Layer-3 Switches

Campus Network Design & Operations Workshop

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Last updated 4th October 2018

What's a Layer 3 switch?

- It's an Ethernet switch!
    - Can look at Ethernet headers
    - Builds MAC address table

- And it's a router!
    - Can look at IP headers
    - Has IP forwarding table and ARP table

- Which function it performs depend on how you configure it
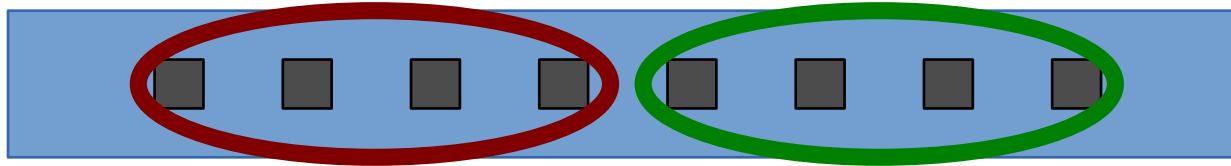- Out-of-the-box it will default to a simple L2 Ethernet switch

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Factory Default
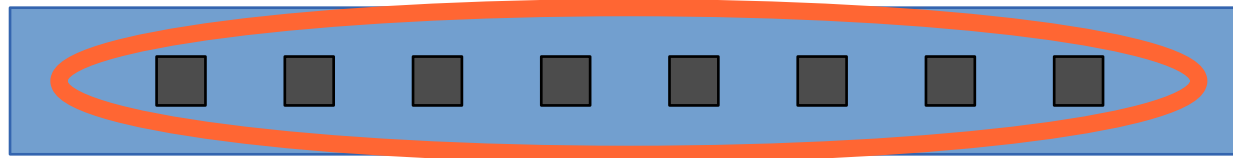

```
vlan 1
!
interface range Gi 1 - 8
  no shutdown
  switchport
  switchport mode access
  switchport access vlan 1
!
```

VLANs

```
vlan 10,20

interface range Gi 1 - 4
  switchport mode access
  switchport access vlan 10

interface range Gi 5 - 8
  switchport mode access
  switchport access vlan 20
```
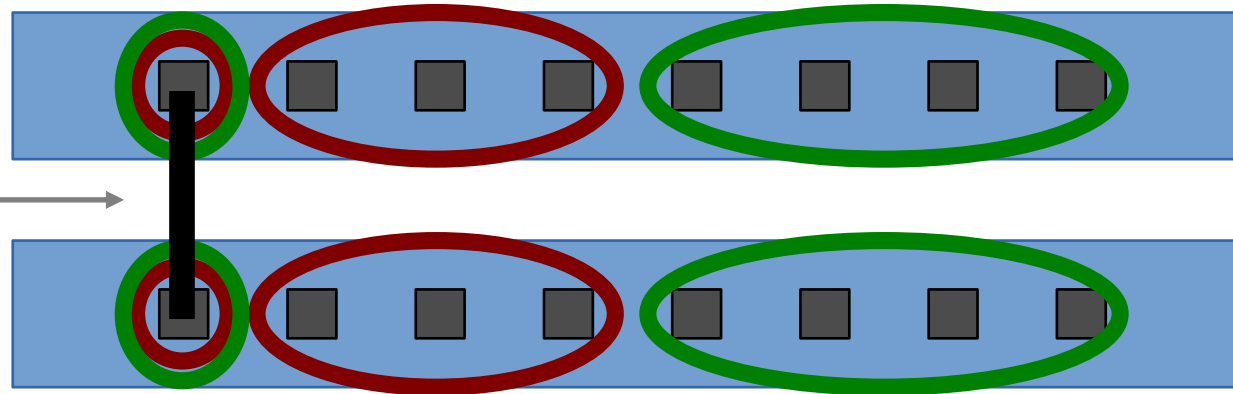
Question: how does the device behave differently after this config change?

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VLAN trunking


```
interface Gi1
   switchport mode trunk
   switchport trunk allowed vlan 10,20
```

Question: what is different about the frames on this wire?

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Management IP address
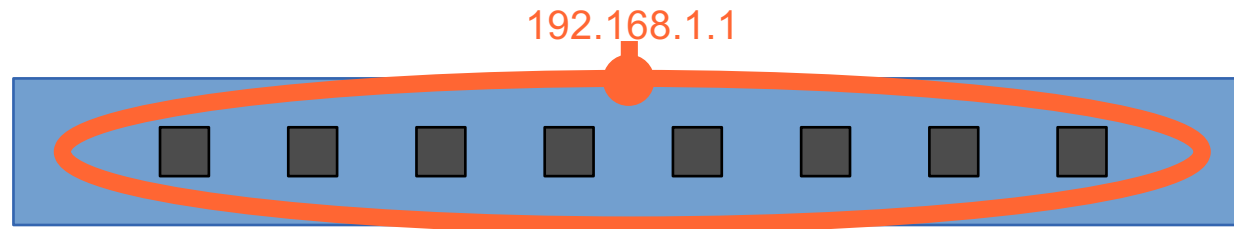
192.168.1.1

```
vlan 1

interface range Gi 1 - 8
  switchport access vlan 1

interface Vlan1
  ip address 192.168.1.1 255.255.255.0

ip default-gateway 192.168.1.254
! or: ip route 0.0.0.0 0.0.0.0 192.168.1.254
```

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The Management Interface

- The switch has its own IP interface on vlan 1, with its own IP address

- Imagine the switch's CPU is plugged into vlan 1 (but without using up a physical port)

- You use this to manage the switch (ssh, snmp)

- Like any other IP device, it needs a default gateway to be able to send packets to a destination address on a different subnet

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IP routing

- Extend this by giving the switch an IP address on multiple VLANs
  - Each address is of course within the IP subnet for that particular VLAN
- Enable the internal router within the switch
- It can receive datagrams on one VLAN, and resend them on another
- You have a layer 3 switch!

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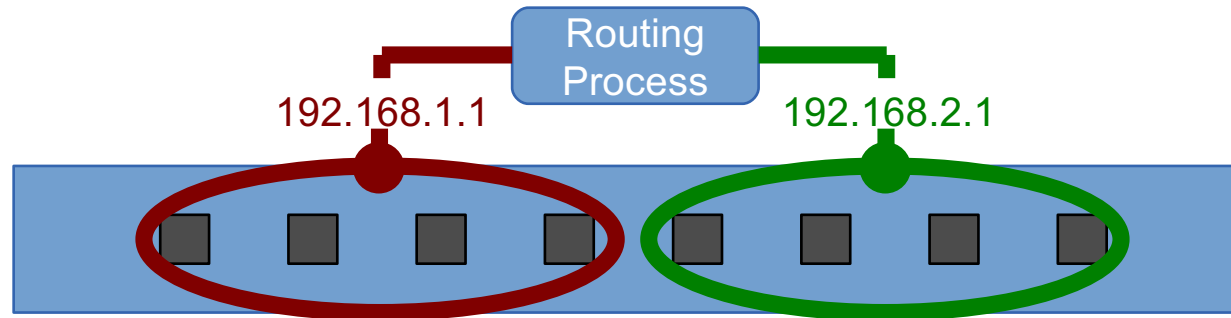
IP routing


```
vlan 10,20
ip routing

interface Vlan10
  ip address 192.168.1.1 255.255.255.0
interface Vlan20
  ip address 192.168.2.1 255.255.255.0

ip route 0.0.0.0 0.0.0.0 192.168.1.254
```
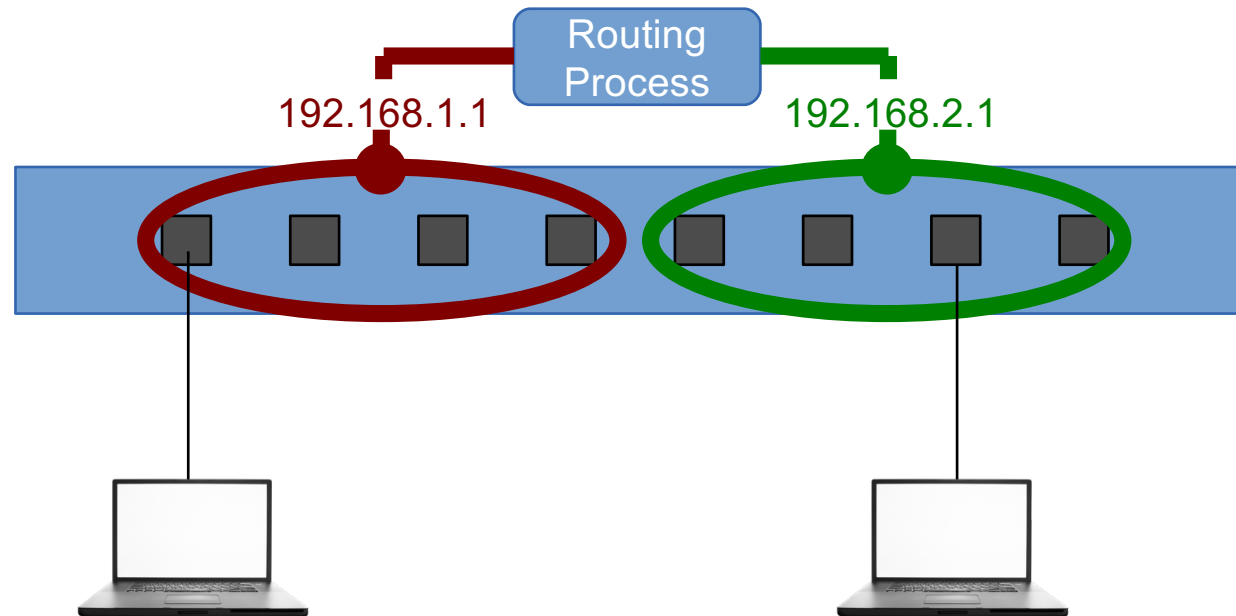
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Routed VLAN interfaces

- It's really that simple!
- We have an IP address on each VLAN
- Other devices can point their default gateway at us
- We will forward datagrams on their behalf
  - based on our IP forwarding table
  - connected routes, static routes etc.

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Acting as a gateway

Routing Process

192.168.1.1   192.168.2.1

IP addr: 192.168.1.50
Gateway: **192.168.1.1**

IP addr: 192.168.2.99
Gateway: **192.168.2.1**

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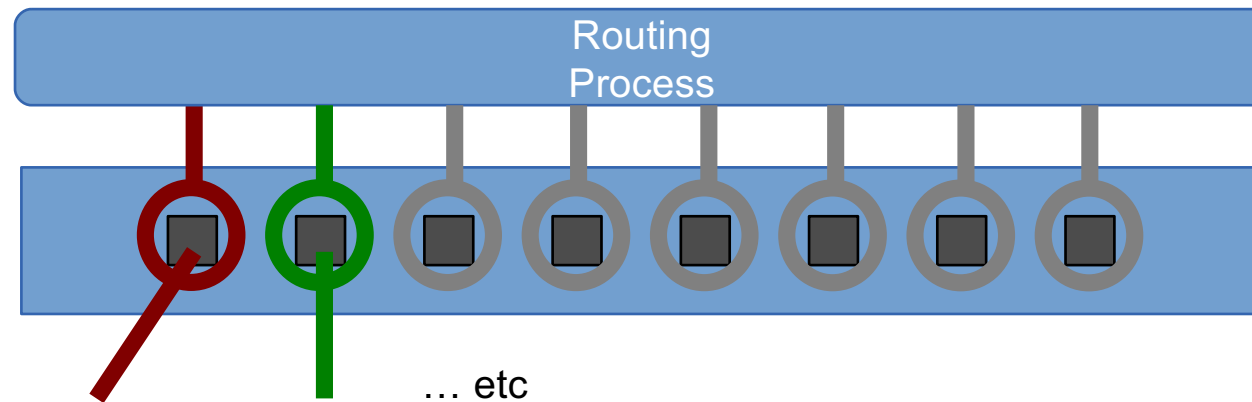Network Startup Resource Center

IPv6 is the same
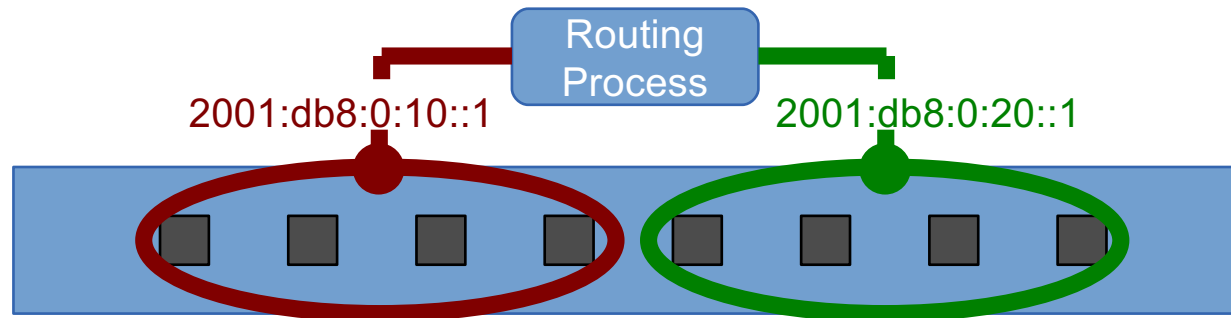

```
ipv6 unicast-routing
!
interface Vlan10
  ipv6 address 2001:db8:0:10::1/64
interface Vlan20
  ipv6 address 2001:db8:0:20::1/64
!
ipv6 route ::/0 2001:db8:0:10::ff
```

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Simple campus: 1 subnet/building

... etc

```
interface Gi1
  switchport mode access
  switchport access vlan 10

interface Vlan10
  ip address 192.168.1.1 255.255.255.0
```

```
interface Gi2
  switchport mode access
  switchport access vlan 20

interface Vlan20
  ip address 192.168.2.1 255.255.255.0
```
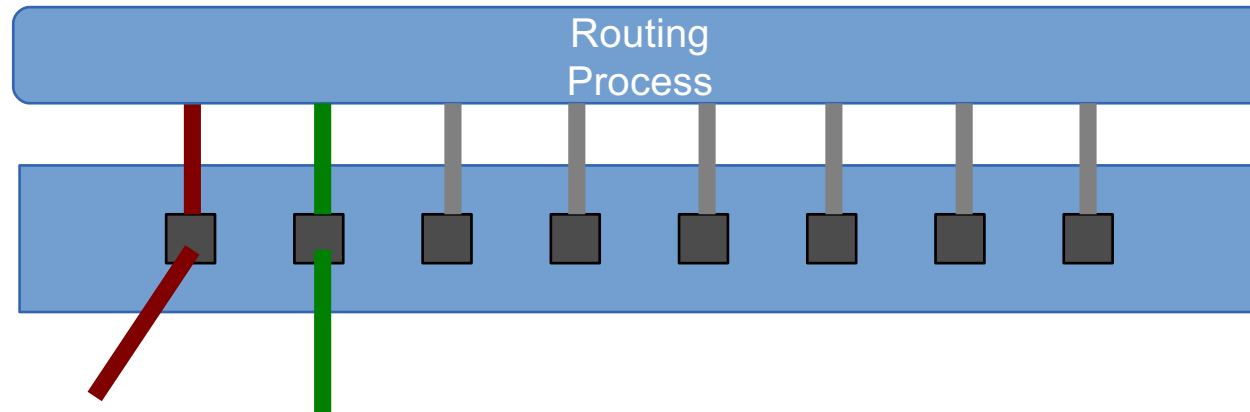
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Multiple subnets per building


```
interface Gi1
  switchport mode trunk
  switchport trunk allowed vlan 10-12

interface Vlan10
  ip address 10.1.0.1 255.255.255.0
interface Vlan11
  ip address 10.1.1.1 255.255.255.0
interface Vlan12
  ip address 10.1.2.1 255.255.255.0
```

```
interface Gi2
  switchport mode trunk
  switchport trunk allowed vlan 20-22

interface Vlan20
  ip address 10.2.0.1 255.255.255.0
interface Vlan21
  ip address 10.2.1.1 255.255.255.0
interface Vlan22
  ip address 10.2.2.1 255.255.255.0
```

Question: what has to be different at the building aggregation switch?

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Hints and tips

- Remember, one subnet = one VLAN

- Don't use vlan 1
  - It's the "default vlan" and often has special default behaviour
  - It may appear by default on all ports
  - It's often hard to use with tagging
  - Better to ignore it or remove it completely
  - VLANs 2 to 4094 are usable

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Hints and tips

- Don't enable the same VLAN on links to different buildings!
  - A layer 3 switch lets you do this but that doesn't mean it's a good idea. "VLAN spaghetti"
- Implies: a wired VLAN per building, a wifi VLAN per building etc
- Choose a consistent scheme
  - e.g. vlan 2-9 for NOC, vlan 10-19 for building 1, vlan 20-29 for building 2 etc.

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Routed interfaces / subinterfaces

- Some layer 3 switches let you configure "routed ports" – making it work exactly like a router instead of a switch

- Some also have routed sub-interfaces with VLAN tags

- This means you can route multiple subnets to each building, without having to create any actual VLANs
  - avoids running out of VLANs

- You can re-use the *same* VLAN tags for *different subnets in different buildings!*
  - Makes the distribution/edge switch configs almost identical everywhere

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Fully routed interfaces

Routing Process
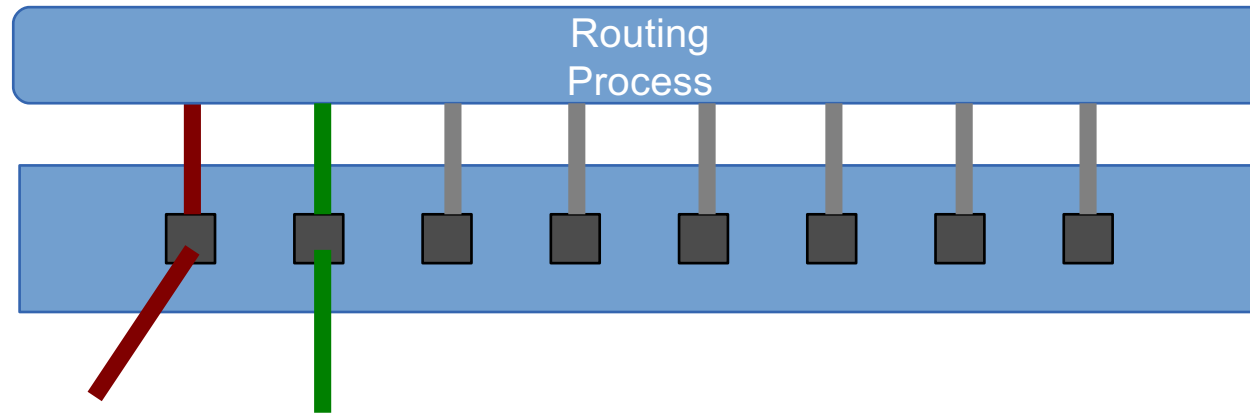
```
interface Gi1
  no switchport

interface Gi1.10
  encapsulation dot1q 10
  ip address 10.1.0.1 255.255.255.0

interface Gi1.11
  encapsulation dot1q 11
  ip address 10.1.1.1 255.255.255.0
```

```
interface Gi2
  no switchport

interface Gi2.10
  encapsulation dot1q 10
  ip address 10.2.0.1 255.255.255.0

interface Gi2.11
  encapsulation dot1q 11
  ip address 10.2.1.1 255.255.255.0
```

Both buildings use vlan tags 10-11 but these are different, isolated subnets

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Questions?