Chapter 3

Virtual Local Area Networks (VLANs)

Part II


Note for Instructors

- These presentations are the result of a collaboration among the instructors at St. Clair College in Windsor, Ontario.
- Thanks must go out to Rick Graziani of Cabrillo College. His material and additional information was used as a reference in their creation.
- If anyone finds any errors or omissions, please let me know at:
    - tdame@stclaircollege.ca.

Virtual Local Area Networks

VLAN Trunking
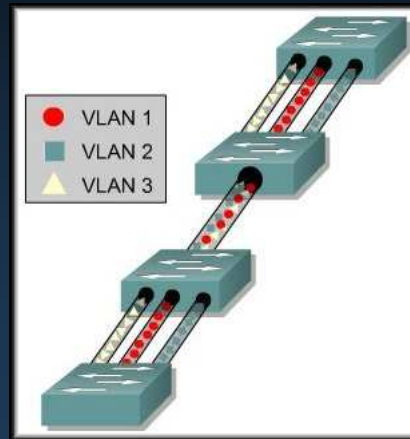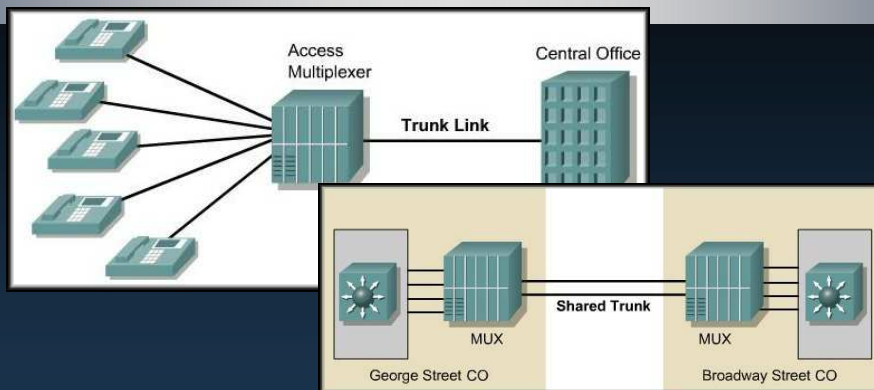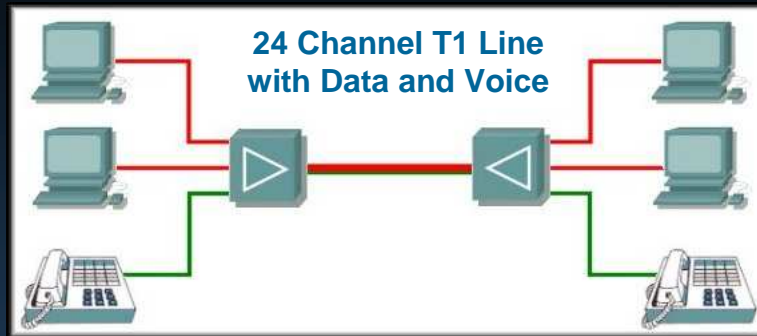

VLAN Trunking

- The concept of trunking began with the telephone industry.
- Multiple calls were moved between customers and central offices or between the offices themselves over a single physical connection.

VLAN Trunking

24 Channel T1 Line with Data and Voice

- The same principle was applied to data communications to make better use of the communication line.
- Additional advantages and cost savings were gained by using the same line for voice communications.

VLAN Trunking

No trunk

Trunk

VLAN 1 and VLAN 2
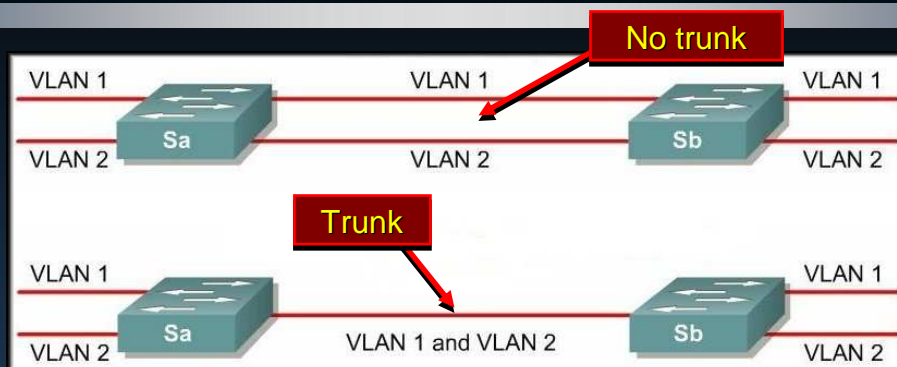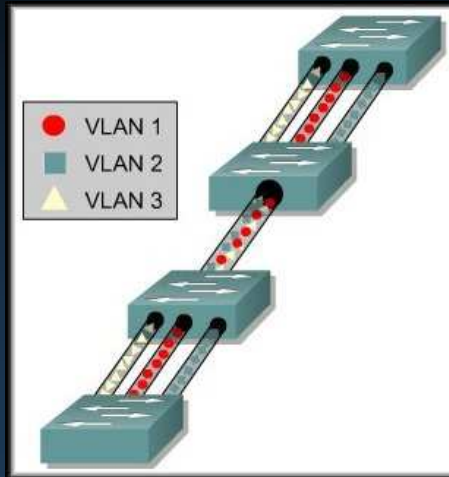
- The same principle of trunking is applied to network switching technologies.
- A trunk is a physical and logical connection between two switches across which network traffic travels.

VLAN Trunking

- It is also important to realize that a trunk link **does not belong** to a specific VLAN.

- The responsibility of a trunk link is to act as a **conduit** for VLANs.
  - Between **switches** and **routers**.
  - Between **switches** and **switches**.

- VLAN 1
- VLAN 2
- VLAN 3

VLAN Trunks

- **What problem does it solve?**

Network 172.17.10.0/24

Faculty
172.17.10.21

PC1

Network 172.17.20.0/24

Student
172.17.20.22

PC2

Network 172.17.30.0/24

Guest
172.17.30.23

S1

S2

1 Switch Port
4 VLANs:
10, 20, 30, 99
subnetwork

Network 172.17.99.0/24
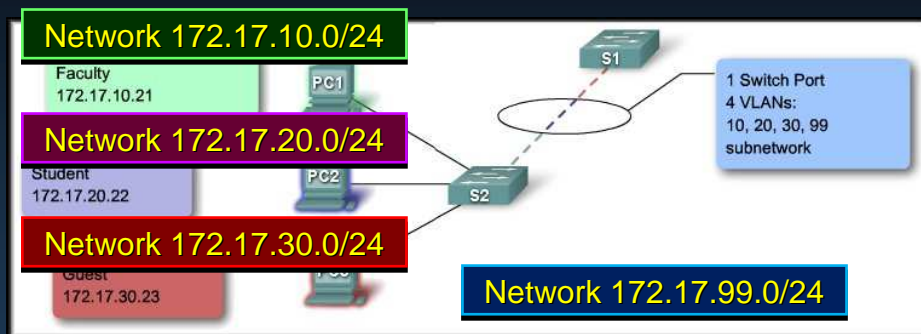
IEEE 802.1Q Frame Tagging

- **Remember that switches are Layer 2 devices.**
  - Only use the Ethernet frame header information.
  - Frame header does not contain information about VLAN membership.
- VLAN membership (i.e. VLAN ID or VLAN Number) must be identified for each frame that is transferred over the trunk.
- The process is called 802.1Q VLAN Tagging.
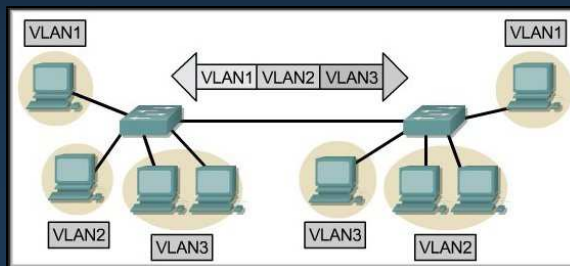
IEEE 802.1Q Frame Tagging

Length 1518 Bytes

6	6	2	1500	4
Destination Address	Source Address	Type / Length	Data Max of 1500 Bytes	FCS

Length 1522 Bytes

6	6	2	2	2	1500	4
Destination Address	Source Address	802.1Q Tag		Type/ Length	Data Max of 1500 Bytes	New FCS
		8100	Tag			

IEEE 802.1Q Frame Tagging

Length 1522 Bytes

6	6	2	2	2	1500	4
Destination Address	Source Address	802.1Q Tag		Type/ Length	Data Max of 1500 Bytes	New FCS
		8100	Tag			

Ethernet Type

3 Bits	1 Bit	12 Bits
User Priority	CFI	VLAN ID

Canonical Format Identifier
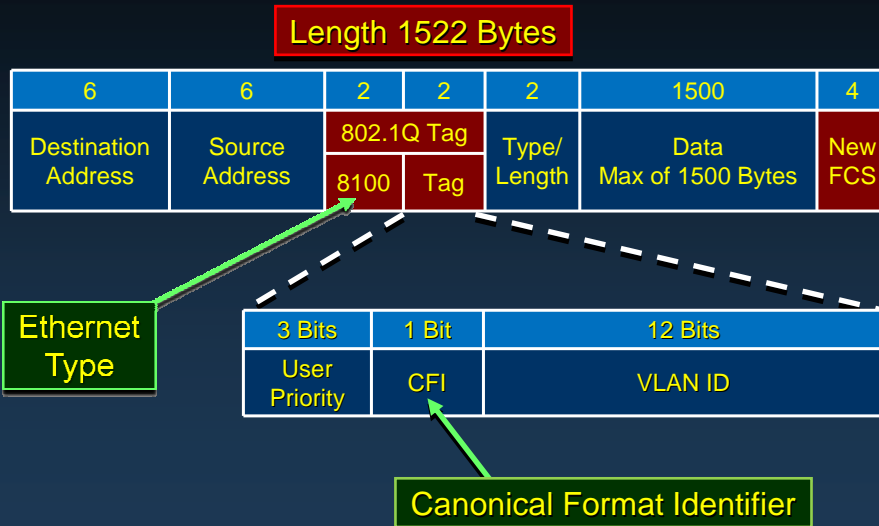
Native VLANs

- Tagged Frames on the native VLAN.
  - Some devices that support trunking tag native VLAN traffic as a default behavior.
  - *Control traffic sent on the native VLAN should be untagged.*
    - If an 802.1Q trunk port receives a tagged frame on the NATIVE VLAN ONLY, it drops the frame.
    - When configuring a switch port on a Cisco switch, you need to identify these devices and configure them so that they do not send tagged frames on the native VLAN.
    - Devices from other vendors that support tagged frames on the native VLAN include IP phones, servers, routers, and switches.

Native VLANs

- **Un-Tagged Frames on the native VLAN.**
  - When a Cisco switch trunk port receives untagged frames it forwards those frames to the native VLAN.
    - Default native VLAN is VLAN 1.
  - When you configure an 802.1Q trunk port, a **default Port VLAN ID (PVID)** is assigned the **value of the native VLAN.**
  - All untagged traffic coming in or out of the 802.1Q port is forwarded **based on the PVID value.**

Native VLANs

- **Configure the trunk to default to native VLAN 1.**

```
S1#configure terminal
S1(config)#interface f0/1
S1(config-if)#switchport mode trunk
S1(config-if)#end
```
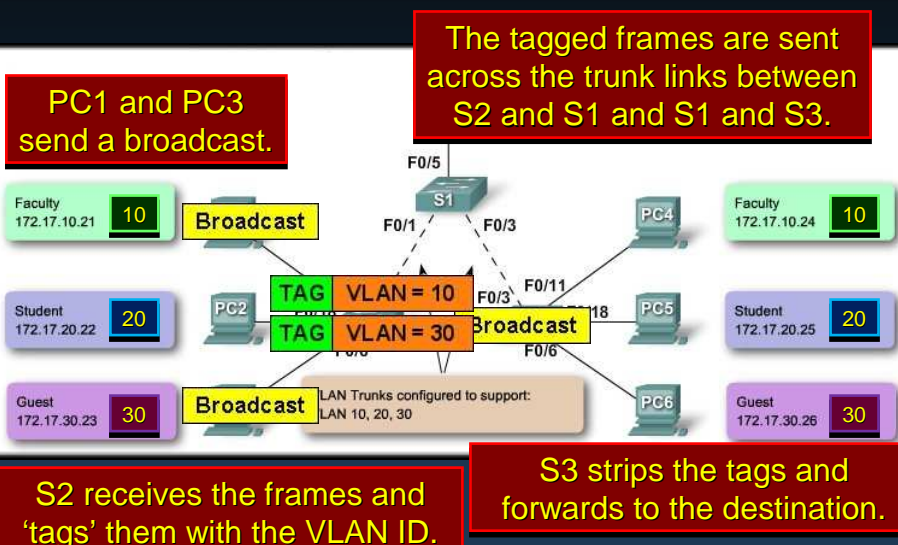
- **Configure the trunk for native VLAN 99.**

```
S1#configure terminal
S1(config)#interface f0/1
S1(config-if)#switchport mode trunk
S1(config-if)#switchport trunk native vlan 99
S1(config-if)#end
```

Native VLANs

- **Verify the configuration.**
    - VLAN 50 is a voice VLAN.

```
S1#show interfaces fa0/1 switchport
Name: Fa0/1
Switchport: Enabled
Administrative Mode: dynamic auto
Operational Mode: down
Administrative Trunking Encapsulation: dot1q
Negotiation of Trunking: On
Access Mode: VLAN 50
Trunking Native Mode VLAN: 99 (VLAN0099)
Administrative VLAN Tagging: Enabled
.
.
.
Administrative private-vlan trunk Native VLAN tagging: Enabled
Administrative private-vlan trunk encapsulation: dot1q
.
.
```

Trunking Operation

The tagged frames are sent across the trunk links between S2 and S1 and S1 and S3.

PC1 and PC3 send a broadcast.

S2 receives the frames and 'tags' them with the VLAN ID.

S3 strips the tags and forwards to the destination.

Trunking Modes

- A Cisco switch can be configured to support **two types** of trunk ports:
    - IEEE 802.1Q
    - ISL **(Inter-Switch Link)**

- Today only 802.1Q is used.
- Legacy networks may still use ISL.

Trunking Modes

- **IEEE 802.1Q:**
    - Assigned a default PVID.
    - Supports simultaneous tagged and untagged traffic.
    - **Untagged traffic:**
        - Associated with the port default PVID.
        - Null VLAN ID traffic belongs to the default PVID.
    - **Tagged traffic:**
        - VLAN ID equal to the outgoing port default PVID is sent untagged.
        - Null VLAN ID traffic belongs to the default PVID.
        - All other traffic is sent with a VLAN tag.

Trunking Modes

- ISL (Inter-Switch Link):
  - All received packets are expected to be encapsulated with an ISL header.
  - All transmitted packets are sent with an ISL header.
  - Untagged frames received from an ISL trunk port are dropped.
    - No longer recommended or supported.
      - 30 bytes of overhead for each frame…..

40 bits	4 bits	4 bits	48 bits	16 bits	24 bits	24 bits	15 bits	1 bits	16 bits	16 bits	Ethernet Frame Max. - 1518 Bytes	32 bits
DA	TYPE	USER	SA	LEN	SNAP/ LLC	HSA	VLAN ID	BPDU/ CDP	INDX	Reserved		FCS (CRC)

Trunking Modes

- Dynamic Trunking Protocol (DTP):
  - Cisco proprietary protocol. Switches from other vendors do not support DTP.
  - Automatically enabled on a switch port when certain trunking modes are configured on the switch port.
  - DTP manages trunk negotiation only if the port on the other switch is configured in a trunk mode that supports DTP.
  - DTP supports both ISL and 802.1Q trunks.
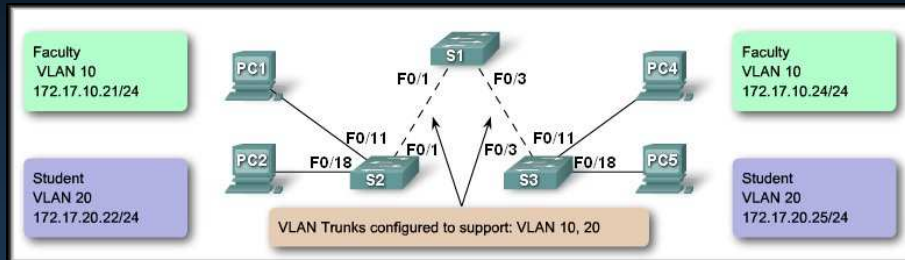 - Some Cisco switches and routers (older versions) do not support DTP.

Trunking Modes

- **Dynamic Trunking Protocol (DTP):**
- **On (default):** `(switchport mode trunk)`
  - Periodically sends DTP advertisements, to the remote port that it is dynamically changing to a trunking state.
- **Dynamic Auto:** `(switchport mode dynamic auto)`
  - The switch port periodically sends DTP frames to the remote port. It advertises to the remote switch port that it is able to trunk but does not request to go to the trunking state.
- **Dynamic Desirable:** `(switchport mode dynamic desirable)`
  - DTP frames are sent periodically to the remote port. It advertises to the remote switch port that it is able to trunk and asks the remote switch port to go to the trunking state.

Trunking Modes

- **Dynamic Trunking Protocol (DTP):**
- **Turn off DTP:** `(switchport nonegogiate)`
  - The local port does not send out DTP frames to the remote port.
  - The local port is then considered to be in an unconditional trunking state.
  - Use this feature when you need to configure a trunk with a switch from another switch vendor.

Virtual Local Area Networks

Configure VLANs and Trunks

Faculty
VLAN 10
172.17.10.21/24

Student
VLAN 20
172.17.20.22/24

Faculty
VLAN 10
172.17.10.24/24

Student
VLAN 20
172.17.20.25/24

VLAN Trunks configured to support: VLAN 10, 20

Configure VLANs and Trunks

- Overview:

    1. Create the VLANs.

    2. Assign switch ports to VLANs statically.

    3. Verify VLAN configuration.

    4. Enable trunking on the inter-switch connections.

    5. Verify trunk configuration.

Configure a VLAN

- **Command Syntax:**
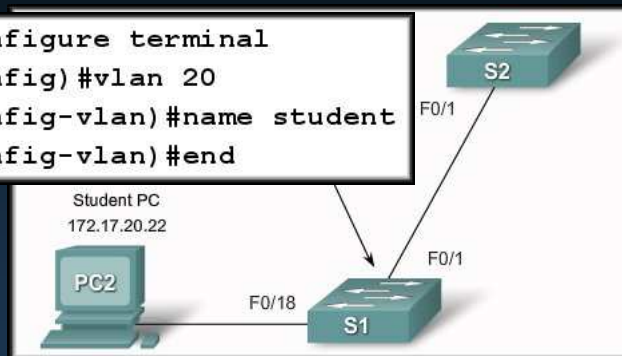
```
S1#configure terminal

S1(config)#vlan vlan id

S1(config-vlan)#name vlan name

S1(config-vlan)#end
```

Configure a VLAN

Configure a VLAN

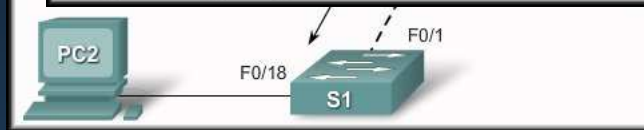```
S1#configure terminal
S1(config)#vlan 20
S1(config-vlan)#name student
S1(config-vlan)#end
```

# Configure a VLAN

## Assign switch ports to a VLAN

```
S1#configure terminal
S1(config)#interface fa0/18
S1(config-if)#switchport mode access
S1(config-if)#switchport access vlan 20
S1(config-if)#end
```

F0/1

PC2   F0/18

S1

Configure a VLAN

Verify VLAN configuration

```
S1#sh vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                Fa0/9, Fa0/10, Fa0/11, Fa0/12
                                                Fa0/13, Fa0/14, Fa0/15, Fa0/16
                                                Fa0/17, Fa0/19, Fa0/20, Fa0/21
                                                Fa0/22, Fa0/23, Fa0/24, Gig1/1
                                                Gig1/2
20   student                          active    Fa0/18
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active
S1#
```

Managing VLANs

Other `show vlan` command options

```
S1#show vlan name student

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
20   student                          active    Fa0/18


VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------
20   enet  100020     1500  -      -      -        -    -        0      0

S1#
```

```
S1#show vlan summary
Number of existing VLANs          : 6
 Number of existing VTP VLANs     : 6
  Number of existing extended VLANs : 0
S1#
```

Managing VLANs

`show interfaces` command

```
S1#show interfaces fa0/18 switchport  ◄━━━
Name: Fa0/18
Switchport: Enabled
Administrative Mode: dynamic auto
Operational Mode: static access
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: native
Negotiation of Trunking: On
Access Mode VLAN: 20 (student)  ◄━━━
Trunking Native Mode VLAN: 1 (default)  ◄━━━
Voice VLAN: none
Administrative private-vlan host-association: none
Administrative private-vlan mapping: none
Administrative private-vlan trunk native VLAN: none
.
.
```

Managing VLANs

Manage VLAN Memberships

Remove port VLAN membership.

```
S1#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                Fa0/9, Fa0/10, Fa0/11, Fa0/12
                                                Fa0/13, Fa0/14, Fa0/15, Fa0/16
                                                Fa0/17, Fa0/18, Fa0/19, Fa0/20
                                                Fa0/21, Fa0/22, Fa0/23, Fa0/24
                                                Gig1/1, Gig1/2
20   student                          active
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active
S1#
```

Managing VLANs

Manage VLAN Memberships

Remove port VLAN membership.

```
S1(config)#interface fa0/18
S1(config-if)#no switchport access vlan 20
S1(config-if)#end
```

Remove a VLAN

```
S1(config)#no vlan 20
S1(config)#end
```

- If you remove the VLAN **before removing the port membership** assignments, the ports **become unusable** until you issue the `no switchport access vlan` command.

Managing VLANs

- **Restoring to Factory Defaults:**
  - To remove all VLAN configuration:

```
S1#show flash:
Directory of flash:/

    1  -rw-       3058048         <no date>  c2950i6q4l2-mz.121-22.EA4.bin
    2  -rw-           556         <no date>  vlan.dat

64016384 bytes total (60957780 bytes free)
S1#
```

```
S1#delete flash:vlan.dat
Delete filename [vlan.dat]?
Delete flash:/vlan.dat? [confirm]

S1#
```

Chapter 3-2

Configure a Trunk

- **Command Syntax:**

```
S1#configure terminal

S1(config)#interface interface-id

S1(config-if)#switchport mode trunk
S1(config-if)#switchport trunk native vlan
                                  vlan-id
S1(config-if)#switchport trunk allowed vlan
                            add vlan-list

S1(config-vlan)#end
```

Chapter 3-2

Configure a Trunk

```
S1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
S1(config)#interface fa0/1
S1(config-if)#switchport mode trunk
S1(config-if)#switchport trunk native vlan 99
S1(config-if)#end
```

Faculty
VLAN 10
172.17.10.21

PC1

Student
VLAN 20
172.17.20.22

PC2

S1

S2

F0/1

Switch S1:
Port F0/1
Trunk Port
VLANS: 10,20,30,99

```
S2#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
S2(config)#interface fa0/1
S2(config-if)#switchport mode trunk
S2(config-if)#switchport trunk native vlan 99
S2(config-if)#end
```

Configure a Trunk

```
S1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
S1(config)#interface fa0/1
S1(config-if)#switchport mode trunk
S1(config-if)#switchport trunk native vlan 99
S1(config-if)#end
```

The native VLAN must match on both switches.

```
S2#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
S2(config)#interface fa0/1
S2(config-if)#switchport mode trunk
S2(config-if)#switchport trunk native vlan 99
S2(config-if)#end
```

Verify Trunk Configuration

```
S1#show interfaces fa0/1 switchport
Name: Fa0/1
Switchport: Enabled
Administrative Mode: trunk
Operational Mode: down
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: dot1q
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 99 (VLAN0099)
Voice VLAN: none
Administrative private-vlan host-association: none
Administrative private-vlan mapping: none
.
.
.
```

Managing a Trunk Configuration

```
S1#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
S1(config)#interface fa0/1
S1(config-if)#no switchport mode trunk
S1(config-if)#no switchport trunk native vlan 99
S1(config-if)#switchport mode access
S1(config-if)#switchport access vlan 10
S1(config-if)#end
%SYS-5-CONFIG_I: Configured from console by console
S1#show interface fa0/1 switchport
Name: Fa0/1
Switchport: Enabled
Administrative Mode: static access
Operational Mode: down
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: native
Negotiation of Trunking: On
Access Mode VLAN: 10 (VLAN0010)
Trunking Native Mode VLAN: 1 (default)
```

Managing a Trunk Configuration

- Pruning:
  - The process of specifying the traffic that will be allowed to traverse the trunk link.
  - Use the command:

    ```
    switchport trunk allowed vlan add vlan-list
    ```

  - The vlan-list is a list of the VLAN IDs, separated by commas, that will be allowed to use the trunk link.
  - The lists must match on both switches.

Common Problems with Trunks

- Native VLAN mismatches:
  - Trunk ports are configured with different native VLANs.
- Trunk Mode mismatches:
  - One trunk port is configured with trunk mode off and the other with trunk mode on.
- VLANs and IP Subnets:
  - End user devices configured with incorrect IP addresses will not have network connectivity. Each VLAN is a logically separate IP subnetwork. Devices within the VLAN must be configured with the correct IP settings.
- Allowed VLANs on trunks:
  - The list of allowed VLANs on a trunk does not match on both ends of the trunk.