Configure Inter VLAN Routing with the Use of an External Router

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Introduction

This document describes how to configure the configurations to set up Inter VLAN routing with the use of an external Cisco router.

Prerequisites

Requirements

Cisco recommends that you have knowledge of this topics:

- Basic Routing knowledge.

Components Used

The information in this document is based on these software and hardware versions:

- Catalyst 3512XL switch that runs Cisco IOS 12.0(5.x)XU
- Cisco 2621 router that runs Cisco IOS 12.1(3)T

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

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

Background Information

This document describes the configurations to setup Inter-VLAN routing with the use of an external Cisco routers and explains it with sample configurations on 802.1Q trunking between a Catalyst 3500-XL switch and a Cisco 2600 router; the results of each command are displayed as they are executed. Cisco 3600 or other members of the Cisco 2600 series routers, with FastEthernet interfaces, and any Catalyst switch can be used in the scenarios presented in this document to obtain the same results.

Trunking is a way to carry traffic from several VLANs over a point-to-point link between the two devices. Initially, there were two ways in which Ethernet trunking was implemented:

- InterSwitch Link (ISL) Cisco proprietary protocol.
- Institute of Electrical and Electronics Engineers (IEEE) 802.1Q standard.

A trunk link is created and used to carry traffic from two or more VLANs, for example, VLAN1 and VLAN2 across a single link between Catalyst switches and/or a Cisco router.

The Cisco router is used to do the Inter-VLAN routing between VLAN-X and VLAN-Y, this configuration can be useful when the Catalyst series switches are Layer 2 (L2) only and cannot route or communicate between the VLANs (such as 2900XL/3500XL/2940/2950/2970).

To create the examples in this document, the next switches in a lab environment were used with cleared configurations:

- Catalyst 3512XL switch that runs Cisco IOS 12.0(5.x)XU
- Cisco 2621 router that runs Cisco IOS 12.1(3)T

For Catalyst 2900XL/3500XL/2940/2950/2970 Switches:

Refer to Table 1 for a sample list of switch models that support trunking:

<table>
<thead>
<tr>
<th>Switch Models</th>
<th>Minimum Release Required for IEEE 802.1Q Trunking</th>
<th>Current Release Required for Trunking (ISL/802.1Q)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2912-XL</td>
<td>11.2(8)SA5 (Enterprise Edition)</td>
<td>12.0(5)WC(1) or later</td>
</tr>
<tr>
<td>C2924-XL</td>
<td>11.2(8)SA5 (Enterprise Edition)</td>
<td>12.0(5)WC(1) or later</td>
</tr>
<tr>
<td>WS-C2924C-XL</td>
<td>11.2(8)SA5 (Enterprise Edition)</td>
<td>12.0(5)WC(1) or later</td>
</tr>
<tr>
<td>WS-C2924M-XL</td>
<td>11.2(8)SA5 (Enterprise Edition)</td>
<td>12.0(5)WC(1) or later</td>
</tr>
<tr>
<td>WS-C2912MF-XL</td>
<td>11.2(8)SA5 (Enterprise Edition)</td>
<td>12.0(5)WC(1) or later</td>
</tr>
<tr>
<td>WS-C2924M-XL-DC</td>
<td>12.0(5)XU</td>
<td>12.0(5)WC(1) or later</td>
</tr>
<tr>
<td>WS-C3508G-XL</td>
<td>11.2(8)SA5 (Enterprise Edition)</td>
<td>12.0(5)WC(1) or later</td>
</tr>
<tr>
<td>WS-C3512-XL</td>
<td>11.2(8)SA5 (Original Edition)</td>
<td>12.0(5)WC(1) or later</td>
</tr>
<tr>
<td>WS-C3524-XL</td>
<td>11.2(8)SA5 (Enterprise Edition)</td>
<td>12.0(5)WC(1) or later</td>
</tr>
<tr>
<td>WS-C3548-XL</td>
<td>12.0(5)XP (Enterprise Edition)</td>
<td>12.0(5)WC(1) or later</td>
</tr>
<tr>
<td>WS-C3524-PWR-XL</td>
<td>12.0(5)XU</td>
<td>12.1(13)AY or later for 802.1Q. ISL is not supported.</td>
</tr>
<tr>
<td>WS-C2940-8TF</td>
<td>12.1(13)AY</td>
<td>12.1(13)AY or later for 802.1Q. ISL is not supported.</td>
</tr>
<tr>
<td>WS-C2940-8TT</td>
<td>12.1(13)AY</td>
<td>12.0(5)WC(1) or later for 802.1Q. ISL is not supported.</td>
</tr>
<tr>
<td>WS-C2950-12</td>
<td>12.0(5)WC(1)</td>
<td>12.0(5)WC(1) or later for 802.1Q. ISL is not supported.</td>
</tr>
</tbody>
</table>
Supported platforms:

- WS-C2950-24: 12.0(5)WC(1)
- WS-C2950C-24: 12.0(5)WC(1)
- WS-C2950T-24: 12.0(5)WC(1)
- WS-C2950G-12-EI: 12.0(5)WC(1)
- WS-C2950G-24-EI: 12.0(5)WC(1)
- WS-C2950G-48-EI: 12.0(5)WC(1)
- WS-C2950SX-24: 12.0(5)WC(1)
- WS-C2950-24-EI-DC: 12.0(5)WC(1)
- WS-C2955T-12: 12.1(13)EA1
- WS-C2955S-12: 12.1(13)EA1
- WS-C2955C-12: 12.1(13)EA1
- WS-C2970G-24T: 12.1(11)AX
- WS-C2970G-24TS: 12.1(14)EA1

12.0(5)WC(1) or later for 802.1Q. ISL is not supported.

Note: Only registered Cisco users have access to internal documents, tools, and information.

Note: In Catalyst 2900XL/3500XL/2940/2950/2970 switches, a VLAN interface, for example, int vlan 1, int vlan 2, and int vlan x can be created for each and every VLAN that is configured on the switch. However, only one VLAN can be used at a time as a management VLAN. The IP address is assigned to the VLAN interface of the management VLAN only. If the IP address is assigned to another VLAN interface whose VLAN is not used as management VLAN, that interface cannot come up. It is preferred to create the VLAN interface only for the management VLAN.

For Cisco 2600 Routers

For 802.1Q trunking, one VLAN is not tagged. This VLAN is called native VLAN. The native VLAN is used for untagged traffic when the port is in 802.1Q trunking mode. While you configure 802.1Q trunking, remember that the native VLAN must be configured the same on each side of the trunk link. It is a common mistake not to match the native VLANs when 802.1Q trunking between the router and the switch is configured.

In this sample configuration, the native VLAN is VLAN1, by default, on both the Cisco router and the Catalyst switch. Dependent on your network needs, you can have to use a native VLAN other than the default VLAN, VLAN1. Commands have been mentioned in the Configurations section of this document on how to change the native VLAN on these devices.

Sample configurations presented in this document can be used on Cisco 2600/3600 and other series routers with Fast Ethernet interfaces or higher. Also, ensure that you use the Cisco IOS
version that supports 802.1Q VLAN trunking. For a sample list of Cisco 2600/3600 routers that support 802.1Q VLAN trunking and the supported Cisco IOS versions, refer to Table 2.

Table 2

<table>
<thead>
<tr>
<th>Router Models</th>
<th>Minimum Release Required for IEEE 802.1Q Trunking</th>
<th>Minimum Required Feature Set (ISL/802.1Q)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco 2620</td>
<td>12.0(1)T</td>
<td>IP PLUS / IP PLUS</td>
</tr>
<tr>
<td>Cisco 2621</td>
<td>12.0(1)T</td>
<td>IP PLUS / IP PLUS</td>
</tr>
<tr>
<td>Cisco 2620</td>
<td>12.1(3a)T</td>
<td>IP PLUS / IP PLUS</td>
</tr>
<tr>
<td>Cisco 2650</td>
<td>12.1(3a)T</td>
<td>IP PLUS / IP PLUS</td>
</tr>
<tr>
<td>Cisco 3620</td>
<td>12.0(1)T</td>
<td>IP PLUS / IP PLUS</td>
</tr>
<tr>
<td>Cisco 3640</td>
<td>12.0(1)T</td>
<td>IP PLUS / IP PLUS</td>
</tr>
<tr>
<td>Cisco 3661</td>
<td>12.0(5)T</td>
<td>IP PLUS / IP PLUS</td>
</tr>
<tr>
<td>Cisco 3662</td>
<td>12.0(5)T</td>
<td>IP PLUS / IP PLUS</td>
</tr>
<tr>
<td>Cisco 4500-M</td>
<td>12.0(1)T</td>
<td>IP PLUS / IP PLUS</td>
</tr>
<tr>
<td>Cisco 4700-M</td>
<td>12.0(1)T</td>
<td>IP PLUS / IP PLUS</td>
</tr>
</tbody>
</table>

Note: Only registered Cisco users have access to internal documents, tools, and information.

Note: Table 2 only lists the minimum or current maintenance/main releases that support this sample configuration. Router models with certain network modules can have different minimum Cisco IOS versions.

Note: The minimum supported release cannot necessarily be the recommended release. To determine the best maintenance release for your Cisco product, search for bugs listed by product component in the Bug Toolkit.

Note: Table 2 lists the minimum feature set required to do IP Inter-VLAN routing and trunking to support this sample configuration.

Configure

In this section, you are presented with the information to configure the features described in this document.

Network Diagram

This document uses the network setup shown in this diagram.
Configurations

This document uses this configuration.

- Catalyst 3500-XL
- Cisco 2600 Router
- 802.1Q Configuration on the Router for Cisco IOS Versions Earlier than 12.1(3)T

**Note:** The next screen captures show the commands that were entered on the 3500XL switch. Comments between the commands are added in blue italics to explain certain commands and steps.

**Catalyst 3500-XL**

```bash
!-- Set the privileged mode
!-- and Telnet password on the switch.
switch(config)

Configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
switch(config) #hostname 3512xl
3512xl(config) #enable password mysecret
3512xl(config) #line vty 0 4
3512xl(config-line) #login
3512xl(config-line) #password mysecret
3512xl(config-line) #exit
3512xl(config) #no logging console
3512xl(config) #^Z

!-- Set the IP address and default gateway for VLAN1 for management purposes.
3512xl(config)
Configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
3512xl(config) #interface vlan 1
3512xl(config-if) #ip address 10.10.10.2 255.255.255.0
3512xl(config-if) #exit
3512xl(config) #ip default-gateway 10.10.10.1
```
!-- Set the VTP Mode. In our example, we have set the mode to be transparent.
!-- Depending on your network, set the VTP Mode accordingly. 3512xl#vlan database
3512xl(vlan)#vtp transparent
Setting device to VTP TRANSPARENT mode.

!-- Adding VLAN2. VLAN1 already exists by default. 3512xl(vlan)#vlan 2
VLAN 2 added:
Name: VLAN0002
3512xl(vlan)#exit
APPLY completed.
Exiting....

!-- Enable trunking on the interface fastEthernet 0/1. !-- Enter the trunking encapsulation as either a
dot1q.
3512xl#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
3512xl(config)#interface fastEthernet 0/1
3512xl(config-if)#switchport mode trunk
3512xl(config-if)#switchport trunk encapsulation dot1q

!-- In case of 2940/2950 series switches, none of the above two commands are used,
!-- 2940/2950 series switches only support 802.1q encapsulation which is configured automatically,
!-- when trunking is enabled on the interface by using switchport mode trunk command.
!-- In case of dot1q, you need to make sure that the native VLAN matches across the link.

!-- On Catalyst Switches, by default, the native VLAN is 1.
!-- It is very important that you change the native VLAN on the router accordingly.
!-- You may change the native VLAN, if needed, by using the following command:
!-- 3512xl(config-if)#switchport trunk native vlan <vlan ID>

!-- Allow all VLANs on the trunk.
3512xl(config-if)#switchport trunk allowed vlan all
3512xl(config-if)#exit

!-- The following set of commands can place FastEthernet 0/2 into VLAN2.
3512xl(config)#interface fastEthernet 0/2
3512xl(config-if)#switchport mode access
3512xl(config-if)#switchport access vlan 2
3512xl(config-if)#exit

!-- FastEthernet 0/3 is already in VLAN1 by default.
3512xl(config)#interface fastEthernet 0/3
3512xl(config-if)#switchport mode access
3512xl(config-if)#^Z

!-- Remember to save the configuration.
3512xl#write memory
Building configuration...
3512xl#show running-config
Building configuration...
Current configuration:

! version 12.0
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption

! hostname 3512xl
!
no logging console
enable password mysecret
!
!
!
!
!
!
!
!
!
!
!
!
!
!
!
ip subnet-zero
!
!
!
!
interface FastEthernet0/1
switchport mode trunk
switchport trunk encapsulation dot1q
!
interface FastEthernet0/2
switchport access vlan 2
switchport mode access
!
interface FastEthernet0/3
switchport mode access
!
interface FastEthernet0/4
!
interface FastEthernet0/5
!
interface FastEthernet0/6
!
interface FastEthernet0/7
!
interface FastEthernet0/8
!
interface FastEthernet0/9
!
interface FastEthernet0/10
!
interface FastEthernet0/11
!
interface FastEthernet0/12
!
interface GigabitEthernet0/1
!
interface GigabitEthernet0/2
!
interface VLAN1
ip address 10.10.10.2 255.255.255.0
no ip directed-broadcast
no ip route-cache
!
ip default-gateway 10.10.10.1
!
line con 0
transport input none
```
stopbits 1
line vty 0 4
password mysecret
login
line vty 5 15
login!
end

2600 Router
Note: The next screen captures show the commands that were entered on the Cisco 2600 router. Comments between the commands are added in italics to explain certain commands and steps.

! -- Set the privileged mode
! -- and Telnet password on the router.

Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# hostname c2600

! -- Select FastEthernet 0/0 for the trunk configuration.
! -- No L2 or Layer 3 (L3) configuration is done here.

! -- Enable trunking on the sub-interface FastEthernet 0/0.1.
! -- The actual trunks are configured on the sub-interfaces.

Note: The encapsulation dot1Q 1 native command was added in Cisco IOS version 12.1(3)T.

! -- Configure L3 information on the sub-interface 0/0.1.

c2600(config)# interface fastEthernet 0/0
! -- Make sure that the native VLAN matches across the link.
! -- On the switch, by default, the native VLAN is 1.
! -- On the router, configure VLAN1 as the native VLAN.

! -- Configure L3 information on the sub-interface 0/0.1.

c2600(config)# interface fastEthernet 0/0.1

Note: The encapsulation dot1Q 1 native command was added in Cisco IOS version 12.1(3)T.

c2600(config)# no logging console

! -- Enter the trunking encapsulation as dot1q.

! -- Configure L3 information on the sub-interface 0/0.1.

c2600(config)# ip address 10.10.10.1 255.255.255.0
```
c2600(config-subif)#exit

! -- Enable trunking on the sub-interface FastEthernet 0/0.2.
! -- The actual trunks are configured on the sub-interfaces.
! -- Enter the trunking encapsulation as dot1q:

c2600(config)#int fastEthernet 0/0.2
c2600(config-subif)#encapsulation dot1Q 2

! -- Configure L3 information on the sub-interface 0/0.2.

c2600(config-subif)#ip address 10.10.11.1 255.255.255.0
c2600(config-subif)#exit
c2600(config)#*Z

! -- Remember to save the configuration.

c2600#write memory
Building configuration...
[OK]
c2600#

Note: In order to make this setup work, and to successfully ping between workstation1 and workstation2, you need to make sure that the default gateways on the workstations are setup properly. For workstation1, the default gateway must be 10.10.11.1 and for workstation2, the default gateway must be 10.10.10.1.

--------------------------------------------------------------------------------
c2600#show running-config
Building configuration...

Current configuration:
!
version 12.1
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname c2600
!
no logging console
enable password mysecret
!
!
!
!
!
ip subnet-zero
!
!
!
!
!
!
!
!
!
!
!
!
!
!
interface FastEthernet0/0
no ip address
duplex auto
speed auto
!
interface FastEthernet0/0.1
encapsulation dot1q 1 native
ip address 10.10.10.1 255.255.255.0
no ip redirects
!
interface FastEthernet0/0.2
encapsulation dot1q 2
ip address 10.10.11.1 255.255.255.0
no ip redirects
!
interface FastEthernet0/1
no ip address
shutdown
duplex auto
speed auto
!
ip classless
no ip http server
!
!
line con 0
transport input none
line aux 0
line vty 0 4
password mysecret
login
!
no scheduler allocate
end

Debug and Show Commands

This section helps you confirm that your configuration works as expected.

On the Catalyst switch, you can use the next commands to help with the verification:

- `show interface {FastEthernet | GigabitEthernet} <module/port> switchport`
- `show vlan`
- `show vtp status`

On the Cisco 2600 router, use the next commands:

- `show ip route`
- `show interface`

Sample show Command Output

Catalyst Switch

`show int {FastEthernet | GigabitEthernet} <module/port> switchport`

This command is used to check the administrative and operational status of the port. It is also used to make sure that the native VLAN matches on both sides of the trunk. The native VLAN is
used for untagged traffic when the port is in 802.1Q trunking mode.

For 802.1Q trunking, the output command shows:

```
3512xl#show int fastEthernet 0/1 switchport
Name: Fa0/1
Switchport: Enabled
Administrative mode: trunk
Operational Mode: trunk
Administrative Trunking Encapsulation: dot1q
Operational Trunking Encapsulation: dot1q
Negotiation of Trunking: Disabled
Access Mode VLAN: 0 ((Inactive))
Trunking Native Mode VLAN: 1 (default)
Trunking VLANs Enabled: ALL
Trunking VLANs Active: 1,2
Pruning VLANs Enabled: 2-1001

Priority for untagged frames: 0
Override vlan tag priority: FALSE
Voice VLAN: none
```

```
show vlan
```

This command is used to verify that the interfaces (ports) belong to the correct VLAN. In this example, only interface Fa0/2 belongs to VLAN2. The rest are members of VLAN1.

```
3512xl#show vlan
<table>
<thead>
<tr>
<th>VLAN Name</th>
<th>Status</th>
<th>Ports</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>default</td>
<td>active Fa0/3, Fa0/4, Fa0/5, Fa0/6, Fa0/7, Fa0/8, Fa0/9, Fa0/10, Fa0/11, Fa0/12, Gi0/1, Gi0/2</td>
</tr>
<tr>
<td>2</td>
<td>VLAN0002</td>
<td>active Fa0/2</td>
</tr>
<tr>
<td>1002</td>
<td>fddi-default</td>
<td>active</td>
</tr>
<tr>
<td>1003</td>
<td>token-ring-default</td>
<td>active</td>
</tr>
<tr>
<td>1004</td>
<td>fddinet-default</td>
<td>active</td>
</tr>
<tr>
<td>1005</td>
<td>trnet-default</td>
<td>active</td>
</tr>
</tbody>
</table>
```

...(output suppressed)

```
show vtp status
```

This command is used to check the VLAN trunking protocol (VTP) configuration on the switch. In this example, the transparent mode is used. The correct VTP mode depends on the topology of your network.

```
3512xl#show vtp status
<table>
<thead>
<tr>
<th>VTP Version</th>
<th>Configuration Revision</th>
<th>Maximum VLANs supported locally</th>
<th>Number of existing VLANs</th>
<th>VTP Operating Mode</th>
<th>VTP Domain Name</th>
<th>VTP Pruning Mode</th>
<th>VTP V2 Mode</th>
<th>VTP Traps Generation</th>
<th>MD5 digest</th>
</tr>
</thead>
<tbody>
<tr>
<td>: 2</td>
<td>: 0</td>
<td>: 254</td>
<td>: 6</td>
<td>Transparent</td>
<td></td>
<td>Disabled</td>
<td>Disabled</td>
<td>Disabled</td>
<td>0xC3 0x71 0xF9 0x77 0x2B 0xAC 0x5C 0x97</td>
</tr>
</tbody>
</table>
```
Cisco Router

show ip route

This command tells the L3 routing information about the sub-interfaces configured on the router.

c2600#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
    D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
    N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
    E1 - OSPF external type 1, E2 - OSPF external type 2
    i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
    ia - IS-IS inter area, * - candidate default, U - per-user static route
    o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
    a - application route
    + - replicated route, % - next hop override, p - overrides from PfR

Gateway of last resort is not set

    10.0.0.0/8 is variably subnetted, 6 subnets, 2 masks
C        10.10.10.0/24 is directly connected, fastEthernet0/0.1
L        10.10.10.1/32 is directly connected, fastEthernet0/0.1
C        10.10.11.0/24 is directly connected, fastEthernet0/0.2
L        10.10.11.1/32 is directly connected, fastEthernet0/0.2

show interface

This command is used to check the administrative and operational status of the interface. For the router interface status, the output command shows:

c2600#show interfaces fastEthernet 0/0.1
FastEthernet0/0.1 is up, line protocol is up
    Hardware is AmdFE, address is 0003.e36f.41e0 (bia 0003.e36f.41e0)
    Internet address is 10.10.10.1/24
    MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
        reliability 255/255, txload 1/255, rxload 1/255
    Encapsulation 802.1Q Virtual LAN, Vlan ID  1.
    ARP type: ARPA, ARP Timeout 04:00:00

c2600#show interfaces fastEthernet 0/0.2
FastEthernet0/0.2 is up, line protocol is up
    Hardware is AmdFE, address is 0003.e36f.41e0 (bia 0003.e36f.41e0)
    Internet address is 10.10.11.1/24
    MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
        reliability 255/255, txload 1/255, rxload 1/255
    Encapsulation 802.1Q Virtual LAN, Vlan ID  2.
    ARP type: ARPA, ARP Timeout 04:00:00

Related Information

- Configure 802.1q Trunking Between a Catalyst 3550/3750 and Catalyst Switches
- Use PortFast and Other Commands to Fix Workstation Startup Connectivity Delays
- Technical Support & Downloads - Cisco Systems