Using Integrated Routing and Bridging with Virtual LANs

Overview

Cisco Systems leads the industry in providing solutions for both switching (LAN and Asynchronous Transfer Mode [ATM]) and routing within the campus. In addition, we have the most complete implementation of virtual LANs (VLANs) in terms of tagging (Inter-Switch Link [ISL], 802.10, and LAN Emulation [LANE]) and aggregation. However, routing between VLANs is currently limited to IP and Internetwork Packet Exchange (IPX), with Novell-Ethernet encapsulation for IPX only. This scenario has created selling and implementation problems in the field. Integrated routing and bridging (IRB) enables routing and bridging between VLANs, and includes support for IPX with Subnetwork Access Protocol (SNAP) and Service Advertising Protocol (SAP) encapsulations and for AppleTalk.

This paper will cover the following topics:

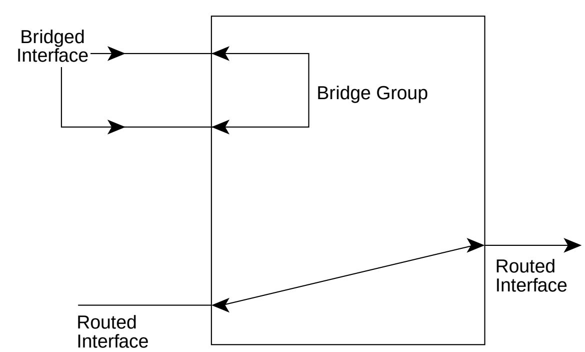
- Introduction to IRB
- Implementing IRB with VLANs
- IRB configurations
- Performance numbers for IRB

Introduction to IRB

IRB was designed to enhance concurrent routing and bridging (CRB), announced in Version 11.0 of Cisco Internetwork Operating System (Cisco IOS™) software. In the past, the router could either route or bridge a protocol, but not both. CRB enables a user to both route and bridge a protocol on separate interfaces within a single router. However, routed traffic is confined to the routed interfaces, and bridged traffic is confined to the bridged interfaces. In other words, for any given protocol, the traffic may be either routed or bridged on a given interface, but not both.

Figure 1 shows a simple example of CRB.

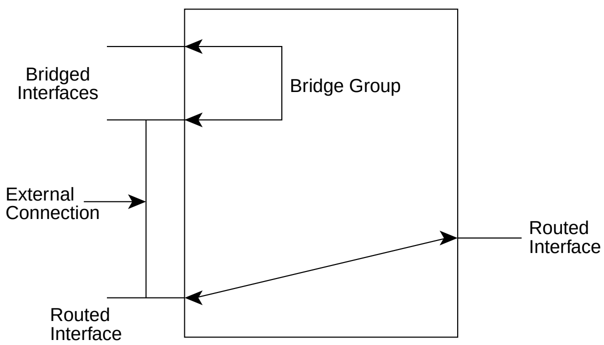
Figure 1 Concurrent Routing and Bridging



As shown in this figure, with CRB the routed interfaces do not communicate with the bridged interfaces. In order to connect a bridged interface to a routed interface, an external connection is needed; connection cannot be made internally.

Figure 2 shows how to communicate between routed interfaces and bridged interfaces with CRB.

Figure 2 Communication between Routed Interfaces and Bridged Interfaces Using CRB

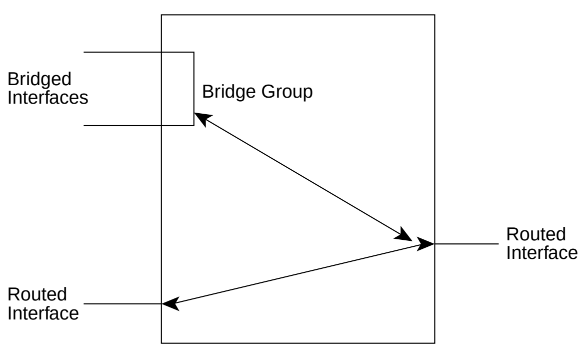


Introducing an external connection between a bridged interface and a routed interface enables the router to communicate between the routed and bridged domains. The router still cannot perform this function internally, and two ports are needed to provide this functionality.

With IRB, a protocol can be routed either between both routed interfaces and bridged interfaces or between different bridge groups internal to the router.

Figure 3 shows an example of IRB.

Figure 3 Integrated Routing and Bridging



The traffic that remains in the bridge group (the bridged traffic) will be bridged among the bridged interfaces, and the traffic that needs to go out to another network (the routed traffic) will be routed internally to the appropriate output routed interface. (See Figure 3.) An external connection is no longer needed to provide this functionality. For example, all the local-area transport (LAT) traffic is bridged within the bridge group and stays local to the bridged interfaces. The IPX traffic destined for a different network is routed from the bridged interface to the destination routed interface.

In order to implement the internal routing and bridging functionality, IRB uses a new interface, the bridged virtual interface (BVI), a virtual interface that represents the whole bridge group to the routed world. Instead of allowing every bridged interface of the same bridge group to have a unique path to the routed interfaces, there is only one BVI per bridge group, and the BVI represents all the interfaces within that bridge group. Bridging occurs within the bridge group, so bridged traffic has no need for the BVI. The interface number of the BVI is the same number as the bridge group it represents, creating a link between the two. For example, BVI 1 relates to bridge group 1. When configuring an Ethernet interface to map to the BVI, you need to configure the bridge group number in the Ethernet interface and create a BVI to match the bridge group. The router will create the connection between the Ethernet interface and the BVI. If three Ethernet interfaces belong to the same bridge group, they use the same BVI to route traffic. IRB routes through the BVI and bridges within the bridge group. The configurations later in this paper show the mapping between physical interfaces, bridge groups, and the BVIs.

Several areas should be noted when considering whether to use IRB or not. First, IRB is not supported on the Route Processor/Switch Processor (RP/SP) for the Cisco 7000 or the Cisco Advanced Gateway Server (AGS)+. It is currently supported on the Cisco 7500 series, will be supported on the Cisco 7200 series, and will be supported on the Route Switch Processor (RSP) on the Cisco 7000 series. IRB supports IP, Internetwork Packet Exchange (IPX), and AppleTalk in both fast switching and process switching modes. IRB is not supported over X.25 or Integrated Services Digital Network (ISDN) bridged interfaces.

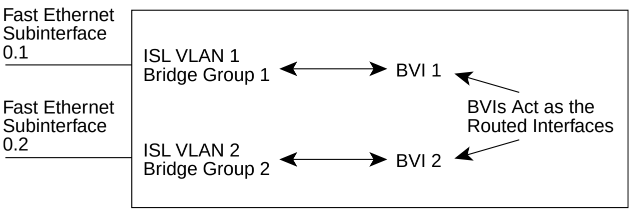
When IRB is enabled, the default behavior in a bridge group is to bridge all packets. If you want to route a given protocol, you need to configure IRB to route that protocol traffic. If you want only to route (and not bridge) a protocol, you need to configure IRB to a) route that protocol, and b) not bridge that protocol. Configuring IRB to route a protocol does not automatically mean that bridging is disabled for that protocol. For nonroutable protocols such as local-area transport (LAT) and NetBIOS, the traffic will always be bridged; bridging for these protocols cannot be disabled.

Implementing IRB with ISL VLANs

Today, IP can be routed over any form of VLAN encapsulation, that is, LANE, ISL, and 802.10. However, some shortcomings exist when other protocols are running in the network. Cisco routers support IPX over ISL with Novell-ether encapsulations only. The other encapsulations, EtherII, SNAP, and SAP, are slated for Release 11.3, which will be available in Q1 ’97. AppleTalk support over ISL will also be available with this release. Customers can use IRB to route AppleTalk and IPX over ISL VLANs. However, IRB does not work with 802.10 VLANs; it works only with ISL VLANs. To gain more familiarity with VLANs, refer to http://wwwin.cisco.com/wbu-pme.

With IRB enabled, IPX and AppleTalk traffic will enter the Fast Ethernet port, but will be seen on the BVI, not on the Fast Ethernet subinterface. The Fast Ethernet subinterface must have both ISL and a bridge group configured. The ISL VLAN number needs to map to the bridge group number. For example, you can configure the Fast Ethernet subinterface 0/0/0.1 to belong to ISL 1 and bridge group 1. How the bridge group maps to the BVI has been discussed; interface BVI 1 is configured to map to bridge group 1. The Fast Ethernet subinterface will put the data into a bridge group, and the BVI, not the Fast Ethernet subinterface, will act as the routed interface. A configuration example of using both ISL and IRB to route is given in the “IRB Configuration” section. Figure 4 shows an example of the ISL/bridge group/BVI mapping.

Figure 4 ISL Mapping to IRB



With the mapping between ISL/bridge group/BVI, IRB can route all the IPX encapsulations, AppleTalk, and IP over ISL. IRB can route the traffic between BVIs back to the Fast Ethernet subinterfaces or to other routed interfaces.

For each ISL VLAN that is configured, that ISL VLAN number should match both the bridge group number and the BVI number. A unique BVI with a corresponding bridge group should exist for that ISL VLAN. See more details in the section “IRB Configuration.”

In networks that run only IP and IPX Novell, the use of IRB for inter-VLAN routing is unnecessary. But if the customer has another type of encapsulation for IPX (SNAP or SAP) or is running AppleTalk, then IRB can be used to route those protocols, and the Fast Ethernet subinterface can be used as the routed interface to route IP between ISL VLANs.

To obtain the best IRB over VLAN performance using ISL, use of the Versatile Interface Processor 2 (VIP2) card with the FE-PA in the Cisco 7500 series routers instead of just the Fast Ethernet Interface Processor (FEIP) is strongly recommended. There is only one option in the Cisco 7200 series. The VIP2 card has the ISL hardware assist on it, and therefore the ISL cyclic redundancy check (CRC) is calculated in hardware instead of software, which provides much faster performance. With the FEIP, the ISL CRC is calculated in software. The Cisco 7200 series has the hardware assist as well.

IRB Configuration

The following steps should be taken to configure IRB to run with ISL:

Step 1 Correctly configure the router to route the appropriate protocols, that is, ip/ipx/appletalk routing.

Step 2 Configure the specific media interface to belong to a bridge group if you want that interface to participate in IRB.

Step 3 For protocol addressing (IP, IPX, AppleTalk), configure the specific addresses, along with the IPX encapsulation and AppleTalk zone if appropriate, in the BVI interface.

Step 4 Turn on IRB, and configure each bridge group to bridge and/or route the appropriate protocol.

Step 5 Configure the ISL VLAN on the Fast Ethernet media interface, not the BVI (if inter-VLAN routing is desired; if you are using IRB without ISL, skip this step.)

For other examples on configuring IRB without ISL, refer to URL

http://wwwcons/public/wonlee/irb.html

Following is a sample configuration of IRB with ISL.

Use Fast Ethernet with ISL to route IP, but use IRB to route and bridge IPX (SNAP) and AppleTalk

The general IRB command to route is

```
bridge <bridge-group-number> route <protocol>
```

The configuration looks like:

```
!
appletalk routing
ipx routing 0000.0c40.0cb8
!
interface Fast Ethernet 1/0/0
no ip address
!
interface Fast Ethernet 1/0/0.1
encapsulation isl 1
ip address 198.18.1.1 255.255.255.0
bridge-group 1
!
interface Fast Ethernet 1/0/0.2
encapsulation isl 2
ip address 198.18.2.1 255.255.255.0
bridge-group 2
!
interface BVI1
no ip address
appletalk cable-range 1-1 1.253
appletalk zone irb-test
ipx encapsulation snap (or novell, or sap, or etherII)
ipx network c6120101
!
interface BVI2
no ip address
appletalk cable-range 2-2 2.253
appletalk zone irb-test
ipx encapsulation snap
ipx network c6120201
!
router eigrp 123
network 198.18.1.0
network 198.18.2.0
!
bridge irb
bridge 1 protocol ieee
bridge 1 route ipx
bridge 1 route appletalk
bridge 2 protocol ieee
bridge 2 route ipx
bridge 2 route appletalk
!
```

To see the IRB characteristics, you can type:

```
#show interface <interface> irb
```

To show the traffic that crosses the ISL subinterfaces or the IRB (labeled as bridged) interfaces, you can type:

```
#show vlan
```

IRB over VLAN Performance

The Alantec PowerBits was used to run a standard routing/bridging test suite for testing the performance of IRB with ISL VLANs. A Cisco 7505 with a VIP2 card and FE-PA and a Catalyst™ 5000 were used to test the ISL trunking capabilities. Tables 1 and 2 show results of the performance tests.

Table 1 IRB and ISL Performance Fast Switching (pps)

Hardware/Software Version	IP	IPX-Novell	IPX-SNAP	AppleTalk
Cisco 7505 (11.2-0.26) Catalyst 5000 (2.1(3))	19,078	25,608	19,308	20,851

Table 2 ISL Performance Fast Switching (pps)

Hardware/Software Version	IP	IPX-Novell
Cisco 7505 (11.2-0.26) Catalyst 5000 (2.1(3))	70,318	70,338

References

Integrated Routing and Bridging Functional Specification. Su, Wilber

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