

# Understanding and Configuring VLAN Routing and Bridging on a Router Using the IRB Feature

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## Introduction

This document describes the progression of VLANs as they are implemented with a router that is routing IP, bridging IP, and bridging IP with Integrated Routing and Bridging (IRB). Also, this document provides a sample configuration on configuring the IRB feature on a router.

**Note:** IRB has deliberately been disabled on the Catalyst 6500 Series Switches and Cisco 7600 Series Routers. For more information, please refer to the General Limitations and Restrictions section under Release Notes for Cisco IOS Release 12.1 E on the Catalyst 6000 and Cisco 7600 Supervisor Engine and MSFC.

## Before You Begin

### Conventions

For more information on document conventions, see the Cisco Technical Tips Conventions.

### Prerequisites

There are no specific prerequisites for this document.

### Components Used

This document is not restricted to specific software and hardware versions.

The information presented in this document was created from devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If you are working in a live network, ensure that you understand the potential impact of any command before using it.

## Background Information

In order for a VLAN to span a router, the router must be capable of forwarding frames from one interface to another, while maintaining the VLAN header. If the router is configured for routing a Layer 3 (network layer)

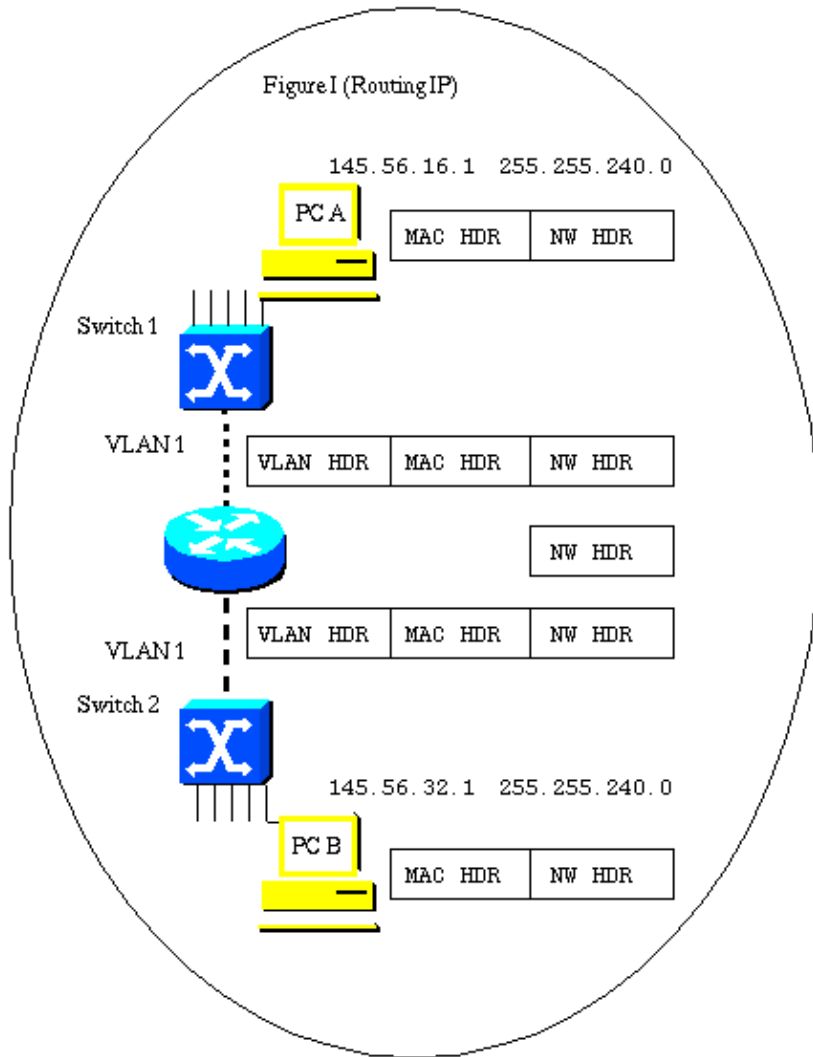
protocol, it will terminate the VLAN and MAC layers at the interface a frame arrives on. The MAC layer header can be maintained if the router is bridging the network layer protocol. However, regular bridging still terminates the VLAN header. Using the IRB feature in Cisco IOS® Release 11.2 or greater, a router can be configured for routing and bridging the same network layer protocol on the same interface. This allows the VLAN header to be maintained on a frame while it transits a router from one interface to another. IRB provides the ability to route between a bridged domain and a routed domain with Bridge Group Virtual Interface (BVI). The BVI is a virtual interface within the router that acts like a normal routed interface that does not support bridging, but represents the comparable bridge group to routed interfaces within the router. The interface number of the BVI is the number of the bridge group that the virtual interface represents. The number is the link between the BVI and the bridge group.

When you configure and enable routing on the BVI, packets that come in on a routed interface, which are destined for a host on a segment in a bridge group, are routed to the BVI. From the BVI, the packet is forwarded to the bridging engine, which forwards it through a bridged interface. This is forwarded based on the destination MAC address. Similarly, packets that come in on a bridged interface, but are destined for a host on a routed network, first go to the BVI. Next, the BVI forwards the packets to the routing engine before it sends them out of the routed interface. On a single physical interface, the IRB can be created with two VLAN sub-interfaces (802.1Q tagging); one VLAN sub-interface has an IP address that is used for routing, and the other VLAN sub-interface bridges between the sub-interface used for routing and the other physical interface on the router.

Since the BVI represents a bridge group as a routed interface, it must be configured only with Layer 3 (L3) characteristics, such as network layer addresses. Similarly, the interfaces configured for bridging a protocol must not be configured with any L3 characteristics.

## **VLAN Routing and Bridging Concept with IRB**

In Figure I, PCs A and B are connected to VLANs that are in turn separated by a router. This illustrates the common misconception that a single VLAN can have a router-based connection in the middle.



You may see pictures indicating that this type of design is one VLAN.

The two switches may be attached to VLANs that have the same number.

They are not in fact the same VLAN.

This figure also shows the flow of the three layers of headers for a frame traversing the links from PC A to PC B.

As the frame flows through the switch, the VLAN header is applied because the connection is a trunk link. There may be several VLANs communicating across the trunk.

The router terminates the VLAN layer and the MAC layer. It examines the destination IP address and forwards the frame appropriately. In this case, the IP frame is to be forwarded out of the port toward PC B. This is also a VLAN trunk and so a VLAN header is applied.

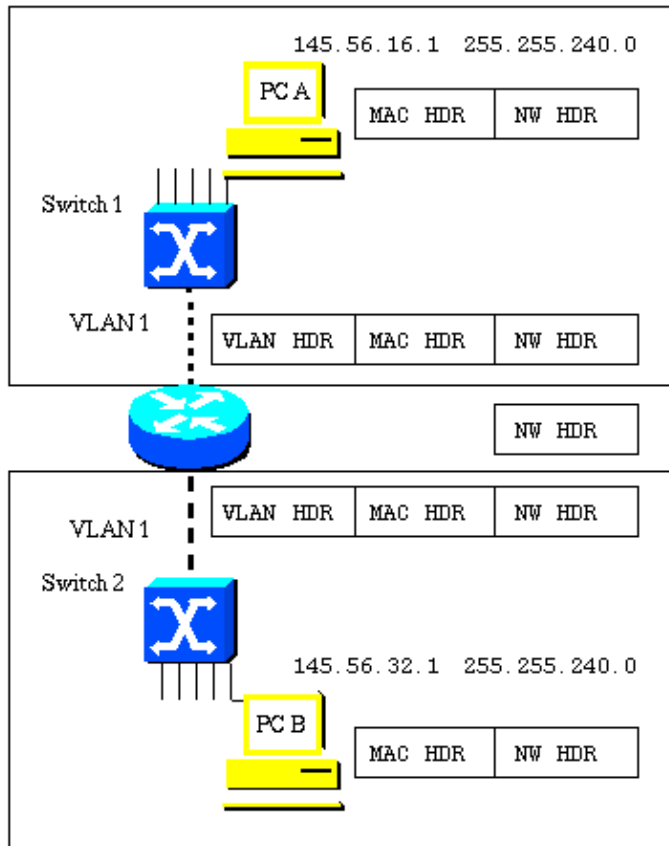
Although the VLAN connecting Switch 2 to the router can be called the same number as the VLAN connecting Switch 1 to the router, it is actually not the same VLAN. The original VLAN header is removed when the frame arrives at the router. A new header may be applied as the frame exits the router. This new header may include the same VLAN number that was used in the VLAN header that was stripped when the frame arrived. This is demonstrated by the fact that the IP frame moved through the router without a VLAN header attached, and was forwarded based on the contents of the IP destination address field, and not on a VLAN ID field.

Because the two VLAN trunks sit on opposite sides of the router, they must be different IP subnets.

In order for the two PCs to have the same subnet address, the router would have to be bridging IP on its interfaces. However, having the devices on VLANs share a common subnet does not mean that they are on the same VLAN.

Figure II shows what the VLAN topology looks like.

Figure II (Routing IP)



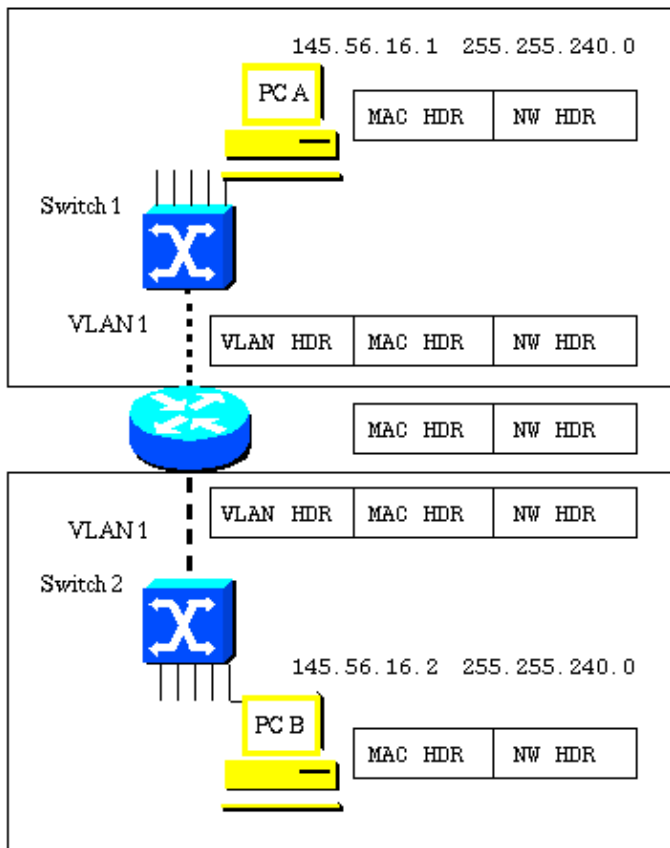
This design results in two physically separate VLANs that may or may not have the same VLAN number.

The need to readdress IP end stations during moves can be avoided by bridging IP on some or all interfaces in the router connecting the VLANs. However, this eliminates all of the benefits of building router-based networks to control broadcasts at the network layer. Figure III shows what changes occur when the router is configured for bridging IP. Figure IV shows what happens when the router is configured for bridging IP with IRB.

Figure III shows that the router is now bridging IP. Both PCs are now on the same subnet.

**Note:** The router (bridge) now forwards the MAC layer header across to the outward-bound interface. The router still terminates the VLAN header and applies a new header prior to sending the frame out to PC B.

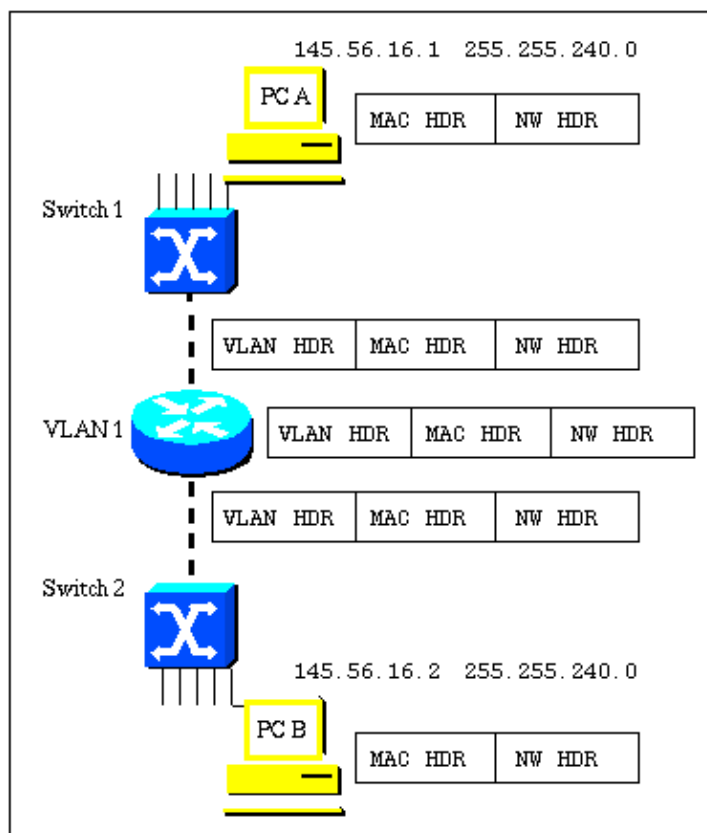
Figure III (Bridging IP)



Eventhough the PCs are now in the same subnet this design results in two physically separate VLANs that may or may not have the same VLAN number.

Figure IV shows what happens when IRB is configured. The VLAN now spans the router, and the VLAN header is maintained as the frame transits the router.

Figure IV (IRBIP)



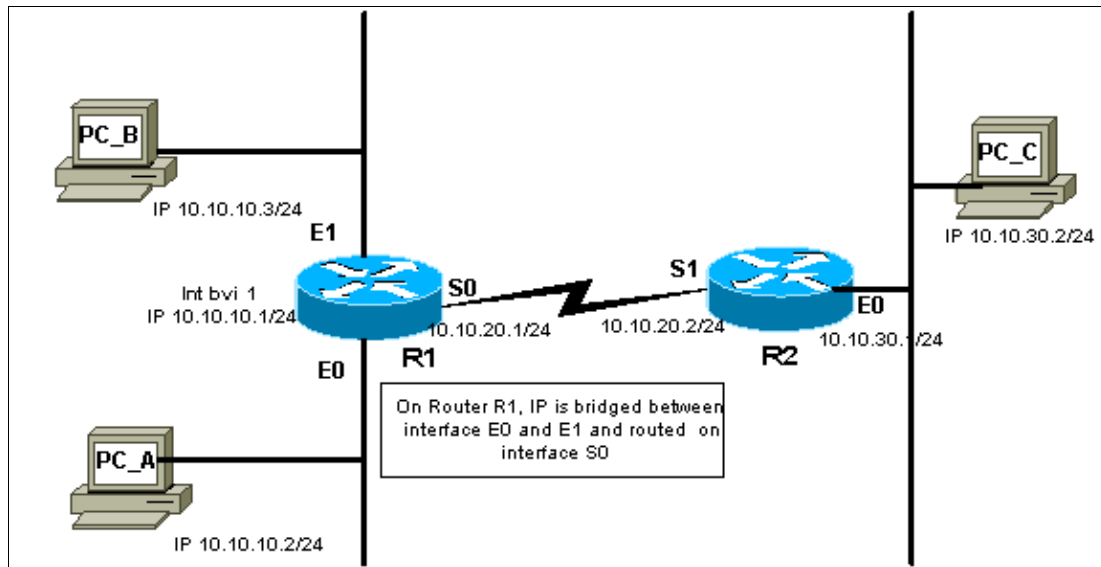
With IRB this is now one single VLAN.

The VLAN header can be maintained as the frame is moved from one interface to another.

## IRB Sample Configuration

This configuration is an example of IRB. The configuration allows bridging IP between two Ethernet interfaces, and routing IP from bridged interfaces using a Bridged Virtual Interface (BVI). In the following network diagram, when PC\_A attempts to contact PC\_B, the router R1 detects that the destination's (PC\_B) IP address is in the same subnet, so the packets are bridged by router R1 between interface E0 and E1. When PC\_A or PC\_B attempt to contact PC\_C, the router R1 detects that the destination's (PC\_C) IP address is in a different subnet, and the packet is routed using the BVI. This way, IP protocol is bridged as well as routed on the same router.

## Network Diagram



## Configuration

### Sample Configuration

```

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname R1
!
!
ip subnet-zero
no ip domain-lookup
bridge irb

!-- This command enables the IRB feature on this router.

!
!
!
interface Ethernet0
no ip address
no ip directed-broadcast
bridge-group 1

!-- The interface E0 is in bridge-group 1.

!
Interface Ethernet1
no ip address
no ip directed-broadcast
bridge-group 1

!-- The interface E1 is in bridge-group 1.

!
Interface Serial0
ip address 10.10.20.1 255.255.255.0
no ip directed-broadcast
no ip mroute-cache
no fair-queue

```

```

!
interface Serial1
no ip address
no ip directed-broadcast
shutdown
!
interface BVI1
ip address 10.10.10.1 255.255.255.0

!-- An ip address is assigned to the logical BVI for routing

!-- IP between bridged interfaces and routed interfaces.

no ip directed-broadcast
!
ip classless
ip route 10.10.30.0 255.255.255.0 10.10.20.2
!
bridge 1 protocol ieee

!-- This command enables the bridging on this router.

bridge 1 route ip

!-- This command enable bridging as well routing for IP protocol.

!
line con 0
transport input none
line aux 0
line vty 0 4
!
end

```

## show Command Outputs

### show interfaces [interface] irb

This command displays the protocols that can be routed or bridged for the specified interface, as follows:

```

R1#show interface e0 irb

Ethernet0

Routed protocols on Ethernet0:
ip

Bridged protocols on Ethernet0:
ip          ipx

!-- IP protocol is routed as well as bridged.

Software MAC address filter on Ethernet0
Hash Len  Address      Matches  Act   Type
0x00:  0  ffff.ffff.ffff    0    RCV  Physical broadcast
0x2A:  0  0900.2b01.0001    0    RCV  DEC spanning tree
0x9E:  0  0000.0c3a.5092    0    RCV  Interface MAC address
0x9E:  1  0000.0c3a.5092    0    RCV  Bridge-group Virtual Interface
0xC0:  0  0100.0ccc.cccc   157   RCV  CDP
0xC2:  0  0180.c200.0000    0    RCV  IEEE spanning tree
0xC2:  1  0180.c200.0000    0    RCV  IBM spanning tree
R1#

```

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## Related Information

- **LAN Product Support**
  - **LAN Switching Technology Support**
  - **Technical Support & Documentation – Cisco Systems**
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