Routed Bridge Encapsulation with ATM Virtual Circuit Bundles

The Routed Bridge Encapsulation with ATM Virtual Circuit Bundles feature enables routed bridge encapsulation (RBE) over ATM permanent virtual circuit (PVC) bundles. This feature supports PVC bundle member selection based on the quality of service (QoS) group or on the type of service (ToS) or Multiprotocol Label Switching (MPLS) Experimental (EXP) bit in each packet over RBE interfaces. The PVC bundles carry RBE traffic configured on ATM point-to-point subinterfaces.

This feature also supports PVC bundle functionality for AAL5 MUX or LLC/SNAP encapsulations and ATM PVC bundle scalability.

History for the Routed Bridge Encapsulation with ATM Virtual Circuit Bundles Feature

Release	Modification
12.4(4)T	This feature was introduced.
12.2(31)SB2	This feature was integrated into Cisco IOS Release 12.2(31)SB2.

Finding Support Information for Platforms and Cisco IOS and Catalyst OS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS and Catalyst OS software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Contents

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Restrictions for Routed Bridge Encapsulation with ATM Virtual Circuit Bundles

The following restrictions apply to the Routed Bridge Encapsulation with ATM Virtual Circuit Bundles feature:

- RBE over switched virtual circuit (SVC) bundles is not supported.
- SVC bundle member selection based on QoS groups is not supported.
- Fast switching is not supported (only Cisco Express Forwarding (CEF) switching and process switching are supported).
- PVC bundle member selection based on QoS groups does not support distributed platforms.
- PVC bundle member selection based on QoS groups does not support bumping, protection, or PVC bundle incompleteness detection.

PVC bundles are supported under the following conditions (numbers are maximum per interface and per router):

- 1000 PVC bundles with AAL5 LLC/SNAP encapsulation, and each PVC bundle with four PVC bundle members
- 800 PVC bundles with two members each and with AAL5 LLC/SNAP encapsulation, and interfaces with 4000 PVCs overall (including PVC bundle members)

Information About Routed Bridge Encapsulation with ATM Virtual Circuit Bundles

To configure the Routed Bridge Encapsulation with ATM Virtual Circuit Bundles feature, you should understand the following concepts:

Benefits of Routed Bridge Encapsulation with ATM Virtual Circuit Bundles

Without this feature, PVC bundle member selection is made based on ToS bit settings (for IP packets) or EXP bit settings (for MPLS packets). With this feature, you can make the PVC bundle member selection based on the QoS group value associated with the packet: on the ingress before route selection or on the egress after selecting the adjacency, the packet's pak_type header is marked with the QoS group to use based on the generic match criterion provided by the Modular QoS command line interface (MQC).

This feature gives you the flexibility to choose PVC bundle members based on various criteria. You can define any classification criterion for the traffic, mark the packets matching that criterion with the QoS group, and send them over a specific PVC bundle member to assign the appropriate quality of service to the corresponding class of traffic.

Memory Impact of Routed Bridge Encapsulation with ATM Virtual Circuit Bundles

The additional memory required for this feature does not exceed 50 bytes per PVC bundle.

Performance Impact of Routed Bridge Encapsulation with ATM Virtual Circuit Bundles

This feature slightly impacts forwarding path performance when PVC bundles are configured with QoS groups. This is because during forwarding, QoS groups must be mapped to the appropriate PVC bundle member index in the array of adjacencies associated with the PVC bundle adjacency.

This feature does not significantly increase CPU usage when traffic at line rates is sent over the PVC bundle (regardless of the selection criterion used for PVC bundle member selection).

How to Configure Routed Bridge Encapsulation with ATM Virtual Circuit Bundles

This section describes how to configure the Routed Bridge Encapsulation with ATM Virtual Circuit Bundles feature. This section consists of the following configuration tasks:

- Specifying the Method for Selecting PVC Bundle Members, page 3 (required)
- Configuring the QoS Group-Based Method for Selection of PVC Bundle Members, page 5 (optional)
- Configuring Explicit InARP PVC Selection for QoS Group-Based PVC Bundle Member Selection, page 6 (optional)
- Verifying Routed Bridge Encapsulation with ATM Virtual Circuit Bundles, page 8 (required)

Specifying the Method for Selecting PVC Bundle Members

This section describes how to specify the method for selection of PVC bundle members. You can specify one of two selection methods:

- QoS group—Use the QoS group value associated with each packet for selection of PVC bundle members.
- ToS or EXP—Use ToS bit settings of each packet (for IP packets) or EXP bit settings of each packet (for MPLS packets) for selection of PVC bundle members.

The selection methods are mutually exclusive. This means that when the selection method based on QoS groups is specified on any PVC bundle member, no other selection method is allowed on the same PVC bundle. Similarly, if the selection method based on ToS or EXP is specified on any PVC bundle member, no other selection method is allowed on the same PVC bundle.

Restrictions

You can change the selection method from QoS groups to ToS or EXP only if no PVC bundle member has QoS groups or Inverse Address Resolution Protocol (InARP) configured.

You can change the selection method from ToS or EXP to QoS groups only if no PVC bundle member has precedence, protection, or bumping configured.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface atm** *slot/port*
4. **bundle** *bundle-name*
5. **selection-method** {**qos-group** | **tos-exp**}
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface atm** *slot/port* **Example:** `Router(config)# interface atm 2/0`	Specifies the ATM interface type and enters interface configuration mode. To determine the correct form of the **interface atm** command, see your ATM network module, port adapter, or router documentation.
Step 4	**bundle** *bundle-name* **Example:** `Router(config-subif)# bundle cisco`	Creates a bundle or modifies an existing bundle and enters bundle configuration mode.

	Command or Action	Purpose
Step 5	**selection-method** {**qos-group** | **tos-exp**} **Example:** `Router(config-if-atm-bundle)# selection-method qos-group`	Specifies the method for selection of PVC bundle members.
Step 6	**end** **Example:** `Router(config-if-atm-member)# end`	Ends the configuration session and returns to privileged EXEC mode.

Configuring the QoS Group-Based Method for Selection of PVC Bundle Members

This section describes how to configure the method for selection of PVC bundle members that is based on QoS groups. To do so, you associate a QoS group or groups with a PVC bundle member. You can specify a QoS group, a range of QoS groups, or any combination of QoS groups and ranges of QoS groups.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface atm** *slot*/*port*
4. **bundle** *bundle-name*
5. **selection-method qos-group**
6. **pvc** *vpi*/*vci*
7. **qos-group** *qos-groups*
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**interface atm** *slot*/*port* **Example:** `Router(config)# interface atm 2/0`	Specifies the ATM interface type and enters interface configuration mode. To determine the correct form of the **interface atm** command, see your ATM network module, port adapter, or router documentation.
Step 4	**bundle** *bundle-name* **Example:** `Router(config-subif)# bundle cisco`	Creates a bundle or modifies an existing bundle and enters bundle configuration mode.
Step 5	**selection-method qos-group** **Example:** `Router(config-if-atm-bundle)# selection-method qos-group`	Specifies the method for selection of PVC bundle members based on QoS group.
Step 6	**pvc** *vpi*/*vci* **Example:** `Router(config-if-atm-bundle)# pvc 1/32`	Creates an ATM PVC and enters ATM VC bundle-member configuration mode.
Step 7	**qos-group** *qos-groups* **Example:** `Router(config-if-atm-member)# qos-group 1`	Associates a QoS group or groups with the PVC bundle member.
Step 8	**end** **Example:** `Router(config-if-atm-member)# end`	Ends the configuration session and returns to privileged EXEC mode.

Configuring Explicit InARP PVC Selection for QoS Group-Based PVC Bundle Member Selection

This section describes how to configure explicit InARP for a PVC bundle member.

When InARP is enabled for a PVC bundle member, InARP requests are sent and are expected to be received on the PVC bundle member, and InARP replies are expected to be received on the PVC bundle member.

This procedure is optional and provides backward compatibility with existing PVC bundles, in which an InARP request is sent or expected to be received on the PVC bundle member with precedence 6. If a PVC bundle with selection based on QoS group is connected to an existing PVC bundle, you must follow this procedure to allow InARP to function. If you do not follow this procedure, InARP is sent over any of the available PVC bundle members.

Restrictions

You can enable InARP for a PVC bundle member only when using the QoS groups method for selecting PVC bundle members.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface atm** *slot*/*port*
4. **bundle** *bundle-name*
5. **selection-method qos-group**
6. **pvc** *vpi*/*vci*
7. **qos-group** *qos-groups*
8. **inarp-vc**
9. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface atm** *slot*/*port* **Example:** `Router(config)# interface atm 2/0`	Specifies the ATM interface type and enters interface configuration mode. To determine the correct form of the **interface atm** command, see your ATM network module, port adapter, or router documentation.
Step 4	**bundle** *bundle-name* **Example:** `Router(config-subif)# bundle cisco`	Creates a bundle or modifies an existing bundle and enters bundle configuration mode.
Step 5	**selection-method qos-group** **Example:** `Router(config-if-atm-bundle)# selection-method qos-group`	Specifies the method for selection of PVC bundle members based on QoS group.
Step 6	**pvc** *vpi*/*vci* **Example:** `Router(config-if-atm-bundle)# pvc 1/32`	Creates an ATM PVC and enters ATM VC bundle-member configuration mode.
Step 7	**qos-group** *qos-groups* **Example:** `Router(config-if-atm-member)# qos-group 1`	Associates a QoS group or groups with the PVC bundle member.

	Command or Action	Purpose
Step 8	**inarp-vc** **Example:** `Router(config-if-atm-member)# inarp-vc`	Enables InARP for the PVC bundle member.
Step 9	**end** **Example:** `Router(config-if-atm-member)# end`	Ends the configuration session and returns to privileged EXEC mode.

Verifying Routed Bridge Encapsulation with ATM Virtual Circuit Bundles

To display information about routed bridge encapsulation with ATM virtual circuit bundles, use the following **show** commands in privileged EXEC mode. You can use these commands in any combination or order.

SUMMARY STEPS

1. **enable**
2. **show atm vc**
3. **show interfaces**
4. **show interfaces virtual-access**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enters privileged EXEC mode. • Enter your password if prompted.
Step 2	**show atm vc** **Example:** `Router# show atm vc`	Displays all ATM PVCs and switched virtual circuits (SVCs) and their traffic information.
Step 3	**show interfaces** **Example:** `Router# show interfaces`	Displays interleaving statistics. • Interleaving data is displayed only if interleaving occurs.
Step 4	**show interfaces virtual-access** **Example:** `Router# show interfaces virtual-access`	Displays multilink bundle information.

Configuration Examples for Routed Bridge Encapsulation with ATM Virtual Circuit Bundles

This section provides the following configuration examples:

Specifying the Method for Selecting PVC Bundle Members: Example

The following example shows how to specify the method for selecting PVC bundle members:

```
interface atm 2/0
 bundle cisco
  selection-method qos-group
  pvc 1/32
  qos-group 1
  end
```

Configuring the QoS Group-Based Method for Selection of PVC Bundle Members: Example

The following example shows how to configure the QoS group-based method for selection of PVC bundle members:

```
interface atm 2/0
 bundle cisco
  selection-method qos-group
  pvc 1/32
  qos-group 1
  end
```

Configuring Explicit InARP PVC Selection for QoS Group-Based PVC Bundle Member Selection: Example

The following example shows how to configure explicit InARP PVC selection for QoS group-based PVC bundle member selection:

```
interface atm 2/0
 bundle cisco
  selection-method qos-group
  pvc 1/32
  qos-group 1
  inarp-vc
  end
```

Additional References

The following sections provide references related to the Routed Bridge Encapsulation with ATM Virtual Circuit Bundles feature.

Related Documents

Related Topic	Document Title
QoS configuration	*Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.4T
QoS commands	*Cisco IOS Quality of Service Solutions Command Reference*, Release 12.4T
ATM configuration	*Cisco IOS Asynchronous Transfer Mode Configuration Guide*, Release 12.4
ATM commands	*Cisco IOS Asynchronous Transfer Mode Command Reference*, Release 12.4T

Standards

Standard	Title
IEEE 802.3 (for RBE)	*Ethernet*

MIBs

MIB	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
RFC 1483 (for RBE)	*Multiprotocol Encapsulation over ATM Adaptation Layer 5*

Technical Assistance

Description	Link
The Cisco Technical Support & Documentation website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/techsupport

Command Reference

This section documents new commands only.

- **inarp-vc**
- **qos-group (ATM VC bundle member)**
- **selection-method**

inarp-vc

To enable Inverse Address Resolution Protocol (InARP) for a permanent virtual circuit (PVC) bundle member, use the **inarp-vc** command in ATM VC bundle-member configuration mode. To disable InARP for a PVC bundle member, use the **no** form of this command.

inarp-vc

no inarp-vc

Syntax Description

This command has no arguments or keywords.

Command Default

InARP is disabled for the PVC bundle member.

Command Modes

ATM VC bundle-member configuration

Command History

Release	Modification
12.4(4)T	This command was introduced.
12.2(31)SB2	This command was integrated into Cisco IOS Release 12.2(31)SB2.

Usage Guidelines

You can use this command only when using the quality of service (QoS) groups method for selecting the PVC bundle members. When InARP is enabled for a PVC bundle member, InARP requests are sent and are expected to be received on the PVC bundle member, and InARP replies are expected to be received on the PVC bundle member.

Examples

The following example associates QoS group 1 with a PVC bundle member and enables InARP on the PVC bundle member:

```
Router> enable
Password:
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# interface atm 2/0
Router(config-subif)# bundle cisco
Router(config-if-atm-bundle)# selection-method qos-group
Router(config-if-atm-bundle)# pvc 1/32
Router(config-if-atm-member)# qos-group 1
Router(config-if-atm-member)# inarp-vc
Router(config-if-atm-member)# end
```

Related Commands

Command	Description
qos-group (ATM VC bundle member)	Associates a QoS group or groups with a PVC bundle member.
selection-method	Specifies the method for selection of the PVC bundle member.

qos-group (ATM VC bundle member)

To associate a quality of service (QoS) group or groups with a permanent virtual circuit (PVC) bundle member, use the **qos-group** command in ATM VC bundle-member configuration mode. To disassociate a QoS group or groups from a PVC bundle member, use the **no** form of this command.

qos-group *qos-groups*

no qos-group *qos-groups*

Syntax Description

qos-groups	QoS group or groups. You can specify a QoS group, a range of QoS groups, or any combination of QoS groups and ranges of QoS groups separated by commas. Specify a range by entering the starting and ending QoS group numbers separated by a hyphen (-).

Command Default

No QoS groups are associated with the PVC bundle member.

Command Modes

ATM VC bundle-member configuration

Command History

Release	Modification
12.4(4)T	This command was introduced.
12.2(31)SB2	This command was integrated into Cisco IOS Release 12.2(31)SB2.

Examples

The following example associates a single QoS group with a PVC bundle member:

```
Router> enable
Password:
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# interface atm 2/0
Router(config-subif)# bundle cisco
Router(config-if-atm-bundle)# selection-method qos-group
Router(config-if-atm-bundle)# pvc 1/32
Router(config-if-atm-member)# qos-group 1
Router(config-if-atm-member)# end
```

The following example associates a range of QoS groups from 1 to 5 with a PVC bundle member:

```
Router> enable
Password:
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# interface atm 2/0
Router(config-subif)# bundle cisco
Router(config-if-atm-bundle)# selection-method qos-group
Router(config-if-atm-bundle)# pvc 1/32
Router(config-if-atm-member)# qos-group 1-5
Router(config-if-atm-member)# end
```

The following example associates QoS groups 1 and 7 with a PVC bundle member:

```
Router> enable
Password:
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# interface atm 2/0
Router(config-subif)# bundle cisco
Router(config-if-atm-bundle)# selection-method qos-group
Router(config-if-atm-bundle)# pvc 1/32
Router(config-if-atm-member)# qos-group 1,7
Router(config-if-atm-member)# end
```

The following example associates a range of QoS groups 1 to 5 and a range of QoS groups 7-10 with a PVC bundle member:

```
Router> enable
Password:
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# interface atm 2/0
Router(config-subif)# bundle cisco
Router(config-if-atm-bundle)# selection-method qos-group
Router(config-if-atm-bundle)# pvc 1/32
Router(config-if-atm-member)# qos-group 1-5,7-10
Router(config-if-atm-member)# end
```

Related Commands

Command	Description
inarp-vc	Enables InARP for a PVC bundle member.
selection-method	Specifies the method for selection of the PVC bundle member.

selection-method

To specify the method for selection of permanent virtual circuit (PVC) bundle members, use the **selection-method** command in ATM VC bundle configuration mode. To disable a selection method, use the **no** form of this command.

selection-method {**qos-group** | **tos-exp**}

no selection-method {**qos-group** | **tos-exp**}

Syntax Description

qos-group	Use the quality of service (QoS) group value associated with each packet for selection of PVC bundle members.
tos-exp	Use ToS bit settings of each packet (for IP packets) or EXP bit settings of each packet (for Multiprotocol Label Switching (MPLS) packets) for selection of PVC bundle members.

Command Default

No selection method is set.

Command Modes

ATM VC bundle configuration

Command History

Release	Modification
12.4(4)T	This command was introduced.
12.2(31)SB2	This command was integrated into Cisco IOS Release 12.2(31)SB2.

Usage Guidelines

You can change the selection method from QoS groups to ToS or EXP only if none of the PVC bundle members have QoS groups or Inverse Address Resolution Protocol (InARP) configured.

You can change the selection method from ToS or EXP to QoS groups only if none of the PVC bundle members have precedence, protection, or bumping configured.

Examples

The following example specifies the QoS groups selection method for a PVC bundle and associates a QoS group with a member of the PVC bundle:

```
Router> enable
Password:
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# interface atm 2/0
Router(config-subif)# bundle cisco
Router(config-if-atm-bundle)# selection-method qos-group
Router(config-if-atm-bundle)# pvc 1/32
Router(config-if-atm-member)# qos-group 1
Router(config-if-atm-member)# end
```

The following example specifies the ToS or EXP selection method for a PVC bundle:

```
Router> enable
Password:
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# interface atm 2/0
Router(config-subif)# bundle cisco
Router(config-if-atm-bundle)# selection-method tos-exp
Router(config-if-atm-member)# end
```

Related Commands

Command	Description
inarp-vc	Enables InARP for a PVC bundle member.
qos-group (ATM VC bundle member)	Associates a QoS group or groups with a PVC bundle member.

Glossary

ARP—Address Resolution Protocol. Internet protocol used to map an IP address to a MAC address. Defined in RFC 826.

ATM—Asynchronous Transfer Mode. The international standard for cell relay in which multiple service types (such as voice, video, or data) are conveyed in fixed-length (53-byte) cells. Fixed-length cells allow cell processing to occur in hardware, thereby reducing transit delays. ATM is designed to take advantage of high-speed transmission media, such as E3, SONET, and T3.

bundle—A logical grouping of one or more physical interfaces using the formats and procedures of multilink Frame Relay. A bundle emulates a physical interface to the Frame Relay data-link layer. The bundle is also referred to as the *MFR interface*.

CEF—Cisco Express Forwarding. Layer 3 IP switching technology that optimizes network performance and scalability for networks with large and dynamic traffic patterns.

fast switching—Cisco feature in which a route cache expedites packet switching through a router.

InARP—Inverse Address Resolution Protocol (ARP). Method of building dynamic routes in a network. Allows an access server to discover the network address of a device associated with a virtual circuit.

MPLS—Multiprotocol Label Switching. Switching method that forwards IP traffic using a label. This label instructs the routers and the switches in the network where to forward the packets based on preestablished IP routing information.

MQC—Modular QoS CLI (command line interface). A CLI structure that lets you create traffic polices and attach them to interfaces. A traffic policy contains a traffic class and one or more QoS features. A traffic class is used to classify traffic, and the QoS features in the traffic policy determine how to treat the classified traffic.

PVC—permanent virtual circuit (or connection). Virtual circuit that is permanently established. PVCs save bandwidth associated with circuit establishment and teardown in situations where certain virtual circuits must exist all the time. In ATM terminology, this is called a permanent virtual connection.

QoS—quality of service. Measure of performance for a transmission system that reflects its transmission quality and service availability.

RBE—routed bridge encapsulation. Process by which a stub-bridged segment is terminated on a point-to-point routed interface. Specifically, the router is routing on an IEEE 802.3 or Ethernet header carried over a point-to-point protocol, such as PPP, RFC 1483 ATM, or RFC 1490 Frame Relay.

SVC—switched virtual circuit. Virtual circuit that is dynamically established on demand and is torn down when transmission is complete. SVCs are used in situations where data transmission is sporadic. Called a switched virtual connection in ATM terminology.

ToS—type of service byte. Second byte in the IP header that indicates the desired quality of service for a specific datagram.

VC—virtual circuit. Logical circuit created to ensure reliable communication between two network devices. A VC is defined by a VPI/VCI pair and can be either permanent or switched.

Note See *Internetworking Terms and Acronyms* for terms not included in this glossary.