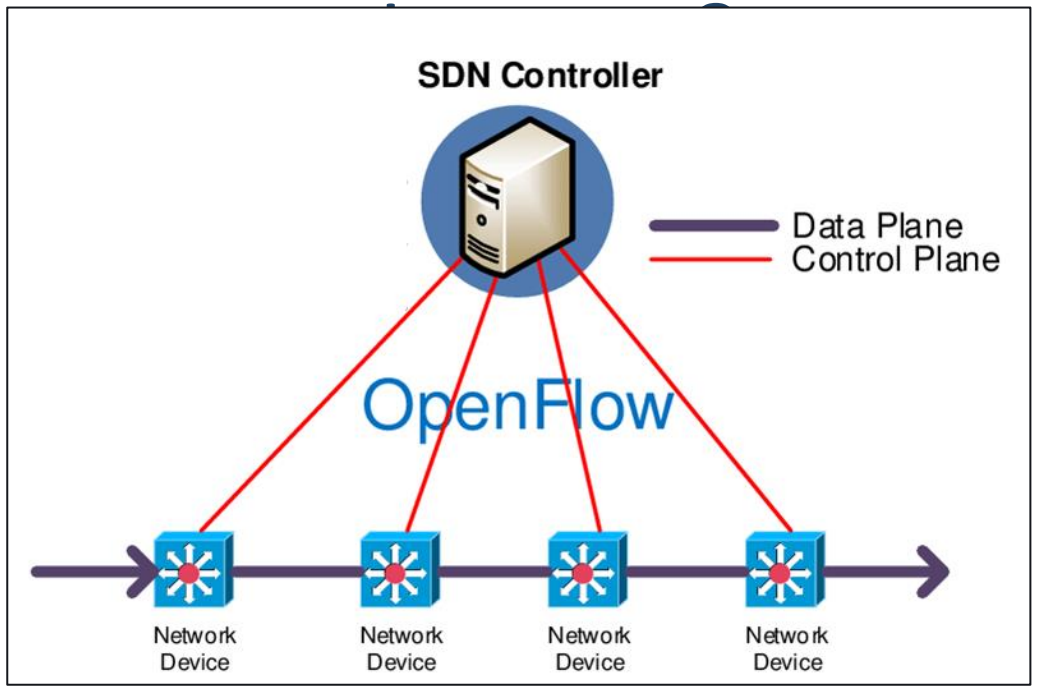
Software Defined Networking



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Traditional Networking

The Old (Current) Way of Doing Networking

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- Networking vendors sell proprietary hardware
- Hardware can be different, but devices talk to each other using protocols
- These protocols are built in the OS/image in each device
- We need to separately configure the logic for each "box" by using:
  - Command Line Interface (CLI)
  - Some kind of Network Management System (NMS)

How Network Devices Make Forwarding Decisions

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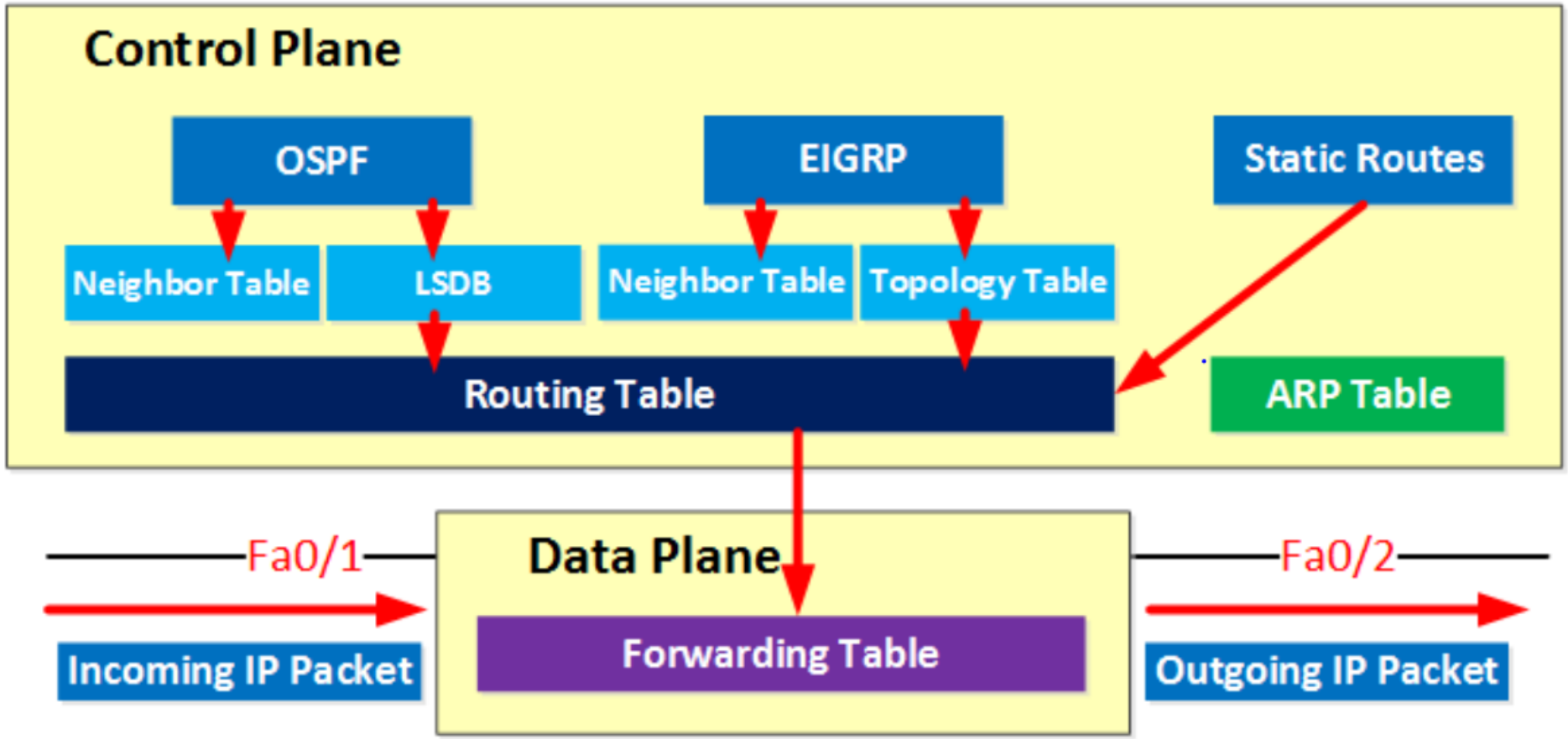
- Switches and routers should decide where to send a particular packet so each device may need to consider, build or change:
  - MAC address tables
  - Routing tables
  - Use ARP to find the destination MAC
  - Decrease the TTL of each packet
- Different **planes** on each device are responsible for the different tasks: **control** plane, **data** plane and **management** plane

Devices and Planes

- **Control plane** (the brain). Responsible for:
  - Building ARP tables
  - Building routing tables
  - Running STP to avoid loops
- **Data plane** (the muscles). Responsible for:
  - Encapsulation/decapsulation
  - Adding or removing headers (802.1Q for example)
  - Replace source/destination address (if there is NAT)
- **Management plane** - used for accessing and managing the devices. Examples - Telnet, SSH

The Control and the Data Planes



Limitation of Traditional Networking

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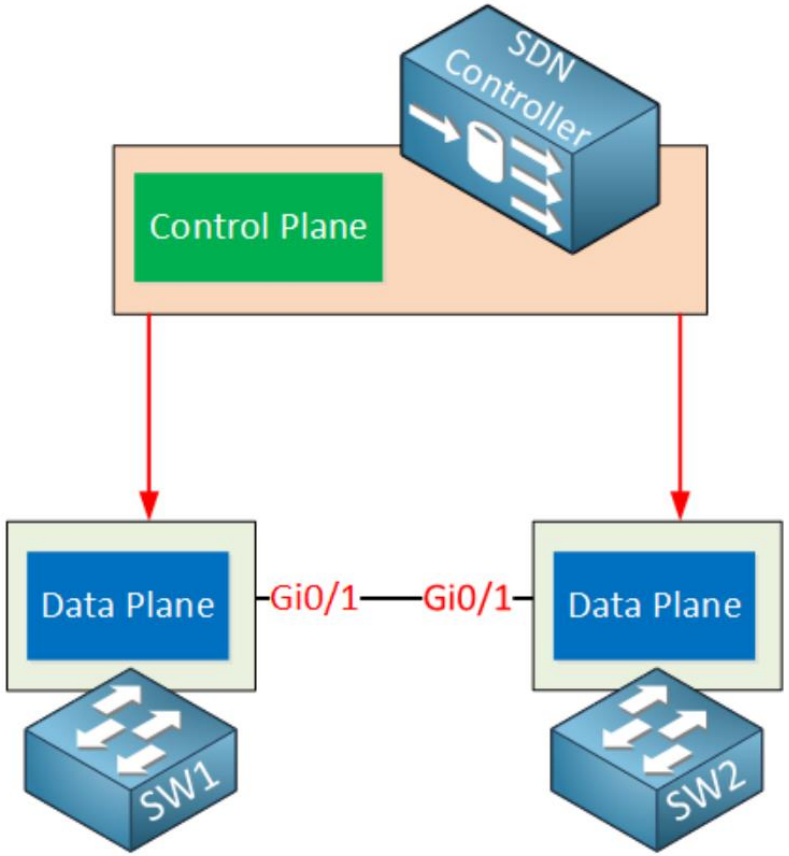
- When adding a new service/server in the network, this may lead to creating and configuring:
  - VLAN
  - STP
  - Subnet
  - Routing
  - Firewall rules (ACL)
  - Etc…
- The whole process is slow, manual and may lead to configuration errors

Software Defined Networking (SDN)

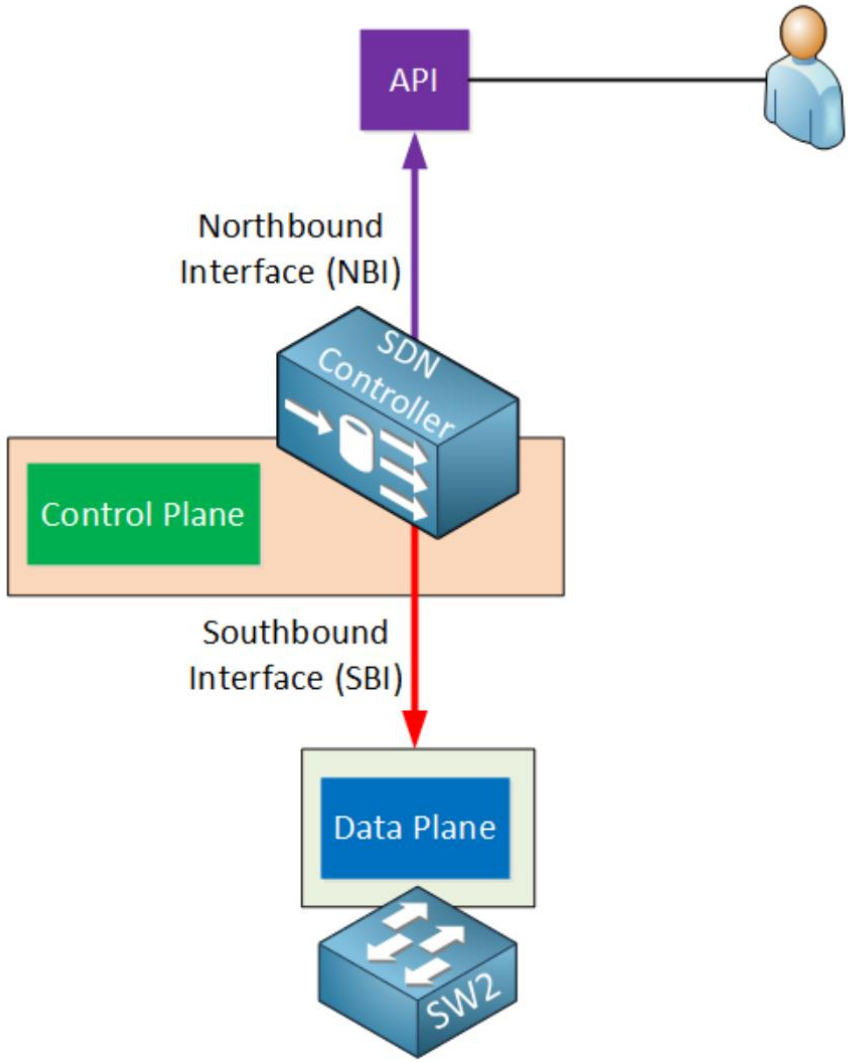
What is SDN?

- SDN - Software Defined Networking
- SDN uses a centralized control plane - SDN controller



SDN Controller Interfaces

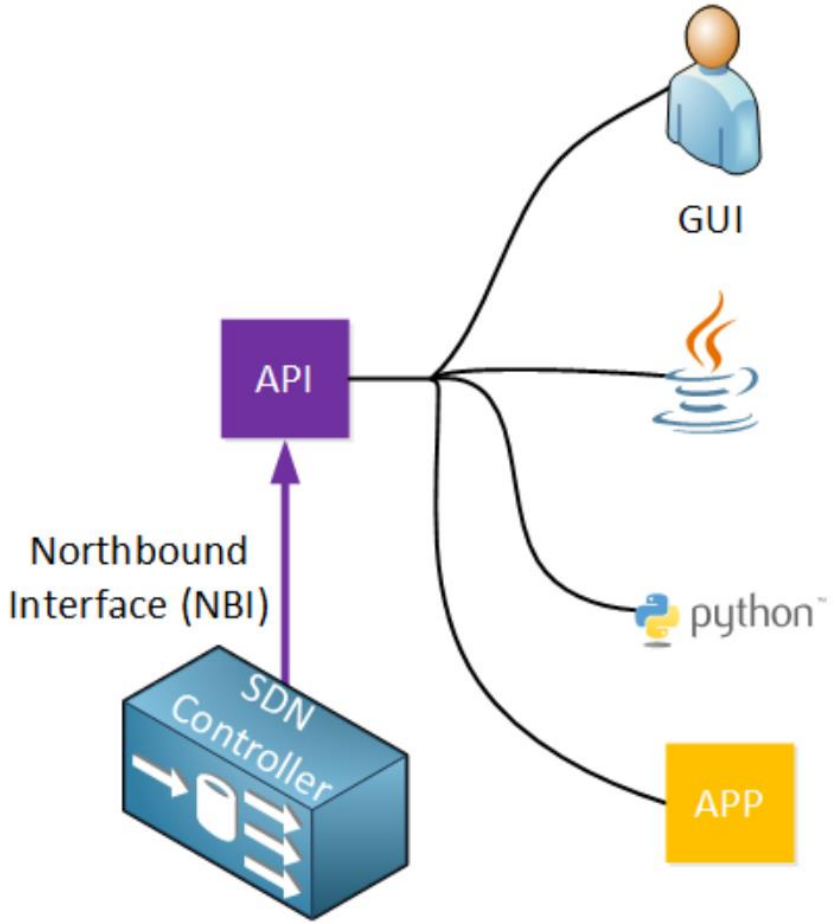
- Northbound Interface (NBI)
  - Used to access and program the controller
  - Can have GUI, CLI and API
  - You can write scripts for automation
- Southbound Interface (SBI)
  - The controller's communication with the "dumb" devices
  - It is a software interface, often API



SDN Northbound Interface

- The interface allows multiple applications to access the controller:
  - GUI
  - Java/Python or other scripts
  - 3rd party apps

- REST API (next slide) is typically used



REST API

- REST - Representational State Transfer
- REST API uses HTTP messages to send and receive information between SDN controller and another application
- Examples for such messages:
  - HTTP GET: used when we want to retrieve information
  - HTTP POST/PUT: used when we want to upload or update information
- The two most used data formats are:
  - JSON (JavaScript Object Notation)
  - XML (eXtensible Markup Language)

JSON

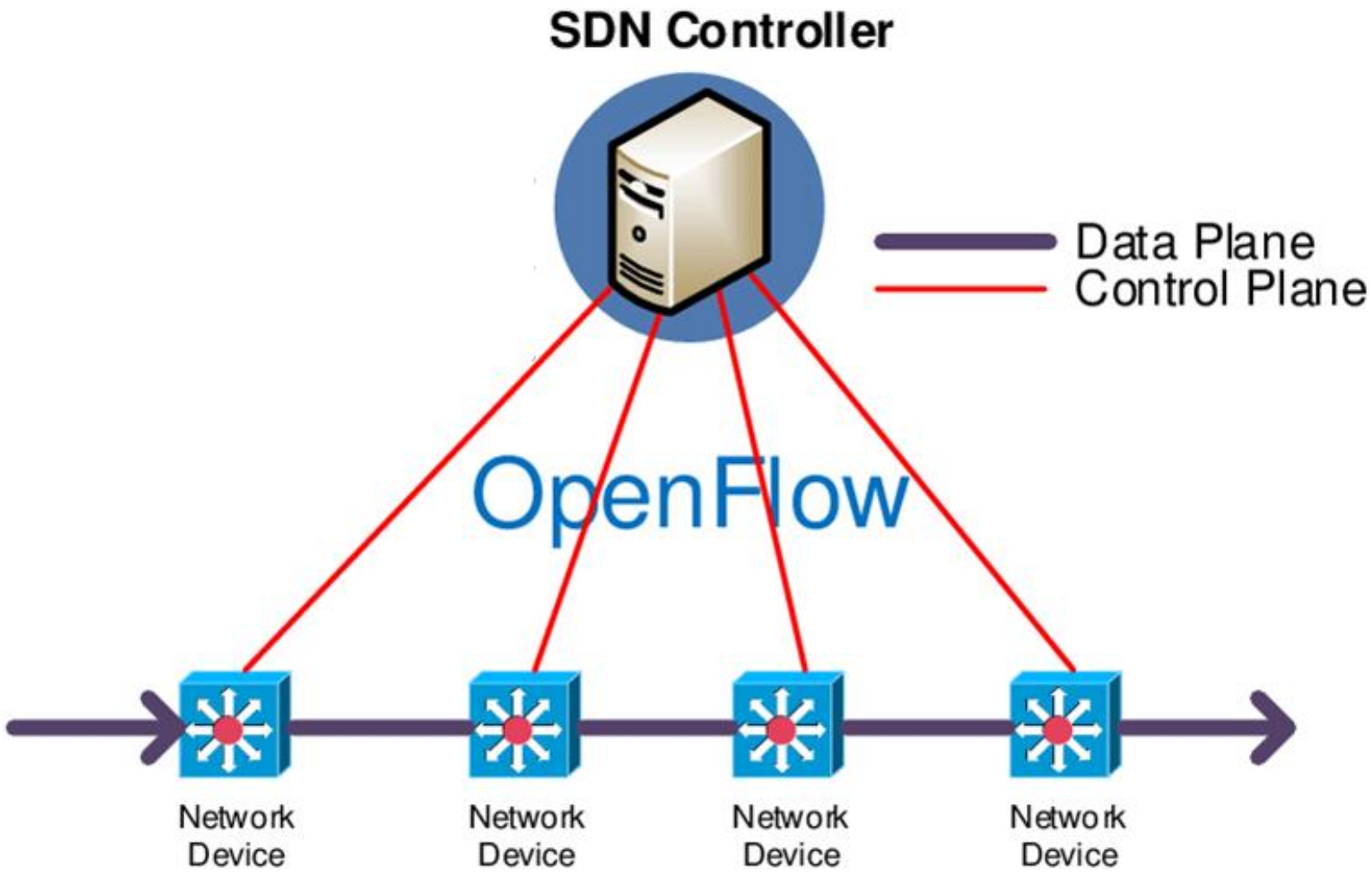
- JSON = JavaScript Object Notation
- Why?
  - User vs machine languages and **information formatting**
  - Easy to read collection of key-value pairs
  - Uses **declarative** ("what") rather than imperative ("how") syntax

```
    "contentVersion": "1.0.0.0",
    "parameters": {
        "location": {
            "value": "westeurope"
        },
        "networkInterfaceName": {
            "value": "vm1903"
        },
        "enableAcceleratedNetworking": {
            "value": true
        },
        "networkSecurityGroupName": {
            "value": "VM1-nsg"
        },
        "networkSecurityGroupRules": {
            "value": [
                {
                    "name": "RDP",
                    "properties": {
                        "priority": 300,
                        "protocol": "TCP",
                        "access": "Allow",
                        "direction": "Inbound",
                        "sourceAddressPrefix": "*",
                        "sourcePortRange": "*",
                        "destinationAddressPrefix": "*",
                        "destinationPortRange": "3389"
                    }
                }
            ]
        },
```

SDN Southbound Interface

- This is the controller's communication with the "dumb" hardware
- It specifies a software (not a physical) interface
- Some popular southbound interfaces:
  - OpenFlow
  - Cisco OpFlex
  - The good old CLI - SNMP/Telnet/SSH

SDN OpenFlow

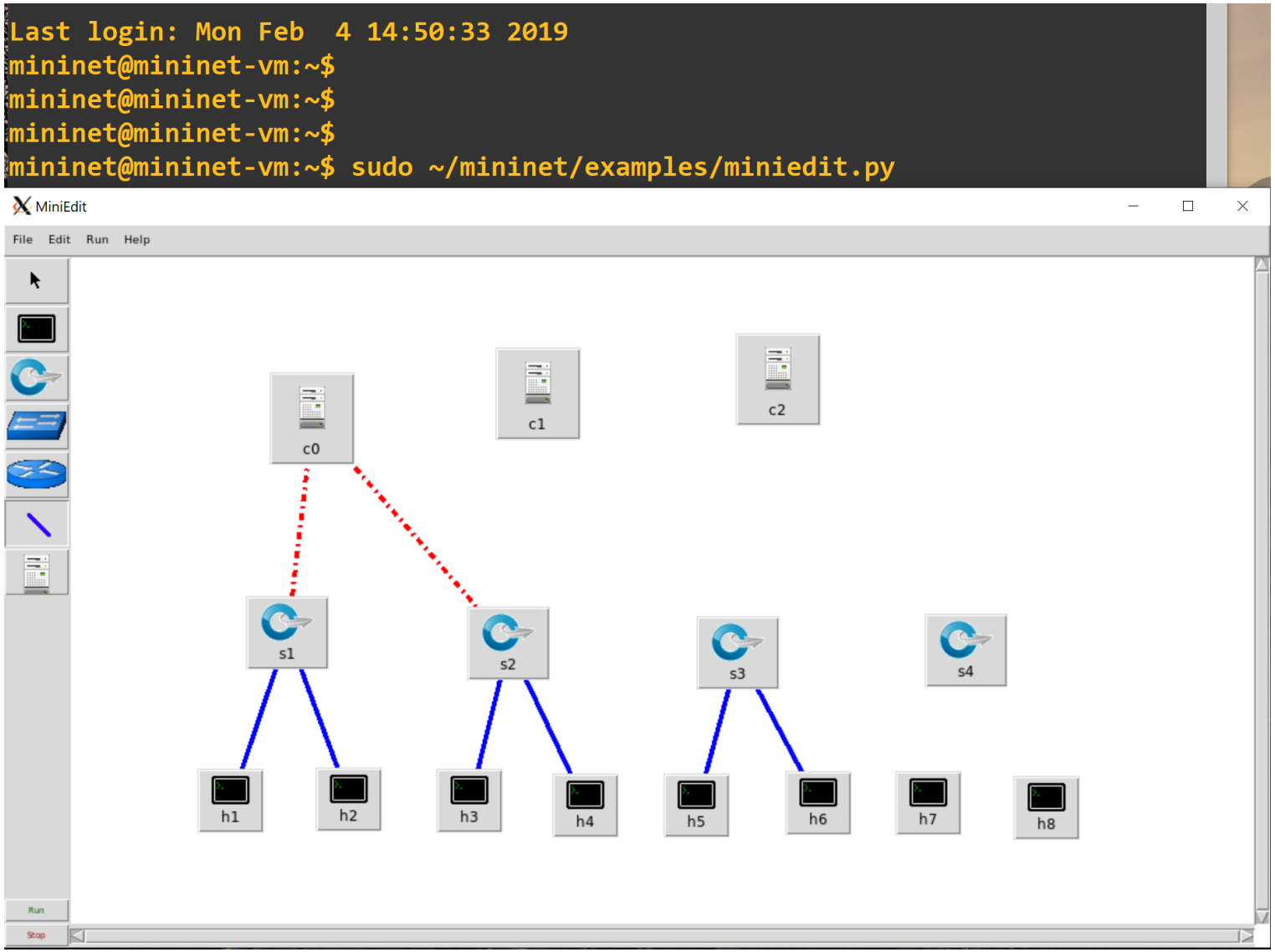


Simulators and Labs for SDN

Mininet and Miniedit

- What you need:
  - **Mininet image**
  - Virtualization software, for example **VirtualBox**
  - Terminal emulator software, for example **PuTTY**
  - X11 display server, for example **Xming**
  - **sudo ~/mininet/examples/miniedit.py**
  - Patience…

Mininet and Miniedit (2)



HPE VAN SDN Controller and Mininet

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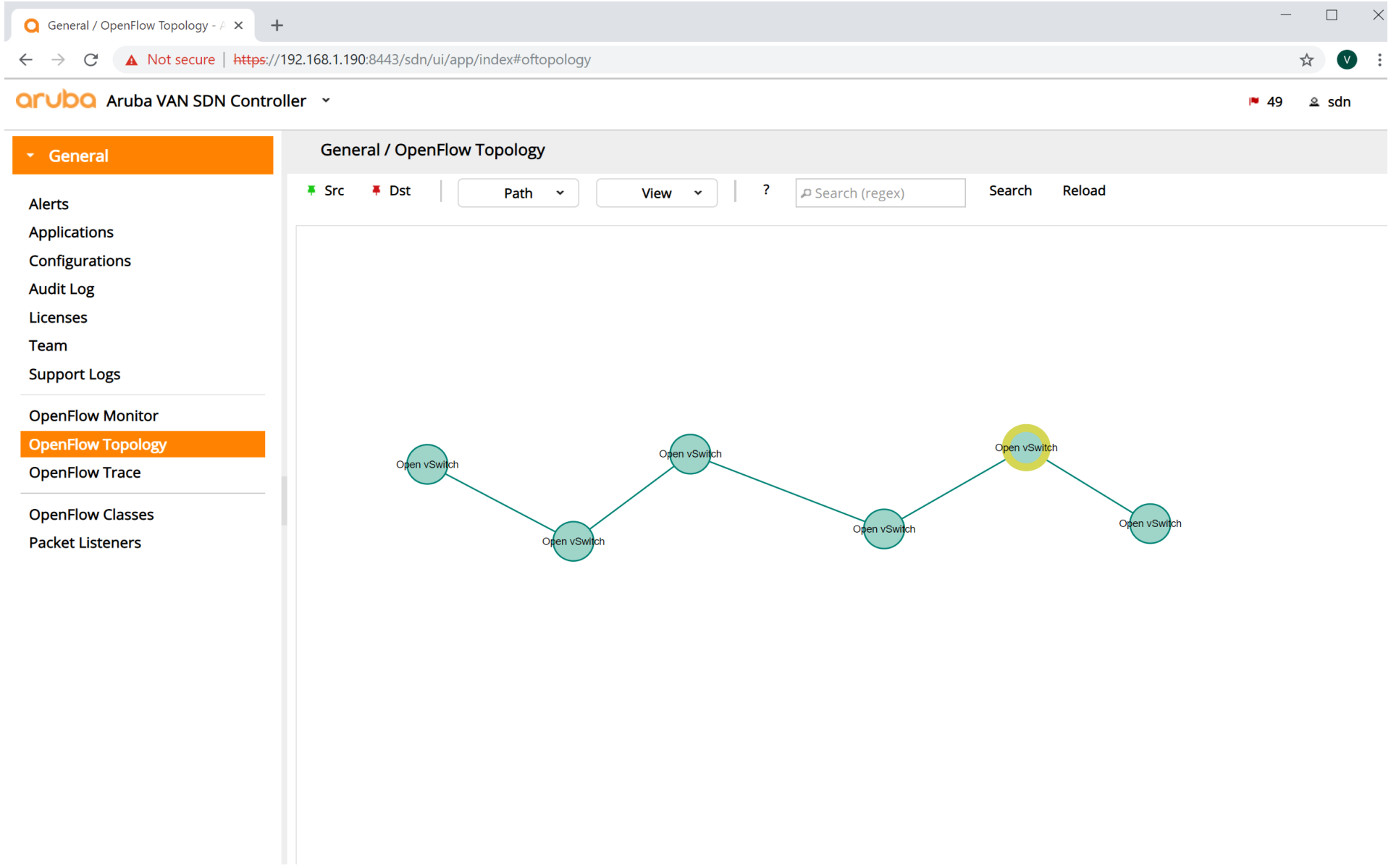
- What you need:
  - **HPE VAN SDN controller appliance**
  - **Mininet image**
  - Connectivity between both VMs and the host
  - Browse to the controller: **https://ip_address:8443/sdn/ui**
    (user: **sdn**, password: **skyline**)
  - Login to Mininet and type:
    sudo mn --controller=remote,ip= --topo=linear,4 --mac

HPE VAN SDN Controller and Mininet (2)



Cisco APIC-EM

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- APIC-EM: Application Policy Infrastructure Controller - Enterprise Module
- Created to be used with existing hardware
- Uses REST API for the northbound interface
- Uses common protocols, like SNMP, Telnet, SSH, for the southbound interface
- Can be installed from an **iso image**
- There are **labs** which does not require local installations

VMWare NSX

- NSX is network virtualization platform, which provides:
  - Logical switching
  - Logical routing
  - Logical firewall and NSX gateway
  - Logical load-balancer
  - Logical VPN
  - NSX API
- You can try the VMware NSX Data Center for free (enable browser pop-ups)

Cisco DNA Center

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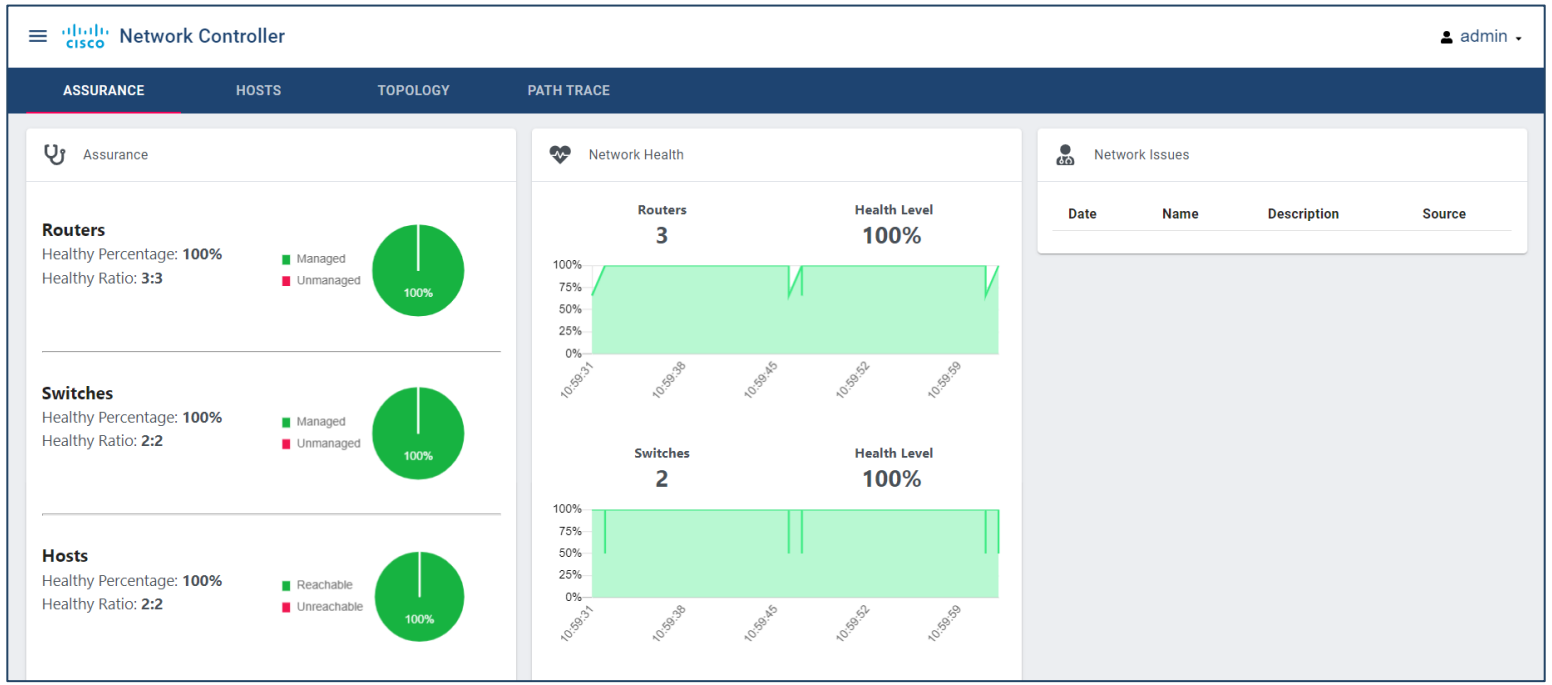
- DNA = Digital Network Architecture
- "Always on" lab vs reserving a lab
- For a quick start, access here with user: **devnetuser** and password: **Cisco123!**
- Inside, you can review the API capabilities and create some API calls either directly or with the help of Postman

Cisco Packet Tracer

- Current versions of Packet Tracer support simulating of the SDN approach with controller
- REST API access can be simulated for the northbound interface (not covered in the course) and SSH can be simulated for the southbound interface



Demonstration

Summary

1. Traditional networking
2. Software Defined Networking (SDN)
3. Simulators and labs for SDN
4. Demonstration

Questions?

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