

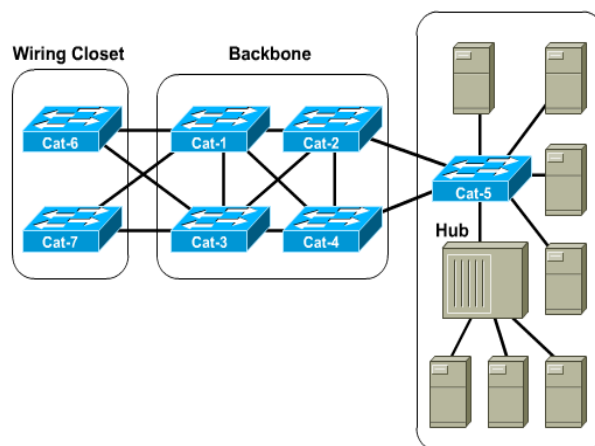
# Computer networks 4 CCNP3 Multilayer Switching

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## Module 3: Implementing Spanning Tree



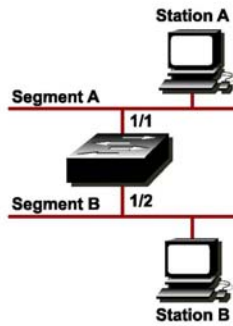
# Transparent Bridges

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## Transparent Bridging

FIGURE

1



A switch has the same characteristics as a transparent bridge.

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# Implementing Spanning Tree

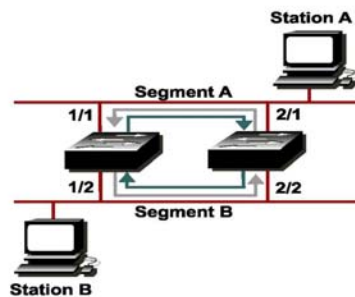
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## What Is a Bridge Loop?

FIGURES

1

2



Bridge loops can occur any time there is a redundant path or loop in the bridged network.

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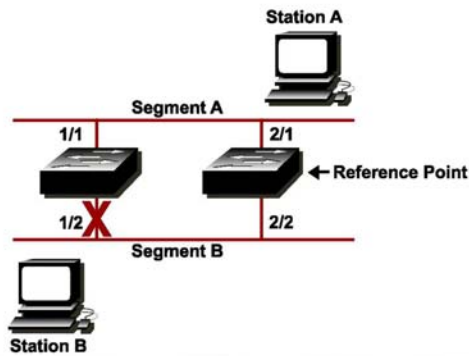
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# Explaining a Loop Free Network

## Preventing Bridge Loops

FIGURE 1



Bridge loops can be prevented by disabling the redundant path.

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# Implementing Spanning Tree

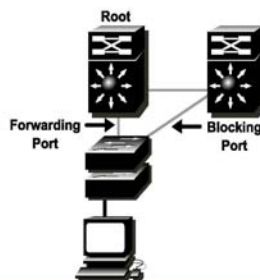
STP executes an algorithm called STA.

STA chooses a reference point, called a root bridge, and then determines the available paths to that reference point.

**If more than two paths exists, STA picks the best path and blocks the rest**

## 802.1D Spanning Tree Protocol

FIGURES 1 2



- Configured root switch
- Redundant switch links
- Optimal path selection

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## Implementing Spanning Tree

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- **Root ID** – The lowest BID in the topology
- **Cost of Path** – Cost of all links from the transmitting switch to the root bridge
- **Bridge ID** – (BID) of the transmitting switch
- **Port ID** – Transmitting switch port ID
- **STP timer values** – Max\_Age, Hello Time, Forward Delay

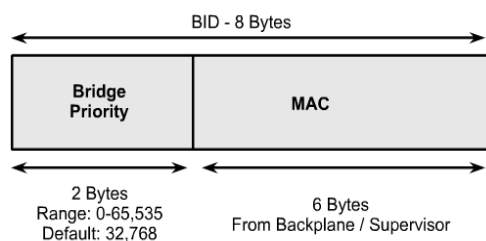
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### Bridge IDs

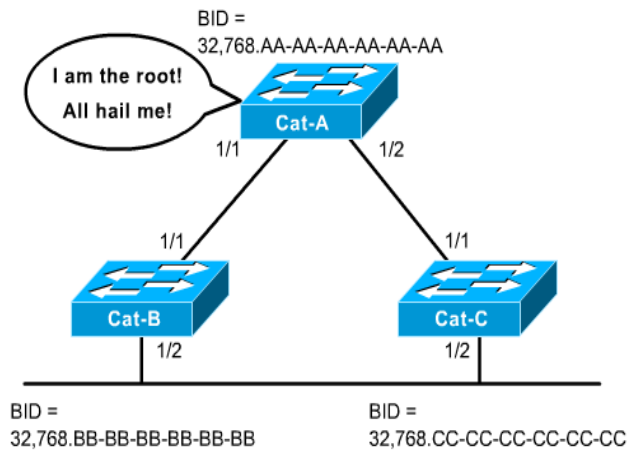


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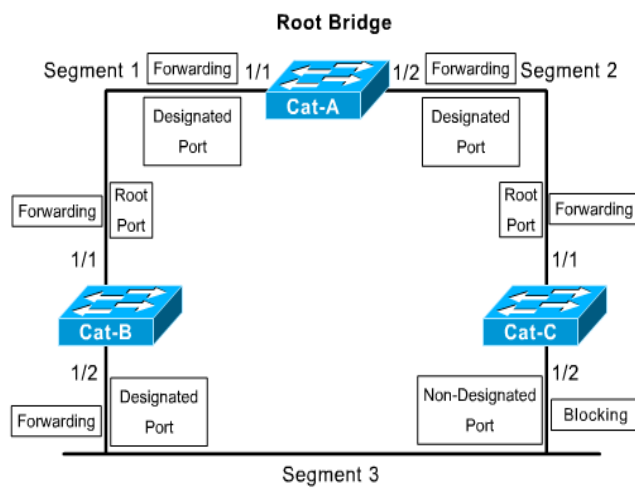


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# Implementing Spanning Tree

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## Implementing Spanning Tree

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| State      | Purpose                       |
|------------|-------------------------------|
| Forwarding | Sending / receiving user data |
| Learning   | Building bridging table       |
| Listening  | Building "active" topology    |
| Blocking   | Receives BPDUs only           |
| Disabled   | Administratively down         |

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## Implementing Spanning Tree

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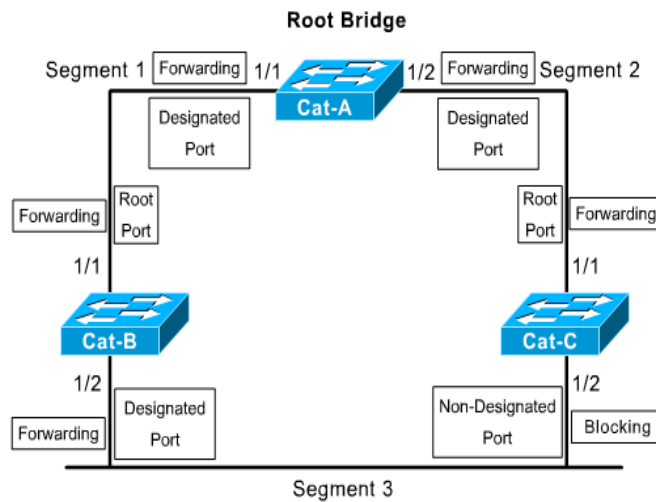
| Timer         | Primary Purpose  | Default |
|---------------|--|---------|
| Hello Time    | Time between sending of Configuration BPDUs by the Root Bridge | 2 Secs  |
| Forward Delay | Duration of Listening and Learning States                      | 15 Secs |
| Max Age       | Time BPDUs stored  | 20 Secs |

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# STP

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## Spanning Tree Enhancements

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Implementation of :

- Rapid Spanning Tree Protocol 802.1w (RSTP);**
- Per VLAN Spanning Tree 802.1q (PVST +);**
- Multiple Spanning Tree 802.1s (MST);**
- Load balancing across links;**
- BPDU guard;**
- Root Guard;**
- Uni-Directional Link Detection (UDLD)**

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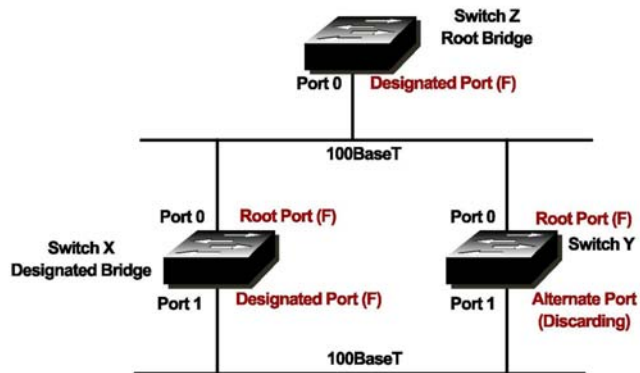
# Rapid Spanning Tree

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## Rapid Spanning Tree Protocol

FIGURE

1



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# Spanning Tree Enhancements

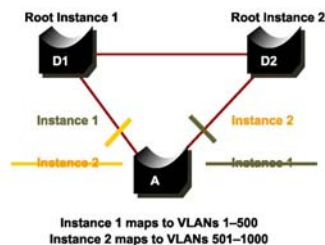
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MST (IEEE 802.1s) extends the IEEE 802.1w Rapid Spanning Tree (RST) algorithm to multiple spanning-trees.

## Multiple Spanning Tree Protocol

FIGURE

1



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# Describing EtherChannel

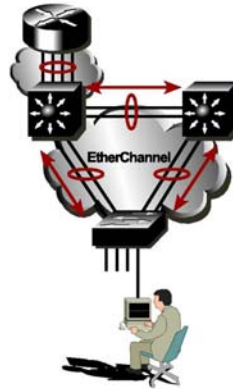
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## EtherChannel

### FIGURES

- 1
- 2

- interface port-channel (channel-group-number)
- channel-protocol pppp
- channel-group 1 mode (mode)



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# Module 4: Implementing Inter-VLAN Routing

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- External Route Processors
- Internal Route Processors

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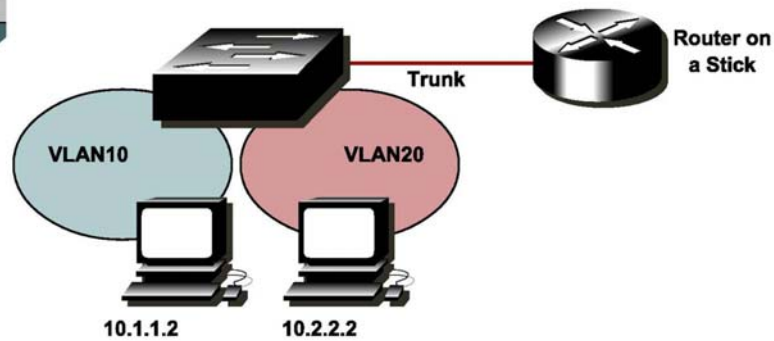
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## Inter-VLAN Routing with External Router

FIGURES

1

2



Single trunk link carries traffic for multiple VLANs to and from router.

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## Advantages and disadvantages of inter-VLAN routing on an external router.

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### Advantages :

- Implementation is simple.
- Layer 3 services are not required on the switch.
- The router provides communications between VLANs.

### Disadvantages:

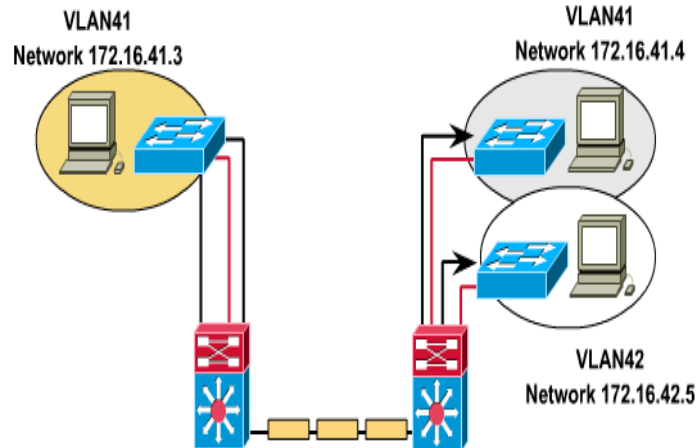
- The router is a single point of failure.
- The single traffic path between the switch and the router may become congested.
- Latency is higher than on a Layer 3 switch.

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# Implementing Multilayer Switching

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# Frame Rewrite

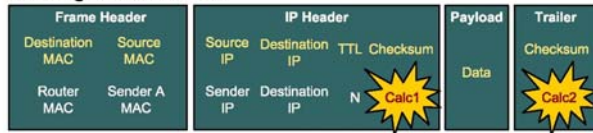
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## IP Unicast Frame and Packet Rewrite

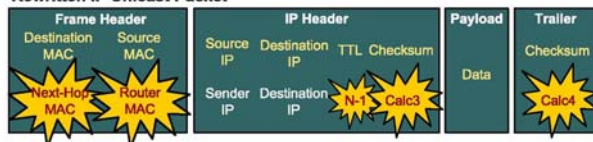
FIGURES

- 1
- 2
- 3

### Incoming IP Unicast Packet



### Rewritten IP Unicast Packet



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## Frame Rewrite

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- **CAM table:** Primary table used to make Layer 2 forwarding decisions. The table is built by recording the source address and inbound port of all frames. When a frame arrives at the switch with a destination MAC address of an entry in the CAM table, the frame is forwarded out only through the port associated with that specific MAC address.
- **TCAM table:** Stores ACL, QoS, and other information generally associated with upper-layer processing.

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## Implementing Multilayer Switching

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Layer 3 switching can occur at two different locations on the switch:

- **Centralized switching** – Switching decisions are made on the route processor by a central forwarding table, typically controlled by an ASIC.
- **Distributed switching** – Switching decisions can be made on a port or line card level rather than on a central route processor. Cached tables are distributed and synchronized to various hardware components so processing can be distributed throughout the switch chassis.

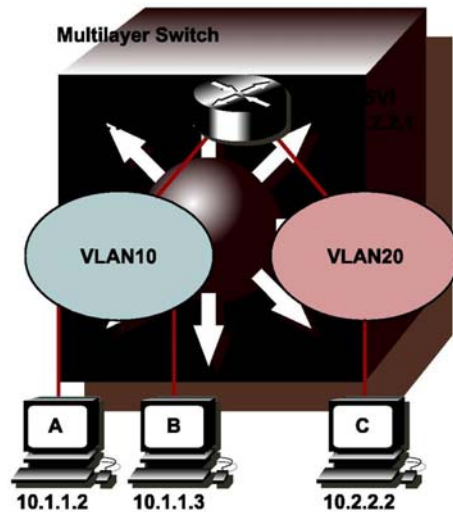
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## Layer 3 Switch Virtual Interface

FIGURE

1



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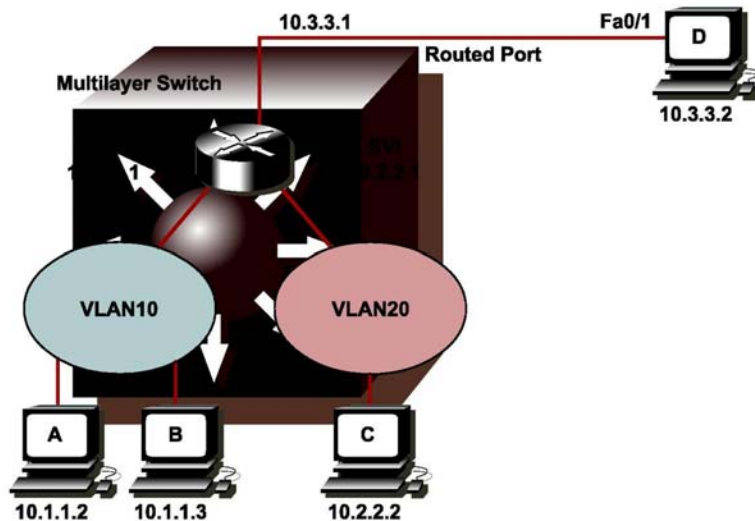
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## Routed Ports on a Multilayer Switch

FIGURE

1



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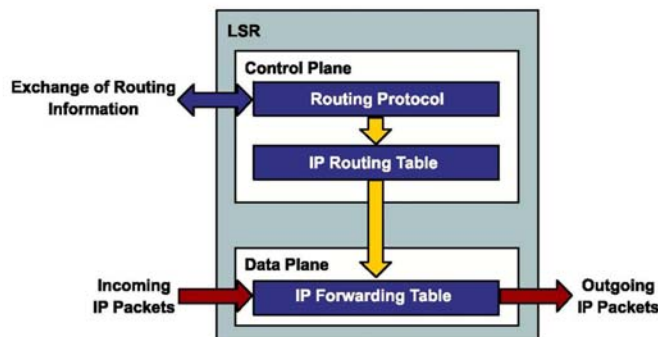
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## Layer 3 Switch Processing

FIGURES

1

2



In Layer 3 switches, the control path and data path are relatively independent.

- The control path code, such as routing protocols, runs on the route processor.
- Data packets are forwarded by the switching fabric.

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## Layer 3 switching

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### Location:

- **Centralized:** Switching decisions are made on the route processor by a central forwarding table, typically controlled by an ASIC.
- **Distributed:** Switching decisions are made on a port or line-card level. Cached tables are distributed and synchronized to various hardware components so that processing can be distributed throughout the switch chassis.

### Methods

- **Route caching:** Also known as flow-based or demand-based switching, a Layer 3 route cache is built in hardware, since the switch sees traffic flow into the switch.
- **Topology-based:** Information from the routing table is used to populate the route cache regardless of traffic flow. The populated route cache is called the forwarding information base (FIB). CEF builds the FIB.

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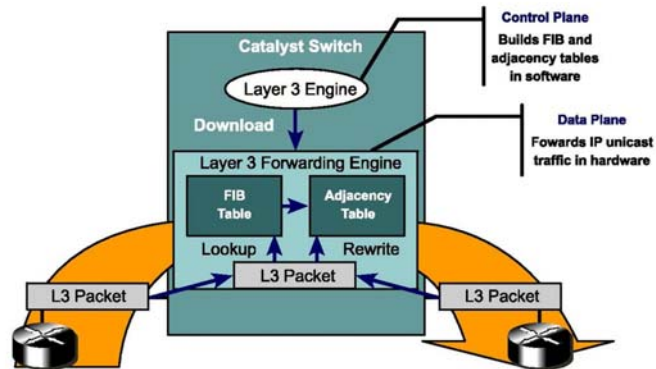
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## CEF-Based Multilayer Switches

FIGURE

1

- CEF caches routing information in the FIB table and Layer 2 next-hop addresses in the adjacency table.



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## Multilayer Switch Packet Forwarding Process

FIGURES

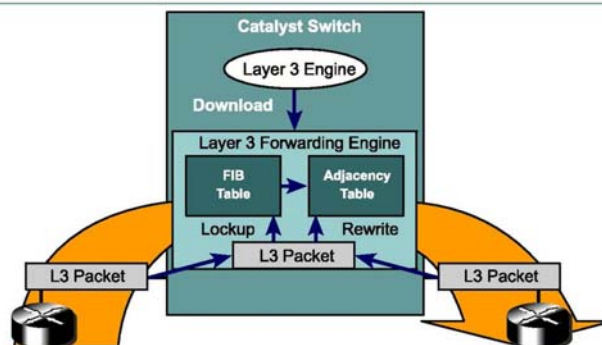
1

2

3

4

- Some IP packets cannot be processed in hardware.
- If an IP packet cannot be processed in hardware, it is processed by the Layer 3 engine.



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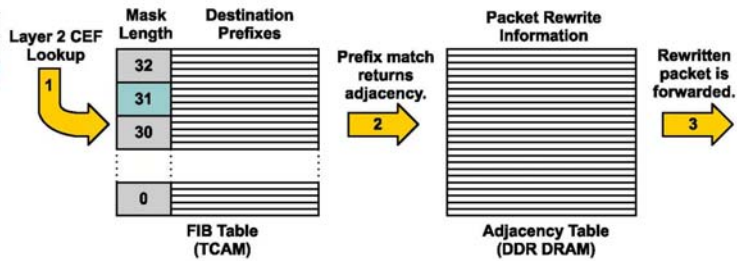
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## CEF-Based MLS Lookups

### FIGURES

- 1
- 2
- 3
- 4



1. Layer 3 packets initiate TCAM lookup.
2. The longest match returns adjacency with rewrite information.
3. The packet is rewritten per adjacency information and forwarded.

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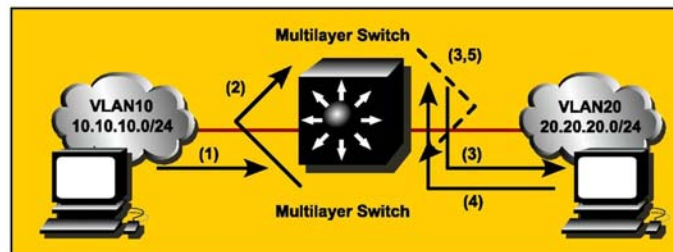
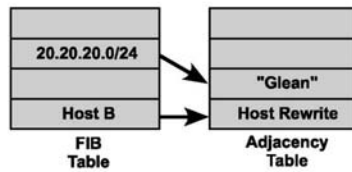
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## ARP Throttling

### FIGURES

- 1
- 2
- 3
- 4



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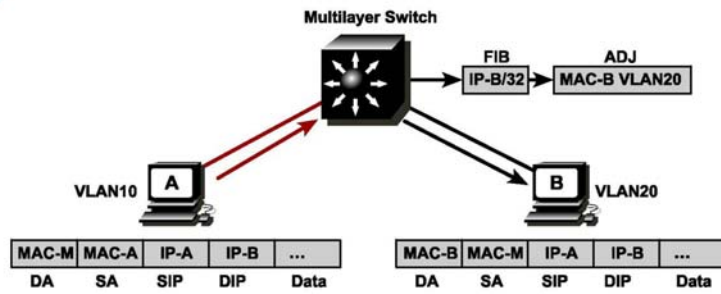
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## CEF-Based MLS Operation

### FIGURES

1  
2  
3  
4



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## Summary

### FIGURE

1

### Summary

- An external router can be configured to route packets between the VLANs on a Layer 2 switch.
- Multilayer switches allow routing and the configuration of interfaces to pass packets between VLANs.
- CEF-based multilayer switching facilitates packet switching in hardware.

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