

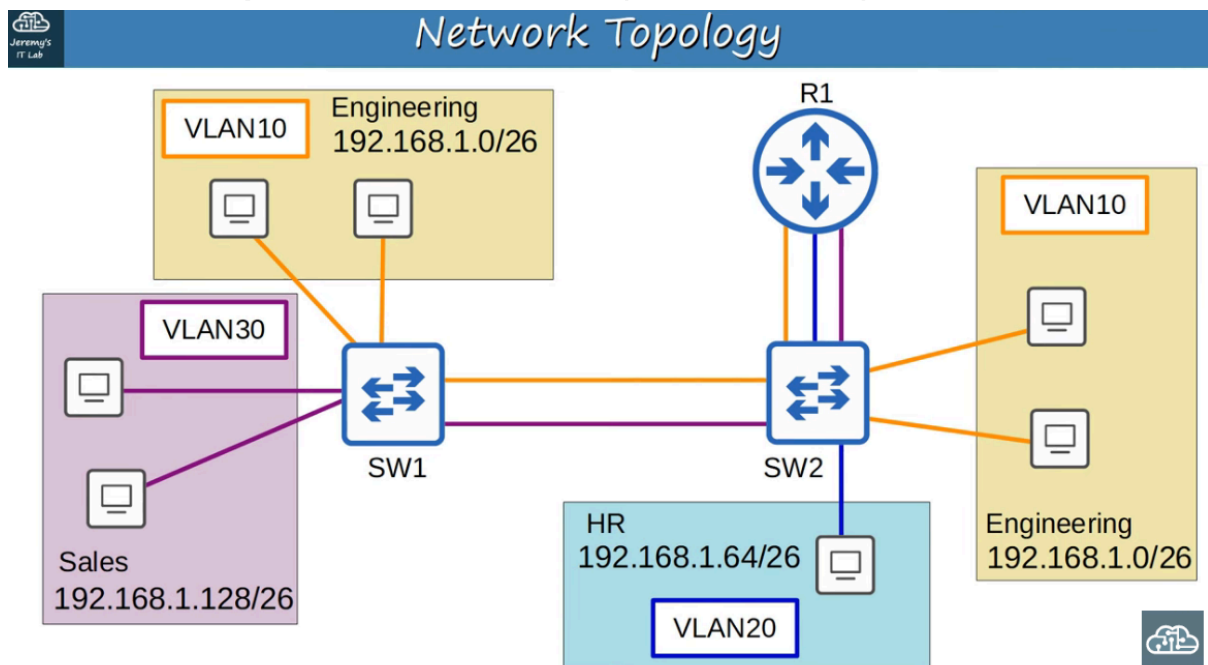
17. VLANs: PART 2

Basic VLAN Topology from Part 1

Basic VLAN Example:

What About This Network Topology?

Network Example with Two Switches (SW1 and SW2):



- Notice:
 - **SW1** and **SW2** are connected.
 - The **Engineering VLAN (VLAN 10)** spans two separate locations.
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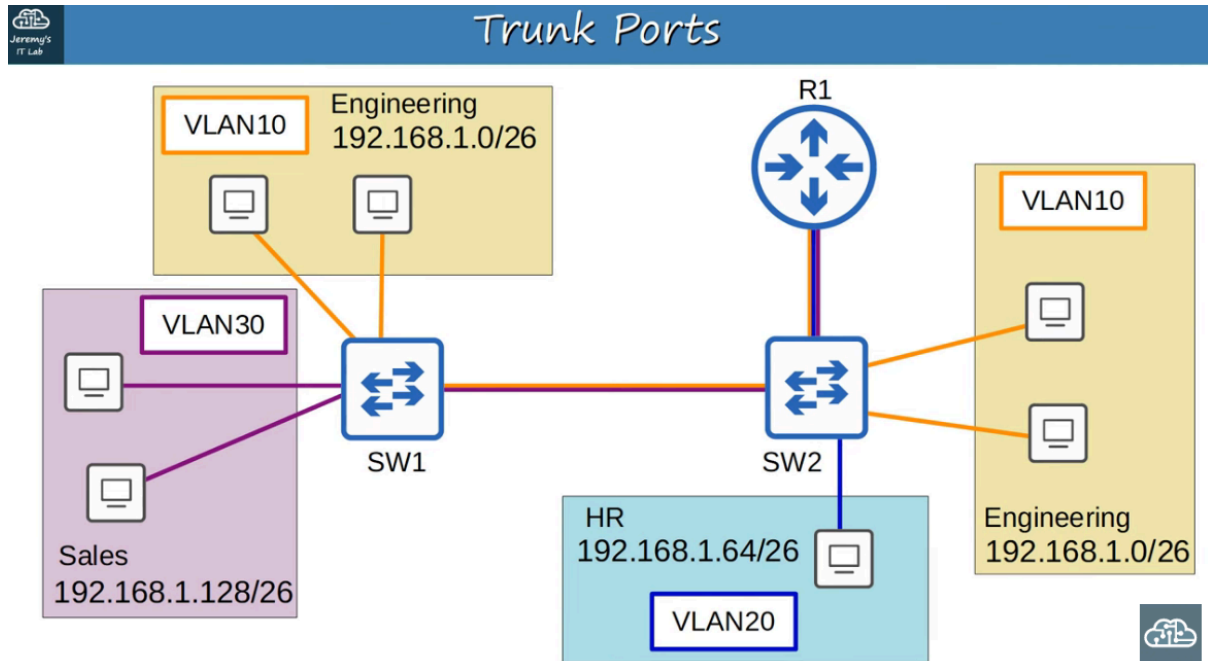
TRUNK PORTS

Why Use TRUNK PORTS?

- In small networks, you can use a separate interface for each VLAN to connect **switches** to **switches** or **switches** to **routers**.
- For larger networks with many VLANs:
 - Using separate interfaces for each VLAN is inefficient and wastes ports.

- Most routers won't have enough interfaces for every VLAN.
- **Solution:** Use **TRUNK PORTS** to carry traffic for multiple VLANs over a single interface.

Trunk Port Diagram:



How Does a Packet Know Which VLAN to Use Over the TRUNK?

VLAN TAGGING

- Switches add **tags** to frames sent over a trunk link.
- This allows the receiving switch to know which VLAN the frame belongs to.

Port Types:

- **Trunk Port** = "Tagged"
- **Access Port** = "Untagged"

VLAN TAGGING PROTOCOLS

Two Main Trunk Protocols:

1. **ISL (Inter-Switch Link)**
 - Old, Cisco proprietary protocol.
 - Rarely used today.
2. **IEEE 802.1Q (aka "dot1q")**
 - Industry-standard protocol.

- Most modern switches support **802.1Q** exclusively.

Ethernet Header with 802.1Q Tag:



802.1Q Tag Structure:

- **802.1Q Tag** is inserted between the **Source** and **Type/Length** fields in the Ethernet frame.
- The **tag** is 4 bytes (32 bits) long and consists of:
 1. **TPID** (Tag Protocol Identifier):
 - 16 bits (2 bytes).
 - Value: **0x8100** indicates the frame is 802.1Q tagged.
 2. **TCI** (Tag Control Information):
 - Includes three subfields:
 - **PCP (Priority Code Point)**: 3 bits (for Class of Service).
 - **DEI (Drop Eligible Indicator)**: 1 bit.
 - **VID (VLAN ID)**: 12 bits (range 1–4094).

VLAN RANGES

- VLAN IDs: **1 – 4094**
- Reserved VLANs:
 1. VLAN 0 and VLAN 4095 (can't be used).
- Common VLAN Ranges:
 1. **1 – 1005**: Standard VLANs.
 2. **1006 – 4094**: Extended VLANs.

NATIVE VLAN

- **Definition**: VLAN that is **not tagged** on a trunk link.
 - By default, VLAN 1 is the **Native VLAN** on Cisco switches.
 - Best practice: Use a **dedicated VLAN** for the Native VLAN (e.g., VLAN 99).
 - The switch does not add an 802.1Q tag to frames in the native VLAN.
 - When a switch receives an untagged frame on a trunk port, it assumes the frame belongs to the native VLAN.
 - **Important that the Native VLAN matches between Switches!**
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TRUNK CONFIGURATION

How to Configure a Trunk Port:

1. Select the interface to configure.
2. Set the encapsulation type to **802.1Q**:
`switchport trunk encapsulation dot1q`
3. Set the interface mode to **Trunk**:
`switchport mode trunk`
4. Check:
`do show interfaces trunk`

Allowing VLANs on a Trunk:

- Use the following command to allow specific VLANs on a trunk:
`switchport trunk allowed vlan <vlan_list>`

```
SW1(config-if)#switchport trunk allowed vlan 10,30
SW1(config-if)#do show interfaces trunk
```

Port	Mode	Encapsulation	Status	Native vlan
Gi0/0	on	802.1q	trunking	1

```
Port      Vlans allowed on trunk
Gi0/0     10,30

Port      Vlans allowed and active in management domain
Gi0/0     10,30

Port      Vlans in spanning tree forwarding state and not pruned
Gi0/0     10,30
SW1(config-if)#
```

```
SW1(config-if)#switchport trunk allowed vlan add 20
SW1(config-if)#do show interfaces trunk
```

Port	Mode	Encapsulation	Status	Native vlan
Gi0/0	on	802.1q	trunking	1

```
Port      Vlans allowed on trunk
Gi0/0     10,20,30

Port      Vlans allowed and active in management domain
Gi0/0     10,30

Port      Vlans in spanning tree forwarding state and not pruned
Gi0/0     10,30
SW1(config-if)#
```

```
SW1(config-if)#switchport trunk allowed vlan remove 20
SW1(config-if)#do show interfaces trunk
```

Port	Mode	Encapsulation	Status	Native vlan
Gi0/0	on	802.1q	trunking	1

Port	Vlans allowed on trunk
Gi0/0	10,30

Port	Vlans allowed and active in management domain
Gi0/0	10,30

Port	Vlans in spanning tree forwarding state and not pruned
Gi0/0	10,30

```
SW1(config-if)#
```

```
SW1(config-if)#switchport trunk allowed vlan except 1-5,10
SW1(config-if)#do show interfaces trunk
```

Port	Mode	Encapsulation	Status	Native vlan
Gi0/0	on	802.1q	trunking	1

Port	Vlans allowed on trunk
Gi0/0	6-9,11-4094

Port	Vlans allowed and active in management domain
Gi0/0	30

Port	Vlans in spanning tree forwarding state and not pruned
Gi0/0	30

```
SW1(config-if)#
```

For security purposes, it is best to change the native VLAN to an **unused VLAN**.
(network security will be explained more in-depth later in the course)
Make sure the native VLAN matches on between switches

```
SW1(config-if)#switchport trunk native vlan 1001
SW1(config-if)#do show interfaces trunk
```

Port	Mode	Encapsulation	Status	Native vlan
Gi0/0	on	802.1q	trunking	1001

Port	Vlans allowed on trunk
Gi0/0	10,30

Port	Vlans allowed and active in management domain
Gi0/0	10,30

Port	Vlans in spanning tree forwarding state and not pruned
Gi0/0	10,30

```
SW1(config-if)#
```

ROUTER ON A STICK (ROAS)

What Is ROAS?

- ROAS allows you to route between multiple VLANs using a **single physical interface** on a router.
- Router uses **sub-interfaces** for each VLAN.

Key Points:

- Sub-interface names follow the format: `<interface_name>.<VLAN_ID>` (e.g., `G0/0.10`).
- Each sub-interface:
 - Is assigned an **IP address**.
 - Is configured with a **VLAN tag** for its VLAN.

Diagram of ROAS Example:

```
R1(config)#interface g0/0
R1(config-if)#no shutdown
R1(config-if)#
*Apr 15 04:29:49.681: %LINK-3-UPDOWN: Interface GigabitEthernet0/0, changed state to up
*Apr 15 04:29:50.682: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up
R1(config-if)#interface g0/0.10
R1(config-subif)#encapsulation dot1q 10
R1(config-subif)#ip address 192.168.1.62 255.255.255.192
R1(config-subif)#interface g0/0.20
R1(config-subif)#encapsulation dot1q 20
R1(config-subif)#ip address 192.168.1.126 255.255.255.192
R1(config-subif)#interface g0/0.30
R1(config-subif)#encapsulation dot1q 30
R1(config-subif)#ip address 192.168.1.190 255.255.255.192
R1(config-subif)#
```

ROAS Configuration Steps:

1. On the **Router**:

Create a sub-interface for each VLAN:

```
interface G0/0.10
```

```
encapsulation dot1q 10
```

```
ip address <IP_Address> <Subnet_Mask> (last usable ip address of each subnet)
```

2. On the **Switch**:

Configure the interface connected to the router as a **trunk port**:

```
switchport trunk encapsulation dot1q
```

- switchport mode trunk

Verifying ROAS Configuration:

1. Check sub-interfaces with:
`show ip interface brief`
2. View the routing table:
`show ip route`