
University of Colorado Boulder

Fundamentals of Data Communications CSCI 5010

VLANs & Trunking

Levi Perigo, Ph.D.
University of Colorado Boulder
Department of Computer Science
Network Engineering

Review

VLANs & Trunking

- **Multiple networks (virtual)**
  - Why?
- **Trunk ports**
  - Why?
- **VLAN tagging**
  - Native VLAN
- **InterVLAN Routing**
  - Sub-interfaces
  - Router-on-a-stick

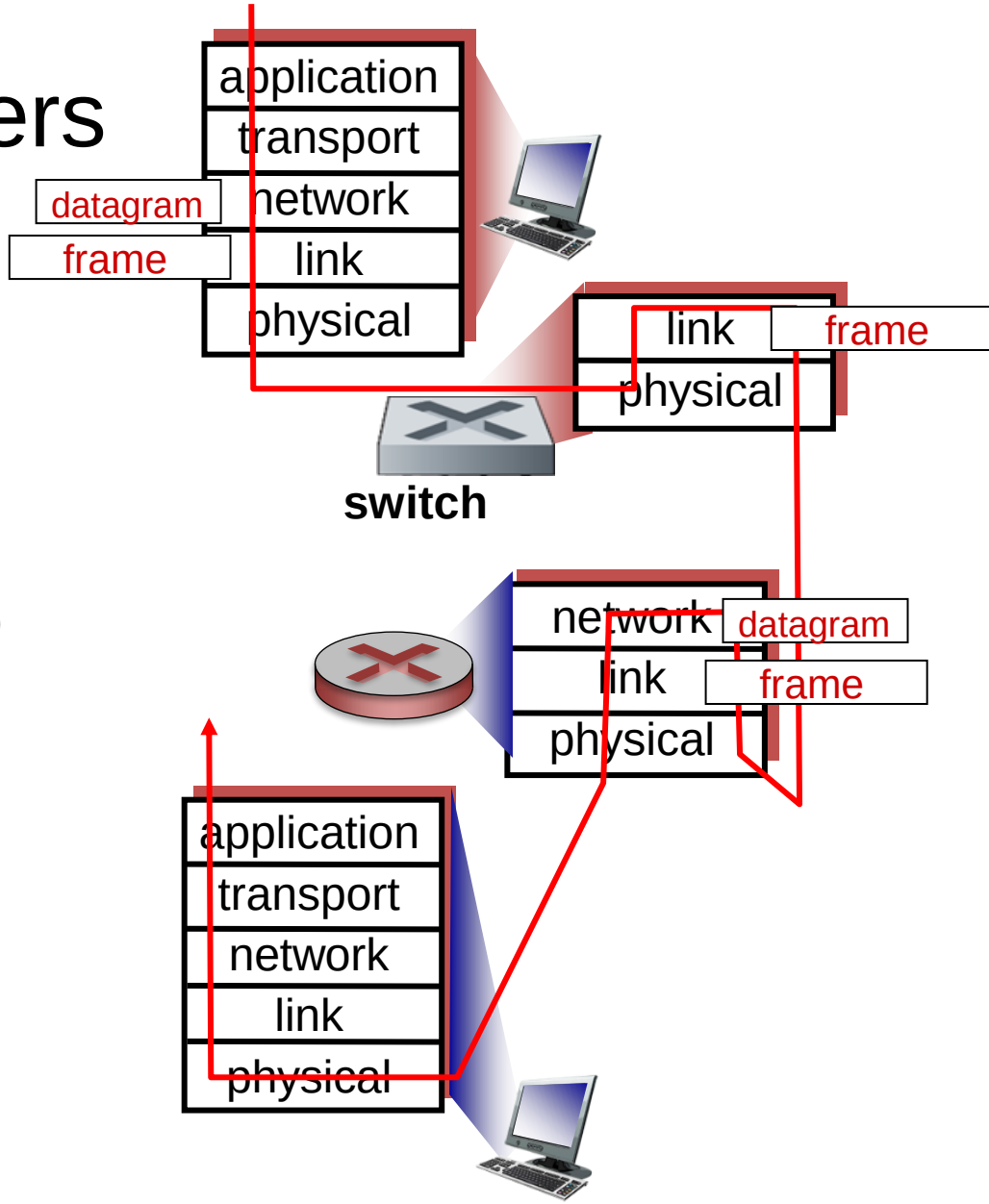
Switches vs. Routers

Both are store-and-forward:

- *Routers:* network-layer devices (examine network-layer headers)
- *Switches:* link-layer devices (examine link-layer headers)

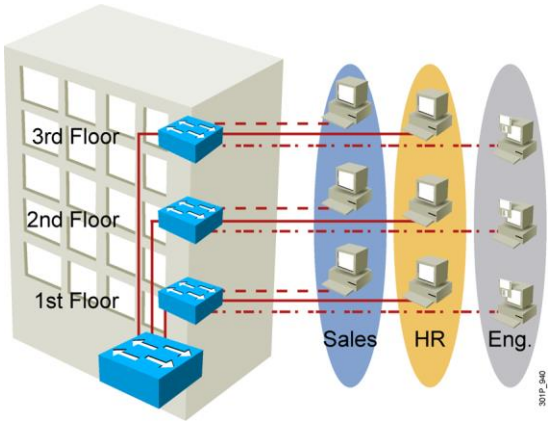
Both have forwarding tables:

- *Routers:* compute tables using routing algorithms, IP addresses
- *Switches:* learn forwarding table using flooding, learning, MAC addresses



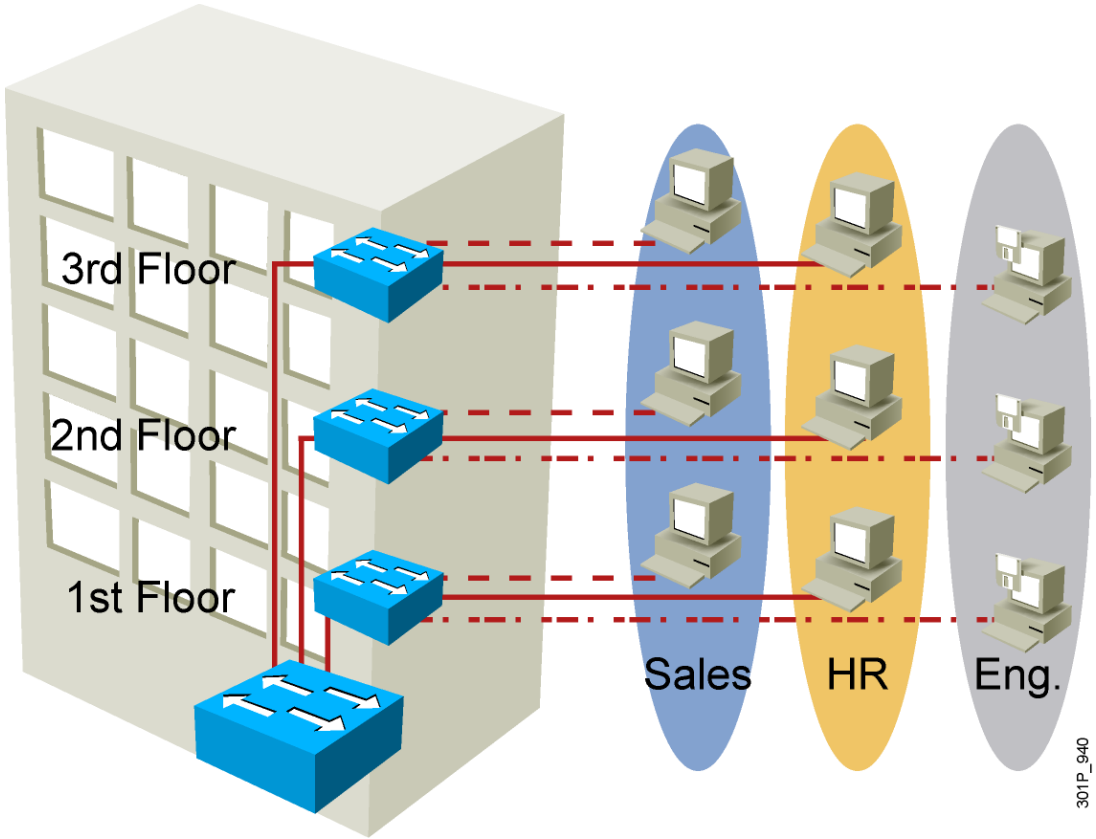
VLAN

- **Virtual LAN:**
  - Broadcast domain created by one or more switches
  - A switch can separate ports in groups each becoming its own broadcast domain
  - Cost effective



- **Usage**
  - Grouping common stations
  - Security
  - Limiting size of Broadcast Domains
  - Separate specialized traffic

VLAN Overview



- Segmentation
- Flexibility
- Security

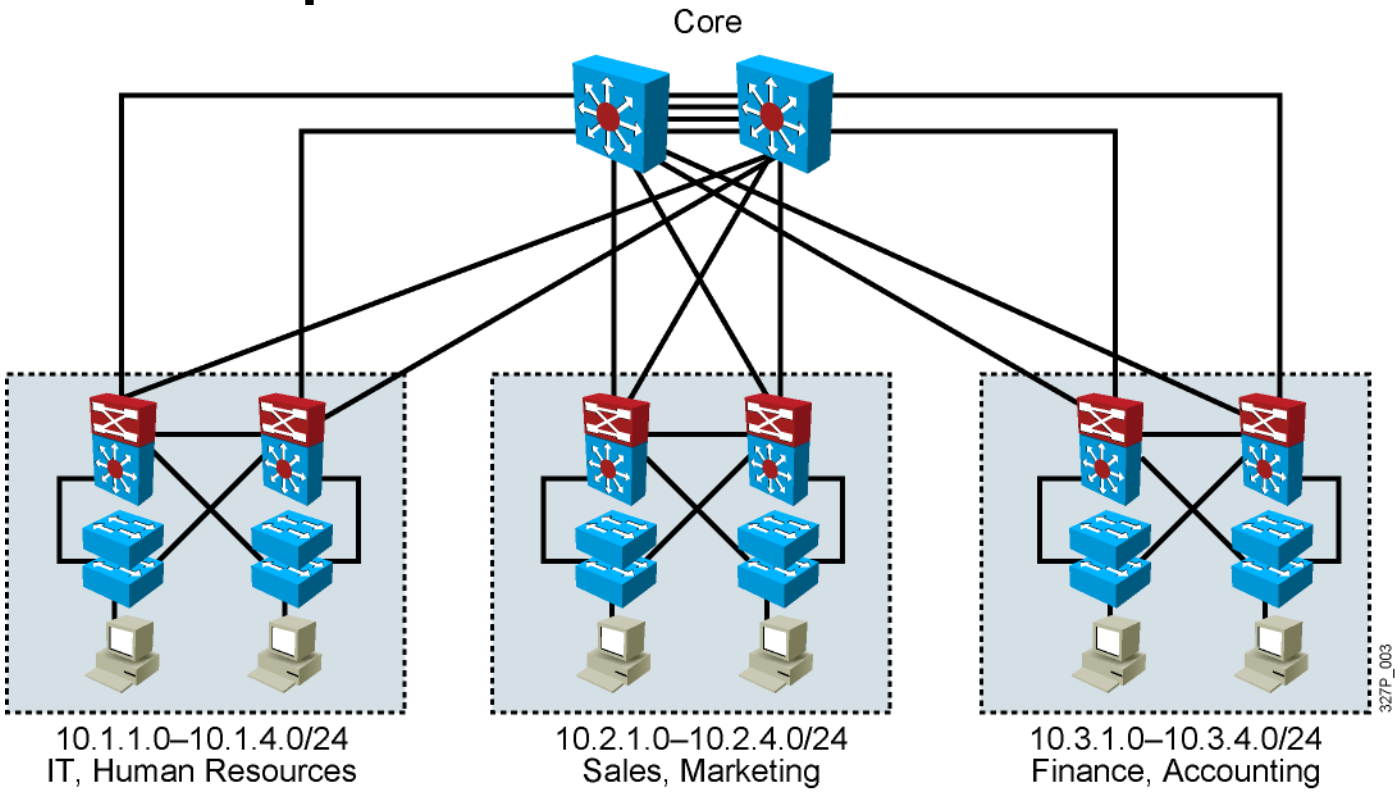
VLAN = Broadcast Domain = Logical Network (Subnet)

Designing VLANs for an Organization

- VLAN design must take into consideration the implementation of a hierarchical network addressing scheme.

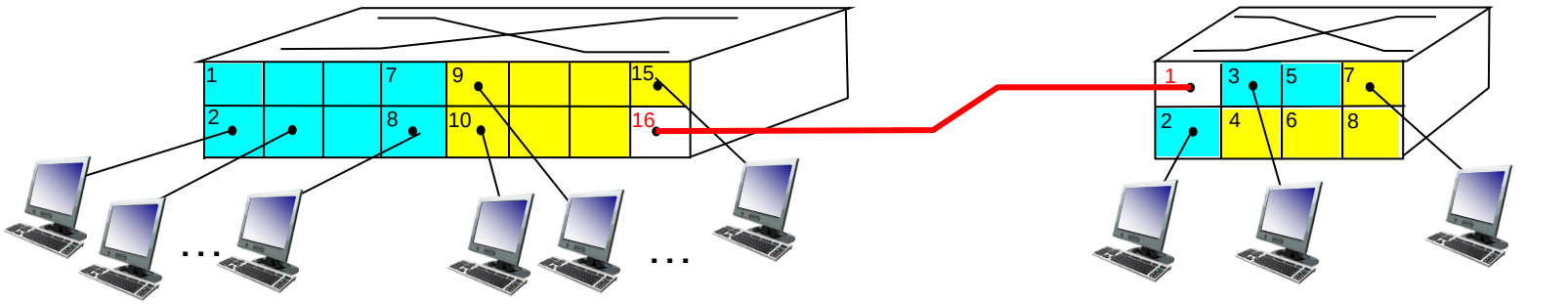
- The benefits of hierarchical addressing are:
  - ***Ease of management and troubleshooting***
  - ***Minimization of errors***
  - ***Reduced number of routing table entries***

Guidelines for Applying IP Address Space



- Allocate one IP subnet per VLAN
- Allocate IP address spaces in contiguous blocks

VLANs Spanning Multiple Switches



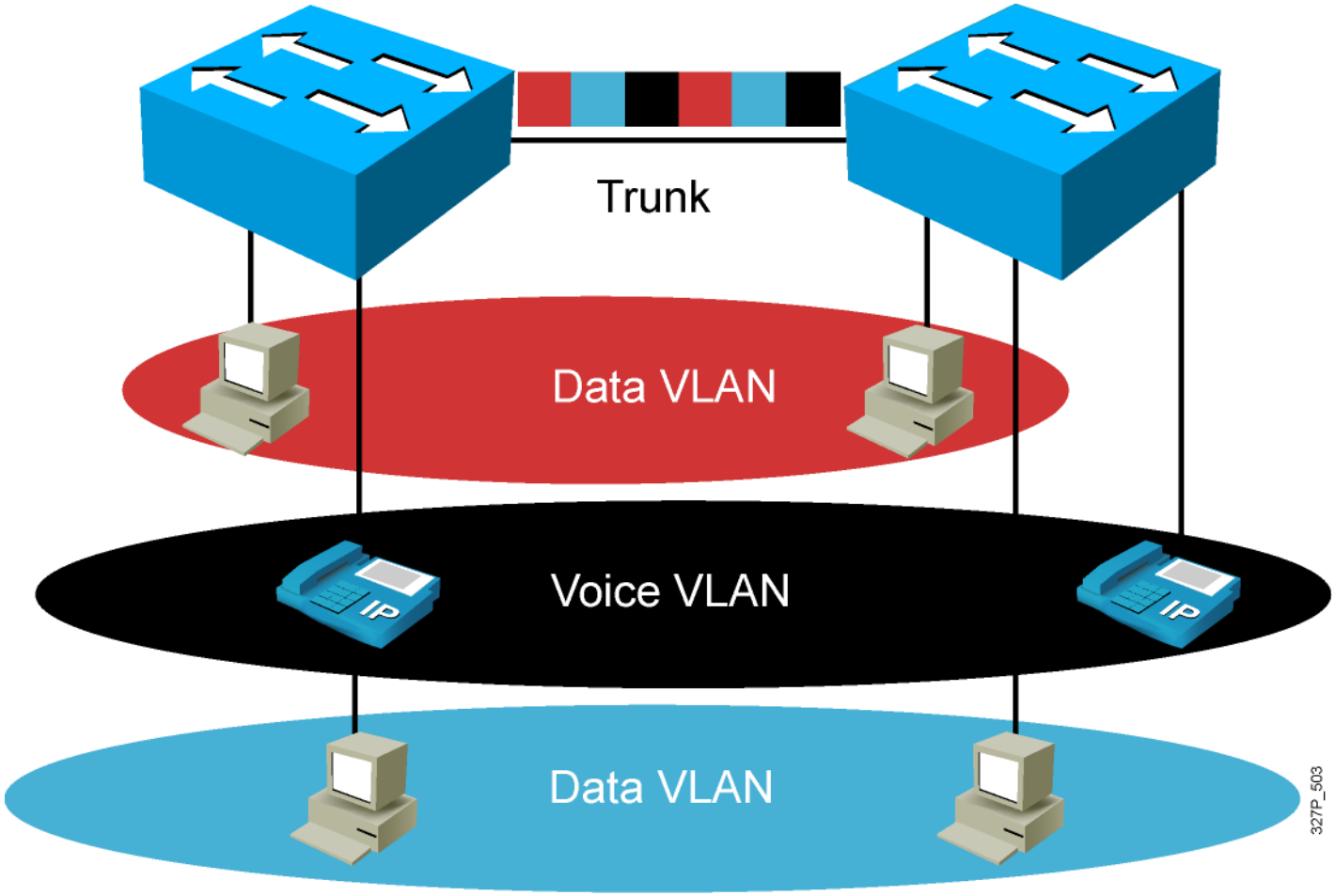
Electrical Engineering (EE)
(VLAN ports 1-8)

Computer Science (CS)
(VLAN ports 9-15)

Ports 2,3,5 belong to EE VLAN
Ports 4,6,7,8 belong to CS VLAN

- *Trunk Port:* carries frames between VLANS defined over multiple physical switches
  - Frames forwarded within VLAN between switches only be 802.1 frames (must carry VLAN ID info)
  - 802.1q protocol adds/removes additional header fields for frames forwarded between trunk ports

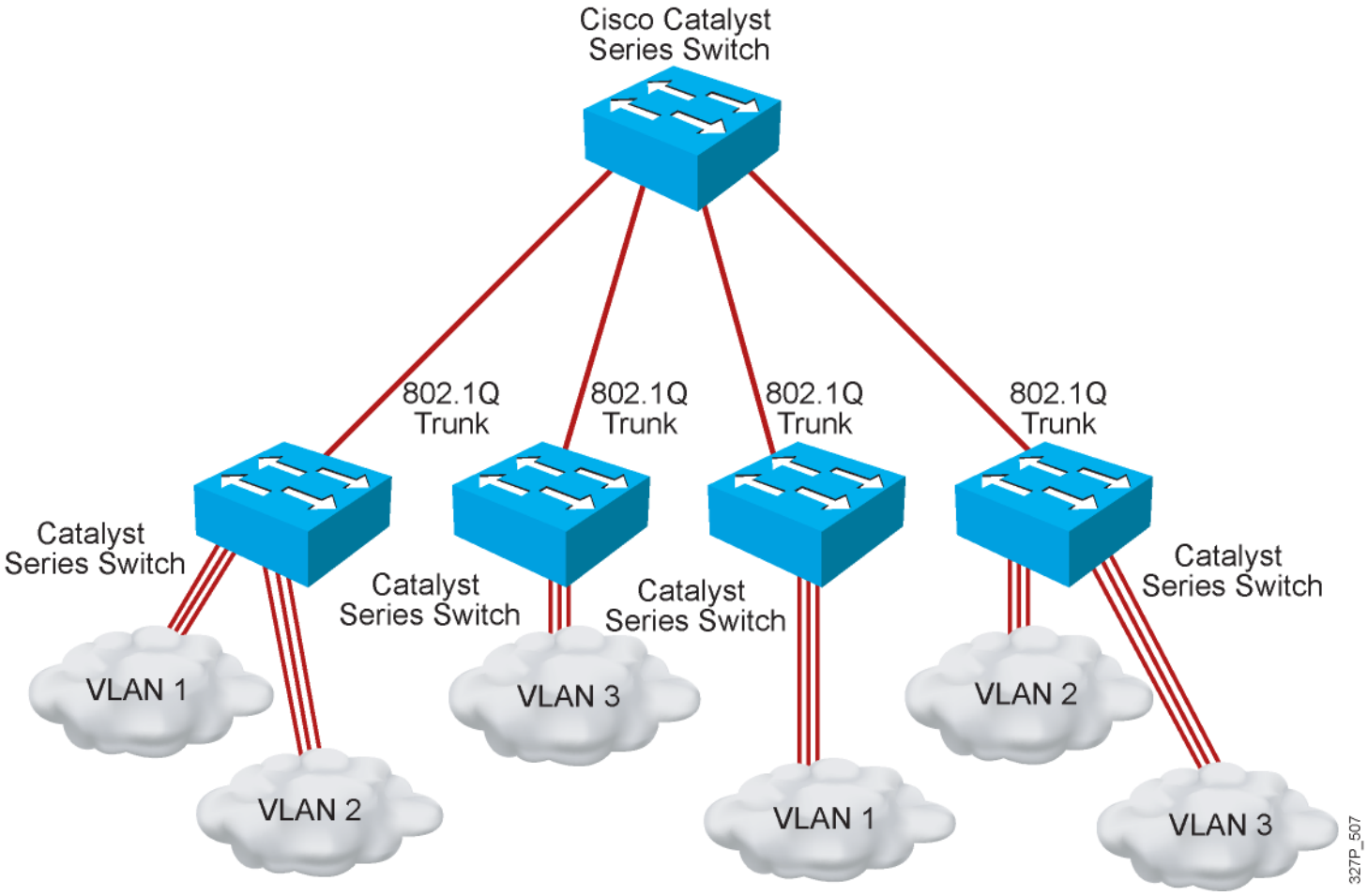
VLAN Operation



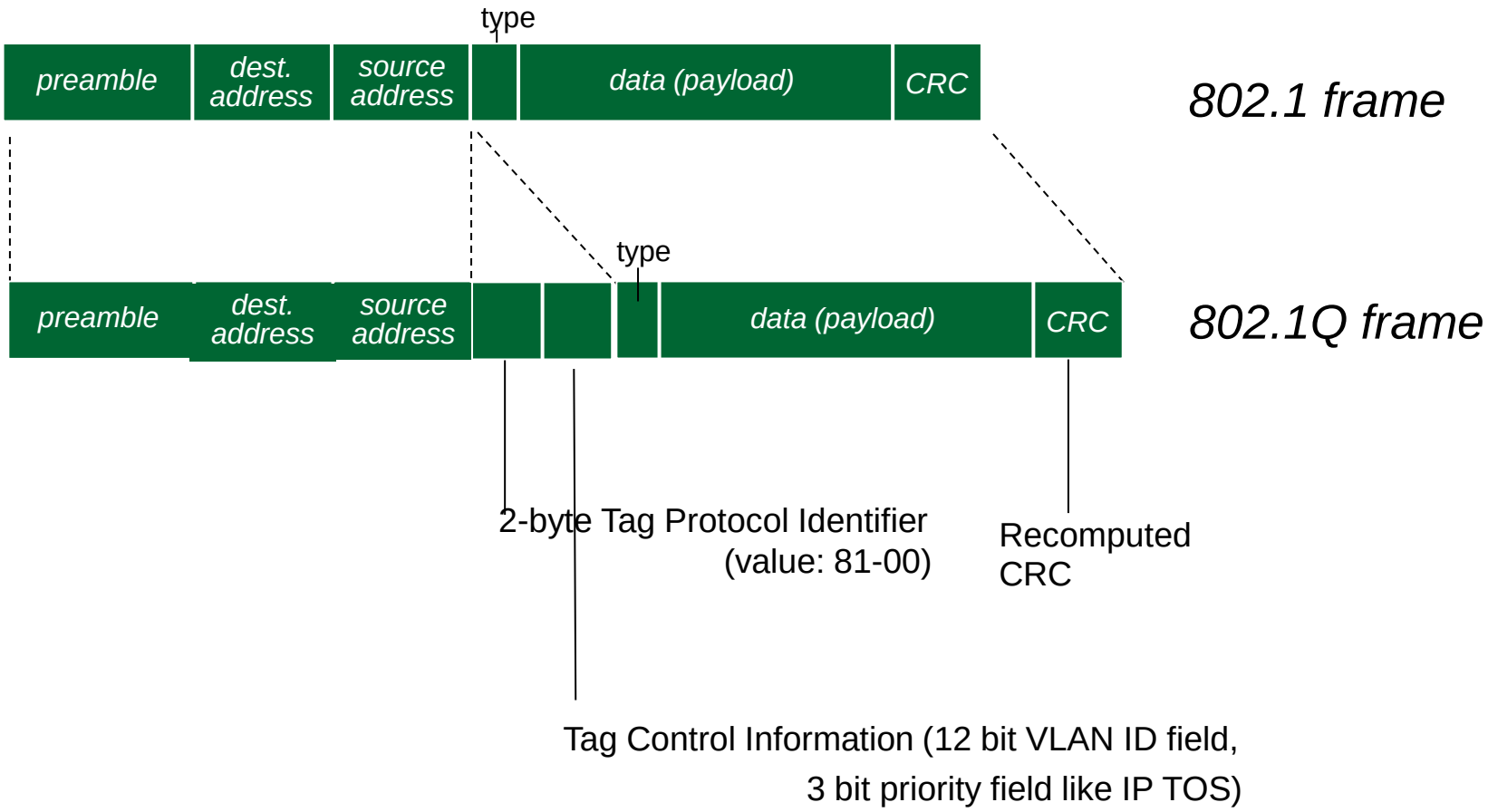
Trunking

- Ethernet trunks carry the traffic of multiple VLANs over a single link and allow you to extend VLANs across an entire network.
- Connection between two switches (and switch to router), designed to propagate VLAN information when supporting VLAN members in more than one switch.
- Frames exchanged between switches are tagged in order to determine to which VLAN they belong.
- Most switches support the IEEE standard trunking protocol
  - ***802.1q***

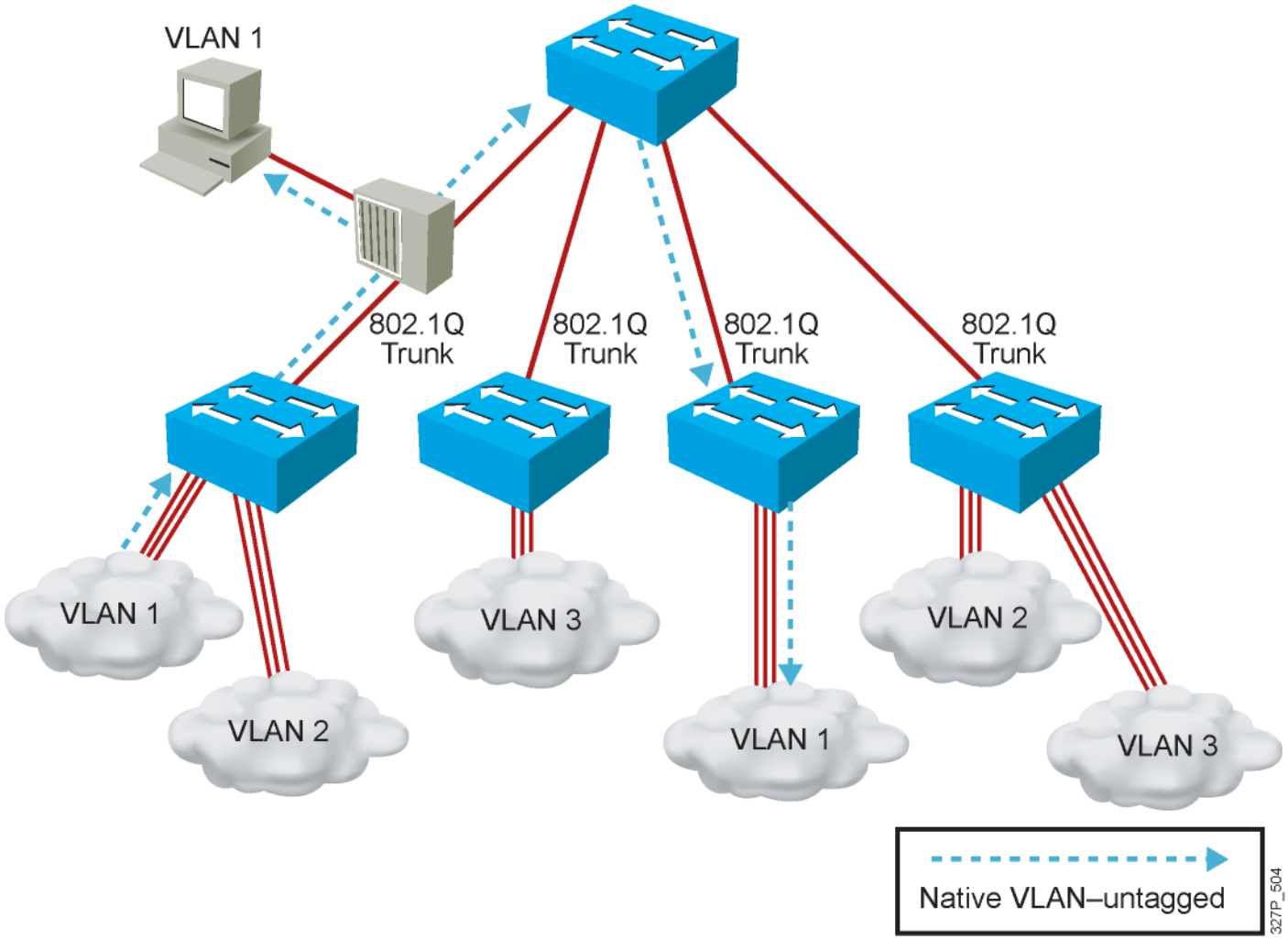
802.1q Trunking



802.1Q VLAN Frame Format



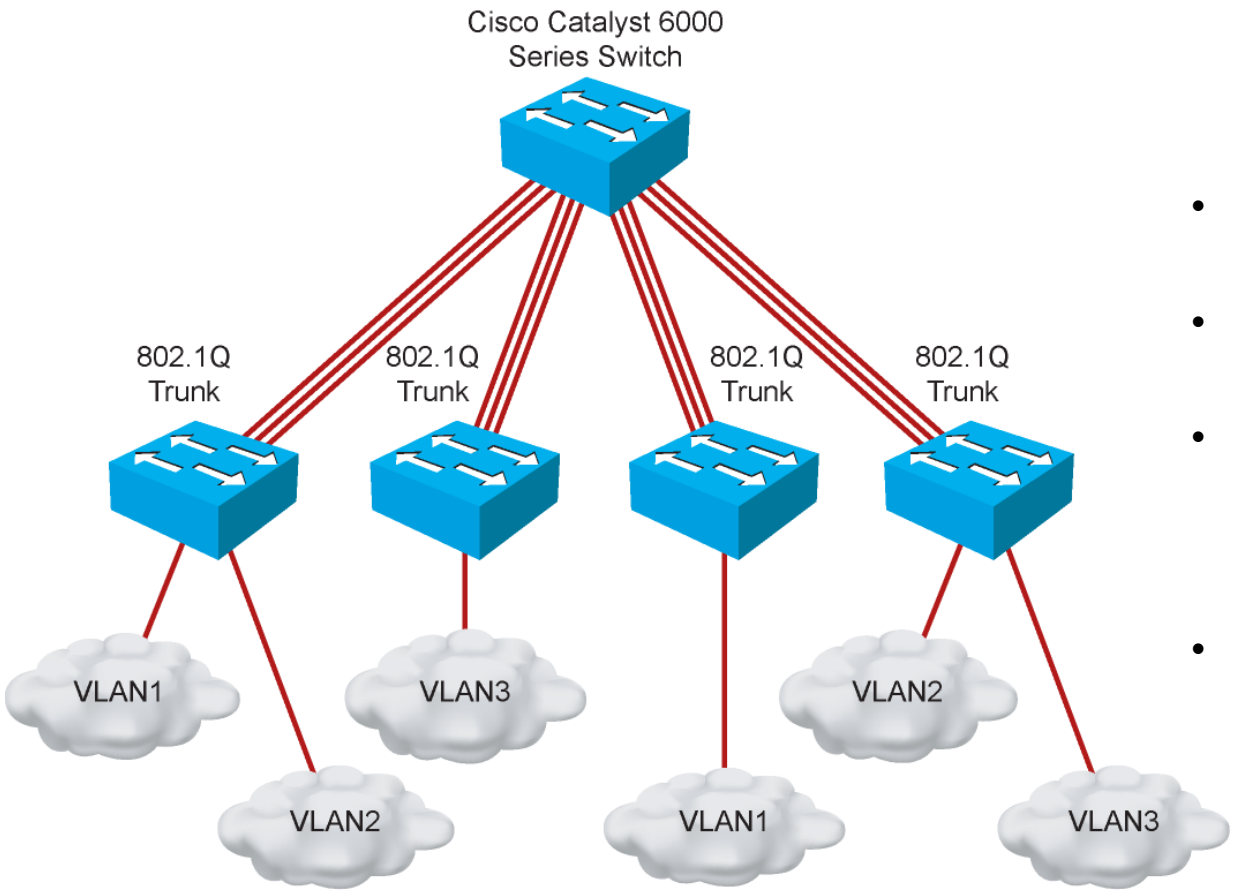
Understanding Native VLANs



VLAN Creation Guidelines

- The maximum number of VLANs is switch-dependent.
- Most Cisco Catalyst desktop switches support 128 separate spanning-tree instances, one per VLAN.
- VLAN 1 is the factory default Ethernet VLAN.
- Cisco Discovery Protocol (CDP) and VTP advertisements are sent on VLAN 1.
- The Cisco Catalyst switch IP address is in the management VLAN (VLAN 1 by default).
- *VLANs must be defined on all switches that frame/VLAN will traverse

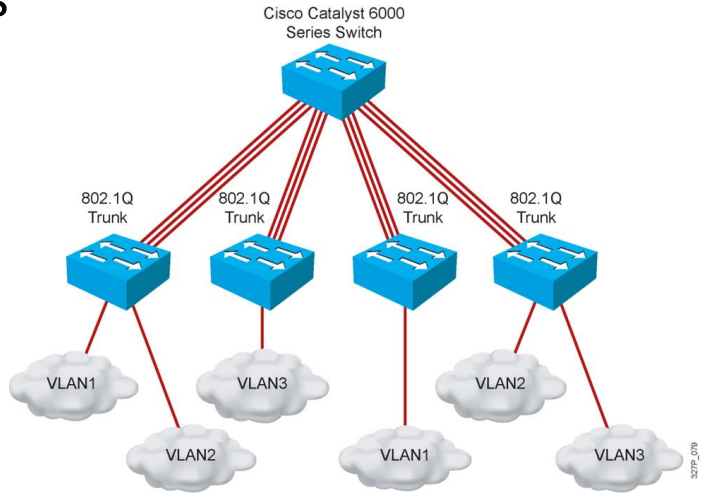
802.1Q Trunking Issues



- Make sure that the native VLAN for an 802.1Q trunk is the same on both ends of the trunk link.
- Note that native VLAN frames are untagged.
- A trunk port cannot be a secure port.
- All 802.1Q trunking ports in an EtherChannel group must have the same configuration.
- VLANs must be defined on all switches that frame/VLAN will traverse

Executing Adds, Moves, and Changes for VLANs

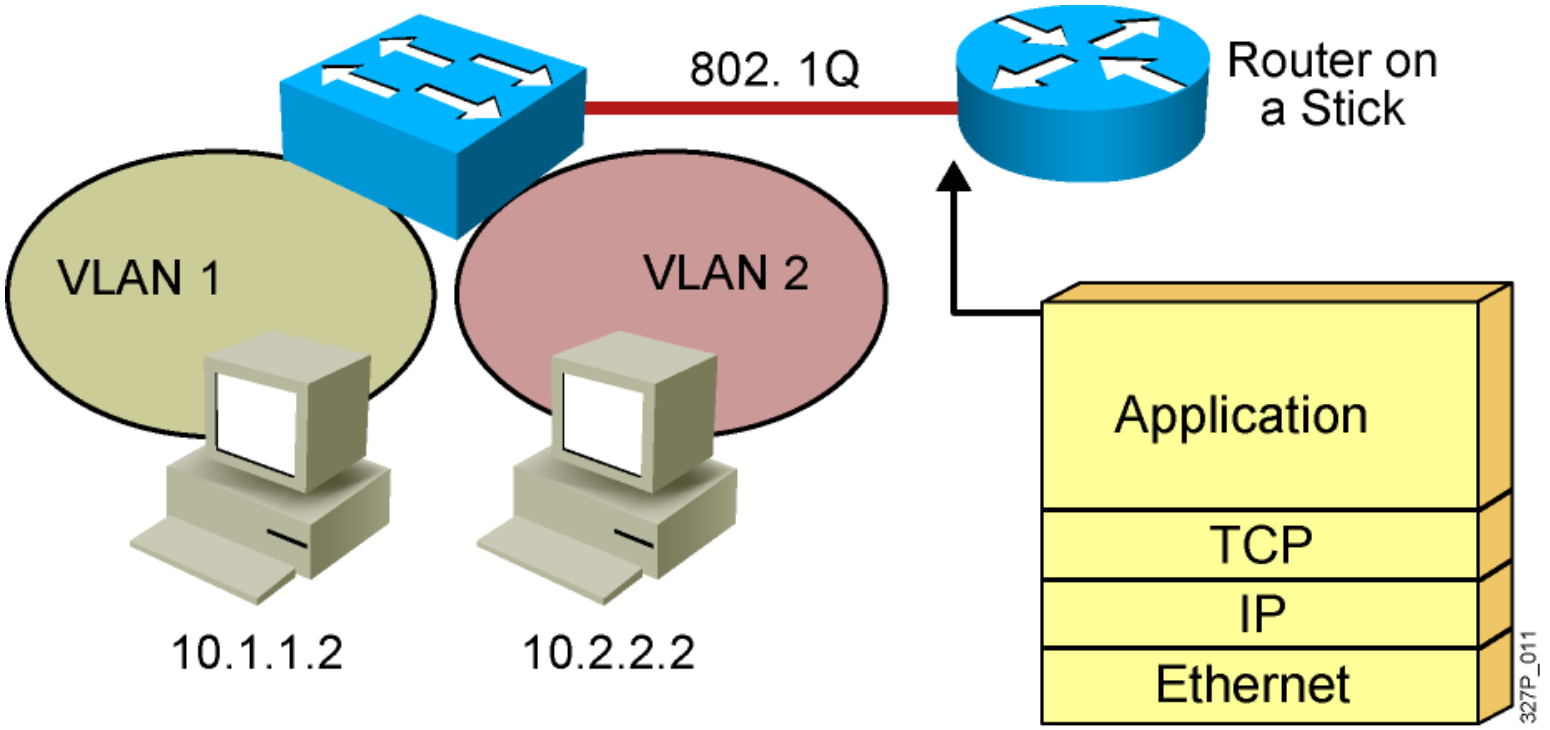
- Changing VLANs typically implies changing IP networks.
- After a port is reassigned to a new VLAN, that port is automatically removed from its previous VLAN.
- When you delete a VLAN, any ports in that VLAN that are not moved to an active VLAN will be unable to communicate with other stations



Inter-VLAN Communication

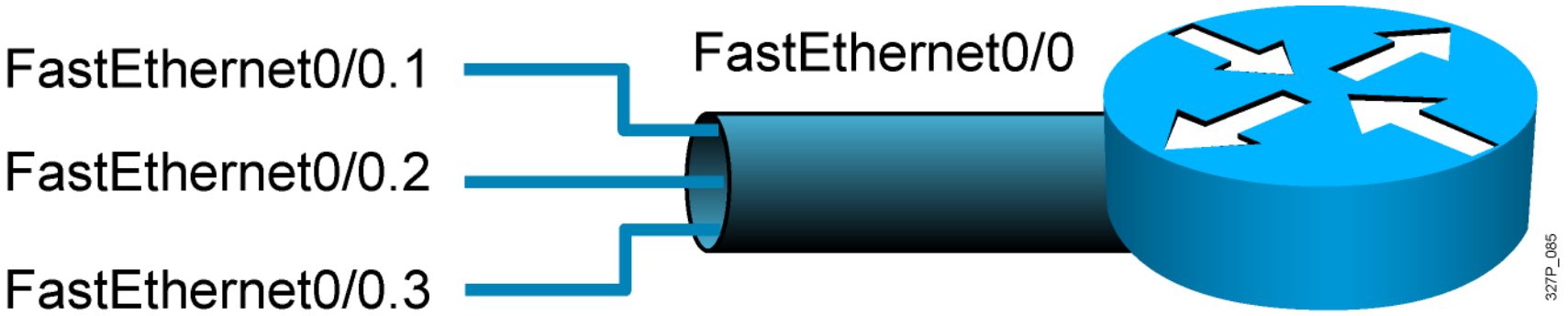
- **Layer 2 Switching**
  - Cannot forward traffic between VLANs, just within them
- **Layer 3 Forwarding (Router)**
  - Each VLAN corresponds to a different subnet
  - The router needs an *interface* on each subnet to forward traffic between them – wasteful
    - ***Instead you can use an Ethernet interface that supports trunking (now we expand trunking concept)***
- **Layer 3 Forwarding (Switch)**
  - Switch with routing capabilities
  - Forwarding on basis of L3 IP routing table
  - Specialized ASICs make forwarding process very fast ($$$)

VLAN-to-VLAN Overview



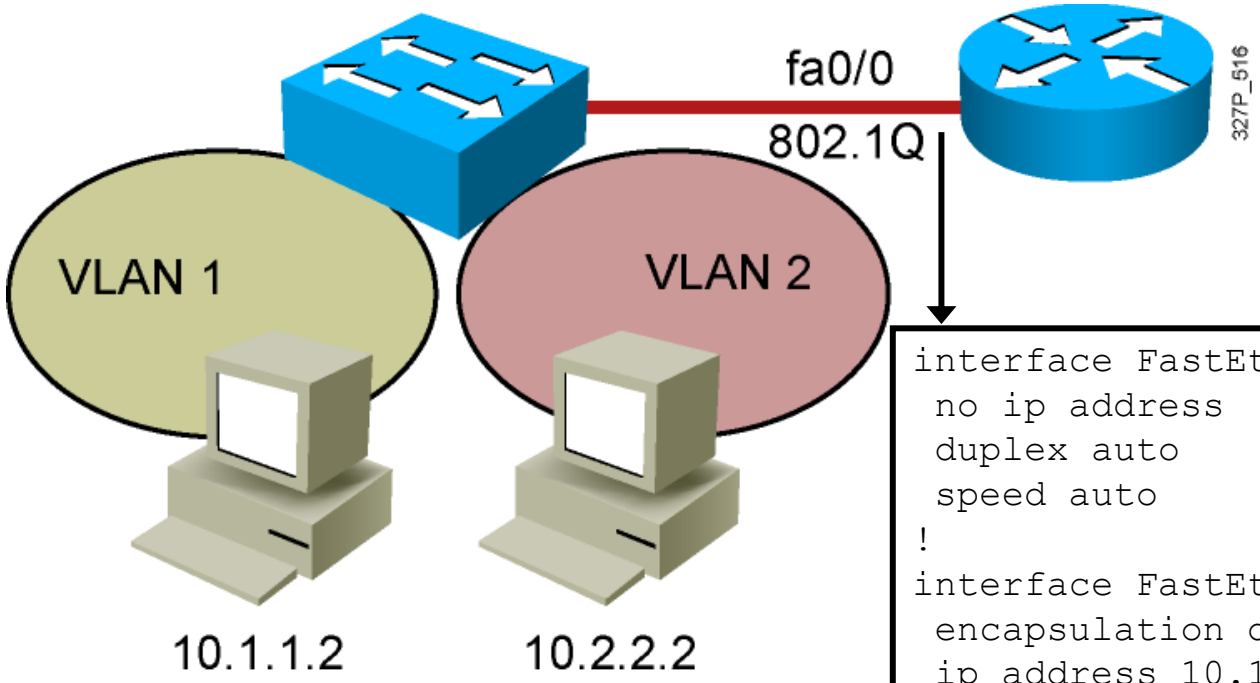
- Network layer devices combine multiple broadcast domains

Dividing a Physical Interface into Subinterfaces



- Physical interfaces on a router can be divided into multiple subinterfaces.

Routing Between VLANs with 802.1Q Trunks




```
interface FastEthernet0/0
 no ip address
 duplex auto
 speed auto
!
interface FastEthernet0/0.1
 encapsulation dot1Q 1 native
 ip address 10.1.1.1 255.255.255.0
!
interface FastEthernet0/0.2
 encapsulation dot1Q 2
 ip address 10.2.2.1 255.255.255.0
```

Review

Questions?

Lab

Switching Configuration

Configuring 802.1Q Trunking

```
(config-if)#
switchport mode {access |  dynamic {auto | desirable} | trunk}
```

- Configures the trunking characteristics of the port

```
(config-if)#
switchport mode trunk
```

- Configures the port as a VLAN trunk

Verifying a Trunk

```
# show interfaces interface [switchport | trunk]
```

```
# show interfaces fa0/11 switchport
Name: Fa0/11
Switchport: Enabled
Administrative Mode: trunk
Operational Mode: down
Administrative Trunking Encapsulation: dot1q
Negotiation of Trunking: On
Access Mode VLAN: 1 (default)
Trunking Native Mode VLAN: 1 (default)
  . . .
```

```
# show interfaces fa0/11 trunk

Port        Mode         Encapsulation  Status        Native vlan
Fa0/11      desirable    802.1q         trunking      1

Port      Vlans allowed on trunk
Fa0/11      1-4094

Port        Vlans allowed and active in management domain
Fa0/11      1-13
```

Adding a VLAN

```
# configure terminal
(config)# vlan 2
(config-vlan)# name switchlab99
```

Verifying a VLAN

```
# show vlan [brief | id vlan-id || name vlan-name]
```

```
# show vlan id 2

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
2    switchlab99                      active    Fa0/2, Fa0/12

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------
2    enet  100002     1500  -      -      -        -    -        0      0

.    .    .
```

Assigning Switch Ports to a VLAN

```
(config-if)#
switchport access [vlan vlan# | dynamic]
```

```
# configure terminal
(config)# interface range fastethernet 0/2 - 4
(config-if)# switchport access vlan 2

# show vlan

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------
1    default                           active    Fa0/1
2    switchlab99                       active    Fa0/2, Fa0/3, Fa0/4
```

Verifying VLAN Membership

```
# show vlan brief
```

```
# show vlan brief
VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1    default                           active    Fa0/1
2    switchlab99                       active    Fa0/2, Fa0/3, Fa0/4
3    vlan3                             active
4    vlan4                             active
1002 fddi-default                      act/unsup
1003 token-ring-default                act/unsup

VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1004 fddinet-default                   act/unsup
1005 trnet-default                     act/unsup
```

Verifying VLAN Membership (Cont.)

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

```
show interfaces interface switchport
```

```
# show interfaces fa0/2 switchport
Name: Fa0/2
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: 2 (switchlab99)
Trunking Native Mode VLAN: 1 (default)
--- output omitted ----
```