MANET Enhancements to PPPoE for Router-to-Radio Links

The MANET Enhancements to PPPoE for Router-to-Radio Links feature provides credit-based flow control and link-quality metrics over mobile radio links. Credit-based flow control provides in-band and out-of-band credit grants in each direction. Link-quality metrics report link performance statistics that are then used to influence routing in Mobile Ad Hoc Networks (MANETs).

Prerequisites for MANET Enhancements to PPPoE for Router-to-Radio Links

To use the PPP over Ethernet (PPPoE) and virtual multipoint interface (VMI) features described in this document, a radio device that implements the PPPoE functionality enhancements described in the RFC 2516 and RFC 5578 is required.

Open Shortest Path First (OSPF) enhancements are not tied to the PPPoE/VMI implementations, and do not require such radio devices.

Restrictions for MANET Enhancements to PPPoE for Router-to-Radio Links

Virtual multipoint interfaces (VMIs) can be configured on routed ports on VLAN interfaces.

Information About MANET Enhancements to PPPoE for Router-to-Radio Links

About MANETs

Mobile Ad Hoc Networks (MANETs) for device-to-radio communications address the challenges faced when merging IP routing and mobile radio communications in ad hoc networking applications:

- Optimal route selection based on Layer 2 feedback from the radio network

- Faster convergence when nodes join and leave the network because devices are able to respond faster to network topology changes

- Efficient integration of point-to-point, directional radio topologies with multihop routing

- Flow-controlled communications between each radio and its partner device enables applications such as voice and video to work better because outages caused by moving links are reduced or eliminated. Sessions are more stable and remain active longer

Through the device-to-radio link, the radio can inform the device immediately when a node joins or leaves, and this enables the device to recognize topology changes more quickly than if it had to rely on timers. Without this link-status notification from the radio, the device would likely time out while waiting for traffic. The link-status notification from the radio enables the device to respond faster to network topology changes. Metric information regarding the quality of a link is passed between the device and radio, enabling the device to more intelligently decide on which link to use.

With the link-status signaling provided by the device-to-radio link, applications such as voice and video work better because outages caused by topology changes are reduced or eliminated. Sessions are more stable and remain active longer.

Cross-layer feedback for device-to-radio integration of Radio-Aware Routing (RAR) takes advantage of the functions defined in RFC 5578. The RFC 5578 is an Internet Engineering Task Force (IETF) standard that defines PPP over Ethernet (PPPoE) extensions for Ethernet-based communications between a device and a mobile radio, that operates in a variable-bandwidth environment and has limited buffering capabilities. These extensions provide a PPPoE session-based mechanism for sharing radio network status such as link-quality metrics and establishing flow control between a device and an RAR-compliant radio.

An RAR-compliant radio initiates a Layer 2 PPPoE session with its adjacent device on behalf of every device and radio neighbor discovered in the network. These Layer 2 sessions are the means by which radio network status for each neighbor link is reported to the device. The radio establishes the correspondence between each PPPoE session and each link to a neighbor.

Routing Challenges for MANETs

Mobile Ad Hoc Networks (MANETs) enable users deployed in areas with no fixed communications infrastructure to access critical voice, video, and data services. For example, soldiers in the field can employ unified communications, multimedia applications, and real-time information dissemination to improve situational awareness and respond quickly to changing battlefield conditions. Disaster managers can use video conferences, database access, and collaborative tools to coordinate multiagency responses within an Incident

Command System (ICS) framework. For event planners and trade show managers, MANETs represent a cost-effective way to accommodate mobile end users on a short-term basis.

In MANET environments, highly mobile nodes communicate with each other across bandwidth-constrained radio links. An individual node includes both a radio and a network device, with the two devices interconnected over an Ethernet. Because these nodes can rapidly join or leave the network, MANET routing topologies are highly dynamic. Fast convergence in a MANET becomes a challenge because the state of a node can change well before the event is detected by the normal timing mechanisms of the routing protocol.

Radio link quality in a MANET can vary dramatically because it can be affected by a variety of factors such as noise, fading, interference, and power fluctuation. As a result, avoiding congestion and determining optimal routing paths also pose significant challenges for the device network.

Directional radios that operate on a narrow beam tend to model the network as a series of physical point-to-point connections with neighbor nodes. This point-to-point model does not translate gracefully to multihop, multipoint device environments because it increases the size of each device's topology database and reduces routing efficiency.

Effective networking in a MANET environment therefore requires mechanisms by which

- Devices and radios can interoperate efficiently, and without impacting operation of the radio network.

- Radio point-to-point and device point-to-multipoint paradigms can be rationalized.

- Radios can report status to devices for each link and each neighbor.

- Devices can use this information to optimize routing decisions.

PPPoE Interfaces for Mobile Radio Communications

The Mobile Ad Hoc Network (MANET) implementation uses PPP over Ethernet (PPPoE) sessions to enable intranodal communications between a device and its partner radio. Each radio initiates the PPPoE session as soon as the radio establishes a radio link to another radio. After the PPPoE sessions are active, a PPP session is established end-to-end (device-to-device). This is duplicated each time a radio establishes a new radio link. The virtual multipoint interface (VMI) on the device can aggregate multiple PPPoE sessions and multiplex them to look like a single interface to the routing processes. Underneath the VMI are virtual access interfaces that are associated with each of the PPP and PPPoE connections.

A PPPoE session is established between a device and a radio on behalf of every other device and radio neighbor located in the MANET. These Layer 2 sessions are the means by which radio network status gets reported to the Layer 3 processes in the device. The figure below shows the PPPoE session exchange between mobile devices and directional radios in a MANET network.

Figure 1: PPPoE Session Exchange Between Mobile Devices and Directional Radios
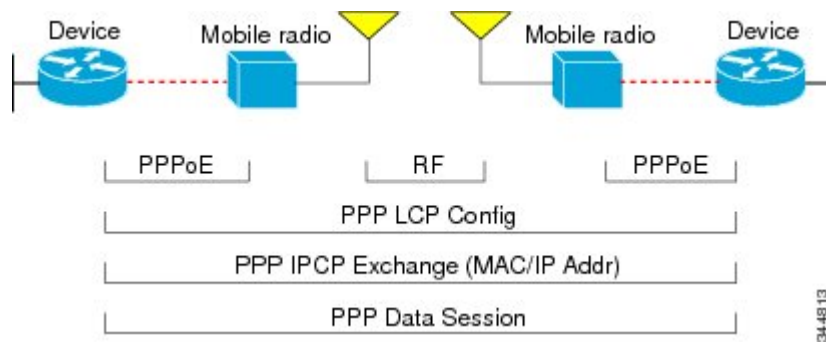
This capability requires that a Radio-Aware Routing (RAR)-compliant radio be connected to a device through Ethernet. The device always considers the Ethernet link to be up. If the radio side of the link goes down, the device waits until a routing update timeout occurs to declare the route down and then updates the routing table. The figure below shows a simple device-to-radio link topology.

The routing protocols optimized for VMI PPPoE are Enhanced Interior Gateway Routing Protocol (EIGRP) (IPv4, IPv6) and Open Shortest Path First version 3 (OSPFv3) for IPv4 and IPv6.

Figure 2: Device-to-Radio Link
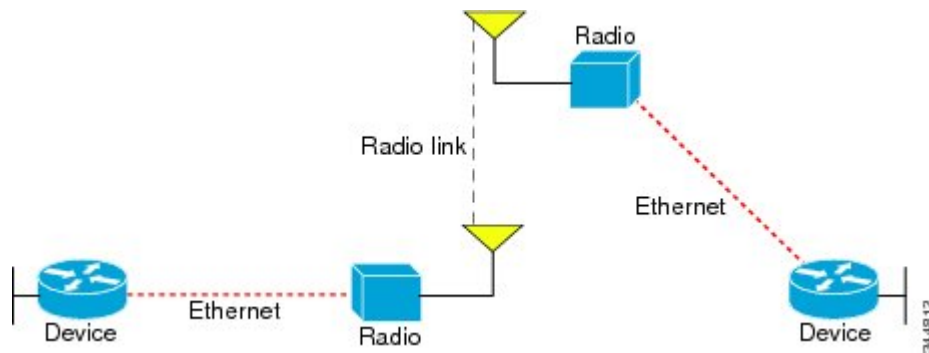
Benefits of Virtual Multipoint Interfaces

The virtual multipoint interface (VMI) provides services that map outgoing packets to the appropriate PPP over Ethernet (PPPoE) sessions based on the next-hop forwarding address for that packet. The VMI also provides a broadcast service that emulates a set of point-to-point connections as a point-to-multipoint interface with broadcast ability. When a packet with a multicast address is forwarded through the VMI in aggregate mode, VMI replicates the packet and sends it through the virtual access interfaces to each of its neighbors.

Directional radios are frequently used in applications that require greater bandwidth, increased power-to-transmission range, or reduced probability of detection. These radios operate in a point-to-point mode and generally have no broadcast capability. However, the routing processes in Mobile Ad Hoc Networks (MANETs) operate most efficiently because the network link is treated as point-to-multipoint, with broadcast capability. For the device, modeling the MANET as a collection of point-to-point nodes has a dramatic impact on the size of its internal database.

The VMI within the device can aggregate all of the per-neighbor PPPoE sessions from the radio Ethernet connection. The VMI maps the sessions to appear to Layer 3 routing protocols and applications as a single point-to-multipoint, multiaccess, broadcast-capable network. However, the VMI preserves the integrity of the

PPPoE sessions on the radio side so that each point-to-point connection can have its own quality of service (QoS) queue.

The VMI also relays the link-quality metric and neighbor up/down signaling from the radio to the routing protocols. The VMI signals are used by the Enhanced Interior Gateway Routing Protocol (EIGRP) for IPv4 and IPv6 neighbors and the Open Shortest Path First version 3 (OSPFv3) for IPv6 neighbors.

IPv6 Address Support on VMIs

You can configure virtual multipoint interfaces (VMIs) with IPv6 addresses only, IPv4 addresses only, or both IPv4 and IPv6 addresses.

IPv6 addresses are assigned to individual device interfaces and enable the forwarding of IPv6 traffic globally on the device. By default, IPv6 addresses are not configured and IPv6 routing is disabled.

Note   The *ipv6-address* argument in the **ipv6 address** command must be in the form documented in RFC 2373 where the address is specified in hexadecimal using 16-bit values between colons. The */prefix-length* argument in the **ipv6 address** command is a decimal value that indicates how many of the high-order contiguous bits of the address comprise the prefix (the network portion of the address) A slash mark must precede the decimal value.

Restrictions for IPv6 Addressing

The **ipv6 address** or the **ipv6 address eui-64** command can be used to configure multiple IPv6 global addresses within the same prefix on an interface. Multiple IPv6 link-local addresses on an interface are not supported.

OSPFv3 Address Families

The Open Shortest Path First version 3 9OSPFv3) address family feature is implemented according to RFC 5838 and enables the concurrent routing of IPv4 and IPv6 prefixes.

When this feature is enabled with Mobile Ad Hoc Networks (MANETs), IPv6 packets are routed in mobile environments over OSPFv3 using IPv4 or IPv6 addresses.

For configuration details, see the *IP Routing: OSPF Configuration Guide*.

Neighbor Up and Down Signaling for OSFPv3 and EIGRP

Mobile Ad Hoc Networks (MANETs) are highly dynamic environments. Nodes might move into, or out of, radio range at a fast pace. Each time a node joins or leaves, the network topology must be logically reconstructed by the devices. Routing protocols normally use timer-driven hello messages or neighbor timeouts to track topology changes, but MANETs reliance on these mechanisms can result in unacceptably slow convergence.

The neighbor up/down signaling capability provides faster network convergence by using link-status signals generated by the radio. The radio notifies the device each time a link to another neighbor is established or terminated by the creation and termination of PPP over Ethernet (PPPoE) sessions. In the device, the routing protocols (Open Shortest Path First version 3 [OSPFv3] or Enhanced Interior Gateway Routing Protocol [EIGRP]) respond immediately to these signals by expediting formation of a new adjacency (for a new neighbor) or tearing down an existing adjacency (if a neighbor is lost). For example, if a vehicle drives behind a building and loses its connection, the device immediately senses the loss and establishes a new route to the

vehicle through neighbors that are not blocked. This high-speed network convergence is essential for minimizing dropped voice calls and disruptions to video sessions.

When virtual multipoint interfaces (VMIs) with PPPoE are used and a partner node has left or a new one has joined, the radio informs the device immediately of the topology change. Upon receiving the signal, the device immediately declares the change and updates the routing tables. The signaling capability provides these advantages:

- Reduces routing delays and prevents applications from timing out

- Enables network-based applications and information to be delivered reliably and quickly over directional radio links

- Provides faster convergence and optimal route selection so that delay-sensitive traffic such as voice and video are not disrupted

- Reduces impact on radio equipment by minimizing the need for internal queueing and buffering

- Provides consistent quality of service for networks with multiple radios

The messaging allows for flexible rerouting when necessary because of these factors:

- Noise on the radio links

- Fading of the radio links

- Congestion of the radio links

- Radio link power fade

- Utilization of the radio

The figure below shows the signaling sequence that occurs when radio links go up and down.

Figure 3: Up and Down Signaling Sequence
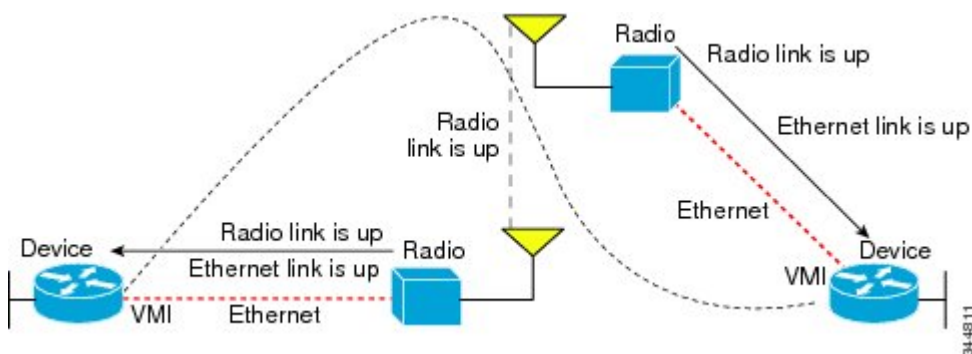
PPPoE Credit-based and Metric-based Scaling and Flow Control

Each radio initiates a PPP over Ethernet (PPPoE) session with its local device as soon as the radio establishes a link to another radio. Once the PPPoE sessions are active for each node, a PPP session is then established end-to-end (device-to-device). This process is duplicated each time a radio establishes a new link.

The carrying capacity of each radio link might vary due to location changes or environmental conditions, and many radio transmission systems have limited buffering capabilities. To minimize the need for packet queueing

in the radio, PPPoE protocol extensions enable the device to control traffic buffering in congestion situations. Implementing flow-control on these device-to-radio sessions allows use of quality of service (QoS) features such as fair queueing.

The flow-control solution utilizes a credit-granting mechanism documented in RFC 5578. When the PPPoE session is established, the radio can request a flow-controlled session. If the device acknowledges the request, all subsequent traffic must be flow controlled. If a flow-control session is requested and cannot be supported by the device, the session is terminated. Typically, both the radio and the device initially grant credits during session discovery. Once a device exhausts its credits, it must stop sending until additional credits are granted. Credits can be added incrementally over the course of a session.

Metrics scaling is used with high-performance radios that require high-speed links. The radio can express the maximum and current data rates with different scaler values. Credit scaling allows a radio to change the default credit grant (or scaling factor) of 64 bytes to its default value. You can display the maximum and current data rates and the scalar value set by the radio in the **show vmi neighbor detail** command output.

How to Configure MANET Enhancements to PPPoE for Router-to-Radio Links

Configuring a Subscriber Profile for PPPoE Service Selection

For virtual multipoint interfaces (VMIs) to work, you must configure a subscriber profile for PPP over Ethernet (PPPoE) service selection. In this task, you configure the PPPoE service name, which is used by Radio-Aware Routing (RAR)-compliant radio PPPoE clients to connect to the PPPoE server.

All PPPoE service names used for MANET implementations *must* begin with *manet_radio* for use with VMI and RFC 5578 features. Example service names are manet_radio and manet_radio_satellite.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **subscriber profile** *profile-name*
4. **pppoe service manet_radio**
5. **exit**
6. **subscriber authorization enable**
7. **exit**

DETAILED STEPS

	Command or Action	**Purpose**
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	**Purpose**
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**subscriber profile** *profile-name* **Example:** `Device(config)# subscriber profile manet`	Enters subscriber profile configuration mode.
Step 4	**pppoe service manet_radio** **Example:** `Device(config-sss-profile)# pppoe service manet_radio`	Adds a PPPoE MANET radio service name to a subscriber profile to enable the use of the VMI.
Step 5	**exit** **Example:** `Device(config-sss-profile)# exit`	Returns to global configuration mode.
Step 6	**subscriber authorization enable** **Example:** `Device(config)# subscriber authorization enable`	Enable Subscriber Service Switch type authorization. • This command is required when virtual private dialup networks (VPDNs) are not used.
Step 7	**exit** **Example:** `Device(config)# exit`	Returns to privileged EXEC mode.

Assigning the Subscriber Profile to a PPPoE Profile

Perform this required task to assign a subscriber profile to a PPP over Ethernet (PPPoE) profile. In this configuration, the BBA group name should match the subscriber profile name previously defined in the subscriber profile. In this case, the profile name used as the service name is manet_radio.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **bba-group pppoe** {*group-name* | **global**}
4. **virtual-template** *template-number*
5. **service profile** *subscriber-profile-name* [**refresh** *minutes*]
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** Device# configure terminal	Enters global configuration mode.
Step 3	**bba-group pppoe** {*group-name* | **global**} **Example:** Device(config)# bba-group pppoe group1	Defines a PPPoE profile and enters BBA group configuration mode. • The **global** keyword creates a profile that serves as the default profile for any PPPoE port that is not assigned a specific profile.
Step 4	**virtual-template** *template-number* **Example:** Device(config-bba-group)# virtual-template 1	Specifies which virtual template will be used to clone virtual access interfaces for all PPPoE ports that use this PPPoE profile.
Step 5	**service profile** *subscriber-profile-name* [**refresh** *minutes*] **Example:** Device(config-bba-group)# service profile subscriber-group1	Assigns a subscriber profile to a PPPoE profile. • The PPPoE server advertises the service names that are listed in the subscriber profile to each PPPoE client connection that uses the configured PPPoE profile. • Use the **refresh** *minutes* keyword and argument to cause the cached PPPoE configuration to time out after a specified number of minutes.
Step 6	**end** **Example:** Device(config-bba-group)# end	(Optional) Returns to privileged EXEC mode.

Troubleshooting Tips

Use the **show pppoe session** and the **debug pppoe** commands to troubleshoot PPP over Ethernet (PPPoE) sessions.

Enabling PPPoE Sessions on an Interface

Perform this required task to enable PPP over Ethernet (PPPoE) sessions on an interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **pppoe enable** [**group** *group-name*]
5. **end**

DETAILED STEPS

	Command or Action	**Purpose**
Step 1	**enable** **Example:** Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** Device# configure terminal	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** Device(config)# interface fastethernet 3/1	Specifies an interface and enters interface configuration mode. • Ethernet, Fast Ethernet, Gigabit Ethernet, VLANs, and VLAN subinterfaces can be used.
Step 4	**pppoe enable** [**group** *group-name*] **Example:** Device(config-if)# pppoe enable group bba1	Enables PPPoE sessions on an interface or subinterface.
Step 5	**end** **Example:** Device(config-if)# end	(Optional) Returns to privileged EXEC mode.

Creating a Virtual Template for IPv4 and IPv6

Perform this optional task to create a virtual template for IPv4 and IPv6. You use the virtual template interface to dynamically clone configurations for each virtual access interface created for a virtual multipoint interface (VMI) neighbor.

Before you begin

Cisco recommends that, when using the virtual template, you turn off the PPP keepalive messages to make CPU usage more efficient and to help avoid the potential for the device to terminate the connection if PPP keepalive packets are missed over a lossy radio frequency (RF) link.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface virtual-template** *number*
4. Perform steps 5 and 8 if you are using IPv4. Perform steps 6, 7, and 8 if you are using IPv6. If you are using both, perform steps 5, 6, 7, and 8.
5. **ip unnumbered** *interface-type interface-number*
6. **ipv6 enable**
7. **ipv6 unnumbered** *interface-type interface-number*
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface virtual-template** *number* **Example:** `Device(config)# interface virtual-template 1`	Creates a virtual template, and enters interface configuration mode.
Step 4	Perform steps 5 and 8 if you are using IPv4. Perform steps 6, 7, and 8 if you are using IPv6. If you are using both, perform steps 5, 6, 7, and 8. **Example:** **Example:**	--
Step 5	**ip unnumbered** *interface-type interface-number* **Example:** `Device(config-if)# ip unnumbered vmi 1`	Enables IP processing of IPv4 on an interface without assigning an explicit IP address to the interface.
Step 6	**ipv6 enable** **Example:** `Device(config-if)# ipv6 enable`	Enables IPv6 processing on the interface.
Step 7	**ipv6 unnumbered** *interface-type interface-number* **Example:**	Enables IPv6 processing on an interface without assigning an explicit IPv6 address to the interface.

	Command or Action	Purpose
	`Device(config-if)# ipv6 unnumbered vmi I`	
Step 8	**end** **Example:** `Device(config-if)# end`	(Optional) Returns to privileged EXEC mode.

Creating a VMI for EIGRP IPv4

Perform this optional task to create the VMI for the Enhanced Interior Gateway Routing Protocol for IPv4 (EIGRP IPv4) and associate it with the interface on which PPP over Ethernet (PPPoE is enabled).

Before you begin

When you create a virtual multipoint interface (VMI), assign the IPv4 address to that VMI definition.

The radio alerts the device with PADT messages that the Layer-2 radio frequency (RF) connection is no longer alive. Cisco recommends that you turn off the PPP keepalive messages to make CPU usage more efficient and to help avoid the potential for the device to terminate the connection if PPP keepalive packets are missed over a lossy RF link.

This configuration includes quality of service (QoS) fair queueing and a service policy applied to the VMI. Make certain that any fair queueing left over from any previous configurations is removed before applying the new policy map to the virtual template in the VMI configuration.

Note   Do not assign any addresses to the corresponding physical interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip routing**
4. **no virtual-template subinterface**
5. **policy-map** *policy-mapname*
6. **class class-default**
7. **fair-queue**
8. **exit**
9. **exit**
10. **interface virtual-template** *number*
11. **ip unnumbered** *interface-type interface-number*
12. **service-policy output** *policy-mapname*
13. **no keepalive**
14. **interface** *type number*
15. **ip address** *address mask*
16. **no ip redirects**

17. **no ip split-horizon eigrp** *autonomous-system-number*
18. **physical-interface** *type number*
19. **exit**
20. **router eigrp** *autonomous-system-number*
21. **network** *network-number ip-mask*
22. **redistribute connected**
23. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip routing** **Example:** `Device(config)# ip routing`	Enables IP routing on the device.
Step 4	**no virtual-template subinterface** **Example:** `Device(config)# no virtual-template subinterface`	Disables the virtual template on the subinterface.
Step 5	**policy-map** *policy-mapname* **Example:** `Device(config)# policy-map fair-queue`	Enters QoS policy-map configuration mode and creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy.
Step 6	**class class-default** **Example:** `Device(config-pmap)# class class-default`	Specifies the name of the class whose policy you want to create or change or specifies the default class (commonly known as the class-default class) before you configure its policy. • Enters Qos policy-map class configuration mode.
Step 7	**fair-queue** **Example:** `Device(config-pmap-c)# fair-queue`	Enables weighted fair queueing (WFQ) on the interface.

	Command or Action	**Purpose**
Step 8	**exit** **Example:** `Device(config-pmap-c)# exit`	Returns to QoS policy-map configuration mode.
Step 9	**exit** **Example:** `Device(config-pmap)# exit`	Returns to global configuration mode.
Step 10	**interface virtual-template** *number* **Example:** `Device(config)# interface virtual-template 1`	Enters interface configuration mode and creates a virtual template interface that can be configured and applied dynamically in creating virtual access interfaces.
Step 11	**ip unnumbered** *interface-type interface-number* **Example:** `Device(config-if)# ip unnumbered vmi 1`	Enables IP processing of IPv4 on a serial interface without assigning an explicit IP address to the interface.
Step 12	**service-policy output** *policy-mapname* **Example:** `Device(config-if)# service-policy output fair-queue`	Attaches a policy map to an input interface, virtual circuit (VC), or to an output interface or VC. • The policy map is as the service policy for that interface or VC.
Step 13	**no keepalive** **Example:** no `Device(config-if)# no keepalive`	Turns off PPP keepalive messages to the interface.
Step 14	**interface** *type number* **Example:** `Device(config-if)# interface vmi 1`	Specifies the number of the VMI.
Step 15	**ip address** *address mask* **Example:** `Device(config-if)# ip address 209.165.200.225 255.255.255.224`	Specifies the IP address of the VMI.
Step 16	**no ip redirects** **Example:** `Device(config-if)# no ip redirects`	Disables the sending of Internet Control Message Protocol (ICMP) redirect messages if the Cisco software is forced to resend a packet through the same interface on which it was received.

	Command or Action	Purpose
Step 17	**no ip split-horizon eigrp** *autonomous-system-number* **Example:** Device(config-if)# no ip split-horizon eigrp 101	Disables the split horizon mechanism for the specified session.
Step 18	**physical-interface** *type number* **Example:** Device(config-if)# physical-interface FastEthernet 0/1	Creates the physical subinterface to be associated with the VMIs on the device.
Step 19	**exit** **Example:** Device(config-if)# exit	Exits interface configuration mode and returns to global configuration mode.
Step 20	**router eigrp** *autonomous-system-number* **Example:** Device(config)# router eigrp 100	Enables EIGRP routing on the device, identifies the autonomous system number, and enters router configuration mode.
Step 21	**network** *network-number ip-mask* **Example:** Device(config-router)# network 209.165.200.225 255.255.255.224	Identifies the EIGRP network.
Step 22	**redistribute connected** **Example:** Device(config-router)# redistribute connected	Redistributes routes from one routing domain into another routing domain.
Step 23	**end** **Example:** Device(config-router)# end	(Optional) Returns to privileged EXEC mode.

Creating a VMI for EIGRP IPv6

Perform this optional task to create the VMI for the Enhanced Interior Gateway Routing Protocol for IPv6 (EIGRP IPv6) and associate it with the interface on which PPP over Ethernet (PPPoE) is enabled.

Before you begin

When you create a virtual multipoint interface (VMI), assign the IPv6 address to that VMI definition.

The radio alerts the device with PADT messages that the Layer-2 radio frequency (RF) connection is no longer alive. Cisco recommends that if you turn off the PPP keepalive messages to make CPU usage more efficient

and help to avoid the potential for the device to terminate the connection if PPP keepalive packets are missed over a lossy RF link.

This configuration includes quality of service (QoS) fair queueing and a service policy applied to the VMI. Make certain that any fair queueing left over from any previous configurations is removed before applying the new policy map to the virtual template in the VMI configuration.

Note   Do not assign any addresses to the corresponding physical interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no virtual-template subinterface**
4. **ipv6 unicast-routing**
5. **ipv6 cef**
6. **policy-map** *policy-mapname*
7. **class class-default**
8. **fair-queue**
9. **exit**
10. **exit**
11. **interface virtual-template** *number*
12. **ipv6 enable**
13. **no keepalive**
14. **service-policy output** *policy-mapname*
15. **interface** *type number*
16. **ipv6 address** *address/prefix-length*
17. **ipv6 enable**
18. **ipv6 eigrp** *as-number*
19. **no ipv6 redirects**
20. **no ipv6 split-horizon eigrp** *as-number*
21. **physical-interface** *type number*
22. **no shutdown**
23. **ipv6 router eigrp** *as-number*
24. **redistribute connected**
25. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.
	Example:	• Enter your password if prompted.
	Device> enable	

	Command or Action	**Purpose**
Step 2	**configure terminal** **Example:** Device# configure terminal	Enters global configuration mode.
Step 3	**no virtual-template subinterface** **Example:** Device(config)# no virtual-template subinterface	Disables the virtual template on the subinterface.
Step 4	**ipv6 unicast-routing** **Example:** Device(config)# ipv6 unicast-routing	Enables IPv6 unicast routing.
Step 5	**ipv6 cef** **Example:** Device(config)# ipv6 cef	Enables IPv6 Cisco Express Forwarding on the device
Step 6	**policy-map** *policy-mapname* **Example:** Device(config-pmap)# policy-map fair-queue	Enters QoS policy-map configuration mode and creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy.
Step 7	**class class-default** **Example:** Device(config-pmap)# class class-default	Specifies the name of the class whose policy you want to create or change or specifies the default class (commonly known as the class-default class) before you configure its policy. • Enters QoS policy-map class configuration mode.
Step 8	**fair-queue** **Example:** Device(config-pmap-c)# fair-queue	Enables weighted fair queueing (WFQ) on the interface.
Step 9	**exit** **Example:** Device(config-pmap-c)# exit	Returns to QoS policy-map configuration mode.
Step 10	**exit** **Example:** Device(config-pmap)# exit	Returns to global configuration mode.

	Command or Action	Purpose
Step 11	**interface virtual-template** *number* **Example:** `Device(config)# interface virtual-template 1`	Enters interface configuration mode and creates a virtual template interface that can be configured and applied dynamically in creating virtual access interfaces.
Step 12	**ipv6 enable** **Example:** `Device(config-if)# ipv6 enable`	Enables IPv6 routing on the virtual template.
Step 13	**no keepalive** **Example:** `Device(config-if)# no keepalive`	Turns off PPP keepalive messages to the virtual template.
Step 14	**service-policy output** *policy-mapname* **Example:** `Device(config-if)# service-policy output fair-queue`	Attaches a policy map to an input interface, virtual circuit (VC), or to an output interface or VC. • The policy map is as the service policy for that interface or VC.
Step 15	**interface** *type number* **Example:** `Device(config-if)# interface vmi 1`	Creates a VMI.
Step 16	**ipv6 address** *address*/*prefix-length* **Example:** `Device(config-if)# ipv6 address 2001:0DB8::/32`	Specifies the IPv6 address for the interface.
Step 17	**ipv6 enable** **Example:** `Device(config-if)# ipv6 enable`	Enables IPv6 routing on the interface.
Step 18	**ipv6 eigrp** *as-number* **Example:** `Device(config-if)# ipv6 eigrp 1`	Enables the EIGRP for IPv6 on a specified interface and specifies the autonomous system number.
Step 19	**no ipv6 redirects** **Example:** `Device(config-if)# no ipv6 redirects`	Disables the sending of Internet Control Message Protocol (ICMP) IPv6 redirect messages if the software is forced to resend a packet through the same interface on which the packet was received
Step 20	**no ipv6 split-horizon eigrp** *as-number*	Disables the split horizon for EIGRP IPv6.

	Command or Action	Purpose
	Example: `Device(config-if)# no ipv6 split-horizon eigrp 100`	• Associates this command with a specific EIGRP autonomous system number.
Step 21	**physical-interface** *type number* **Example:** `Device(config-if)# physical-interface FastEthernet 1/0`	Creates the physical subinterface to be associated with the VMIs on the device.
Step 22	**no shutdown** **Example:** `Device(config-if)# no shutdown`	Restarts a disabled interface or prevents the interface from being shut down.
Step 23	**ipv6 router eigrp** *as-number* **Example:** `Device(config-if)# ipv6 router eigrp 100`	Places the device in router configuration mode, creates an EIGRP routing process in IPv6, and allows you to enter additional commands to configure this process.
Step 24	**redistribute connected** **Example:** `Device(config-router)# redistribute connected`	Allows the target protocol to redistribute routes learned by the source protocol and connected prefixes on those interfaces over which the source protocol is running. • Redistributes IPv6 routes from one routing domain into another routing domain.
Step 25	**end** **Example:** `Device(config-router)# end`	(Optional) Returns to privileged EXEC mode.

Verifying the VMI Configuration

You can use the following commands to verify the virtual multipoint interface (VMI) configuration:

- **show pppoe session all**
- **show interface vmi**
- **show vmi neighbors**
- **show vmi neighbors detail**
- **show ip eigrp interfaces**
- **show ip eigrp neighbors**
- **show ipv6 eigrp interfaces**

- **show ipv6 eigrp neighbors**

- **show ipv6 ospf interface**

Configuration Examples for MANET Enhancements to PPPoE for Router-to-Radio Links

Example: Basic VMI PPPoE Configuration with EIGRP IPv4

The following example shows the basic virtual multipoint interface (VMI) PPP over Ethernet (PPPoE) configuration with the Enhanced Interior Gateway Routing Protocol for IPv4 (EIGRP IPv4) as the routing protocol. This configuration includes one VMI.

```
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname host1
!
logging buffered 3000000
no logging console
enable password test
!
no aaa new-model
clock timezone EST -5
ip cef
!
no ip domain lookup
subscriber authorization enable
!
subscriber profile host1
 pppoe service manet_radio
!
subscriber profile test
 pppoe service manet_radio
!
!
multilink bundle-name authenticated
no virtual-template subinterface
!
archive
 log config
!
policy-map FQ
 class class-default
  fair-queue
!
bba-group pppoe test
 virtual-template 1
 service profile test
!
bba-group pppoe VMI1
 virtual-template 1
 service profile host1
!
!
```

```
interface Loopback1
 ip address 209.165.200.225 255.255.255.224
 no ip proxy-arp
 load-interval 30
!
interface FastEthernet0/0
 no ip address
 no ip mroute-cache
 load-interval 30
 speed 100
 full-duplex
 pppoe enable group VMI1
!
interface Serial1/0
 no ip address
 no ip mroute-cache
 shutdown
 clock rate 2000000
!
interface Serial1/1
 no ip address
 no ip mroute-cache
 shutdown
 clock rate 2000000
!
!
interface Serial1/2
 no ip address
 no ip mroute-cache
 shutdown
 clock rate 2000000
!
interface Serial1/3
 no ip address
 no ip mroute-cache
 shutdown
 clock rate 2000000
!
interface FastEthernet2/0
 switchport access vlan 2
 duplex full
 speed 100
!
interface FastEthernet2/1
 switchport access vlan 503
 load-interval 30
 duplex full
 speed 100
!
interface FastEthernet2/2
 shutdown
!
interface FastEthernet2/3
 shutdown
!
interface Virtual-Template1
 ip unnumbered vmi1
 load-interval 30
 no keepalive
 service-policy output FQ
!
interface Vlan1
 no ip address
 no ip mroute-cache
```

```
  shutdown
!
interface Vlan2
 ip address 209.165.200.226 255.255.255.224
 no ip mroute-cache
 load-interval 30
!
interface Vlan503
 ip address 209.165.200.226 255.255.255.224
 load-interval 30
!
interface vmi1
 ip address 209.165.200.226 255.255.255.224
 no ip redirects
 no ip split-horizon eigrp 1
 load-interval 30
 dampening-change 50
 physical-interface FastEthernet0/0
!
router eigrp 1
 redistribute connected
 network 209.165.200.226 255.255.255.224
 network 209.165.200.227 255.255.255.224
 auto-summary
!
no ip http server
no ip http secure-server
!
control-plane
!
!
line con 0
 exec-timeout 0 0
 stopbits 1
line aux 0
line vty 0 4
 login
!
end
```

Example: Basic VMI PPPoE Configuration with EIGRP IPv6

The following example shows the basic requirements for configuring a virtual multipoint interface (VMI) that uses the Enhanced Interior Gateway Routing Protocol for IPv6 (EIGRP IPv6) as the routing protocol. It includes one VMI.

```
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname host1
!
logging buffered 3000000
no logging console
enable password lab
!
no aaa new-model
clock timezone EST -5
ip cef
!
!
```

```
!
!
no ip domain lookup
ipv6 unicast-routing
ipv6 cef
subscriber authorization enable
!
subscriber profile host1
 pppoe service manet_radio
!
subscriber profile test
 pppoe service manet_radio
!
!
multilink bundle-name authenticated
no virtual-template subinterface
!
!
!
!
archive
 log config
!
!
policy-map FQ
 class class-default
  fair-queue
!
!
!
!
!
bba-group pppoe test
 virtual-template 1
 service profile test
!
bba-group pppoe VMI1
 virtual-template 1
 service profile host1
!
!
!
interface Loopback1
 ip address 209.165.200.226 255.255.255.224
 no ip proxy-arp
 load-interval 30
 ipv6 address 2001:0DB8::/32
 ipv6 enable
 ipv6 eigrp 1
!
interface FastEthernet0/0
 no ip address
 no ip mroute-cache
 load-interval 30
 speed 100
 full-duplex
 pppoe enable group VMI1
!
interface Serial1/0
 no ip address
 no ip mroute-cache
 shutdown
 clock rate 2000000
!
```

```
interface Serial1/1
 no ip address
 no ip mroute-cache
 shutdown
 clock rate 2000000
!
interface Serial1/2
 no ip address
 no ip mroute-cache
 shutdown
 clock rate 2000000
!
interface Serial1/3
 no ip address
 no ip mroute-cache
 shutdown
 clock rate 2000000
!
interface FastEthernet2/0
 switchport access vlan 2
 duplex full
 speed 100
!
interface FastEthernet2/1
 switchport access vlan 503
 load-interval 30
 duplex full
 speed 100
!
interface FastEthernet2/2
 shutdown
!
interface FastEthernet2/3
 shutdown
!
interface Virtual-Template1
 no ip address
 load-interval 30
 ipv6 enable
 no keepalive
 service-policy output FQ
!
interface Vlan1
 no ip address
 no ip mroute-cache
 shutdown
!
interface Vlan2
 ip address 209.165.200.225 255.255.255.224
 no ip mroute-cache
 load-interval 30
!
interface Vlan503
 ip address 209.165.200.225 255.255.255.224
 load-interval 30
 ipv6 address 2001:0DB8::/32
 ipv6 enable
 ipv6 eigrp 1
!
interface vmi1
 no ip address
 load-interval 30
 ipv6 enable
 no ipv6 redirects
```

```
 ipv6 eigrp 1
 no ipv6 split-horizon eigrp 1
 physical-interface FastEthernet0/0
!
no ip http server
no ip http secure-server
!
ipv6 router eigrp 1
 router-id 10.9.1.1
 no shutdown
 redistribute connected
!
control-plane
!
line con 0
 exec-timeout 0 0
 stopbits 1
line aux 0
line vty 0 4
 login
!
end
```

Example: VMI PPPoE Configuration with EIGRP for IPv4 and IPv6

The following examples show how to configure the virtual multipoint interface (VMI) for PPP over Ethernet (PPPoE) using the Enhanced Interior Gateway Routing Protocol (EIGRP) as the IP routing protocol when you have both IPv4 and IPv6 addresses configured on the interface. This configuration includes one VMI. Though EIGRP allows you to use the same autonomous system (AS) number on an IPv4 EIGRP process and on an IPv6 process, we recommend using a unique AS number for each process for clarity.

```
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname host1
!
logging buffered 3000000
no logging console
enable password lab
!
no aaa new-model
clock timezone EST -5
ip cef
!
no ip domain lookup
ipv6 unicast-routing
ipv6 cef
subscriber authorization enable
!
subscriber profile host1
 pppoe service manet_radio
!
subscriber profile test
 pppoe service manet_radio
!
!
multilink bundle-name authenticated
no virtual-template subinterface
!
archive
```

```
 log config
!
policy-map FQ
 class class-default
  fair-queue
!
bba-group pppoe test
 virtual-template 1
 service profile test
!
bba-group pppoe VMI1
 virtual-template 1
 service profile host1
!
!
interface Loopback1
 ip address 209.165.200.225 255.255.255.224
 no ip proxy-arp
 load-interval 30
 ipv6 address 2001:0DB8::/32
 ipv6 enable
 ipv6 eigrp 1
!
interface FastEthernet0/0
 no ip address
 no ip mroute-cache
 load-interval 30
 speed 100
 full-duplex
 pppoe enable group VMI1
!
interface Serial1/0
 no ip address
 no ip mroute-cache
 shutdown
 clock rate 2000000
!
interface Serial1/1
 no ip address
 no ip mroute-cache
 shutdown
 clock rate 2000000
!
interface Serial1/2
 no ip address
 no ip mroute-cache
 shutdown
 clock rate 2000000
!
interface Serial1/3
 no ip address
 no ip mroute-cache
 shutdown
 clock rate 2000000
!
interface FastEthernet2/0
 switchport access vlan 2
 duplex full
 speed 100
!
interface FastEthernet2/1
 switchport access vlan 503
 load-interval 30
 duplex full
```

```
 speed 100
!
interface FastEthernet2/2
 shutdown
!
interface FastEthernet2/3
 shutdown
!
interface Virtual-Template1
 ip unnumbered vmi1
 load-interval 30
 ipv6 enable
 no keepalive
 service-policy output FQ
!
interface Vlan1
 no ip address
 no ip mroute-cache
 shutdown
!
interface Vlan2
 ip address 209.165.200.225 255.255.255.224
 no ip mroute-cache
 load-interval 30
!
interface Vlan503
 ip address 209.165.200.225 255.255.255.224
 load-interval 30
 ipv6 address 2001:0DB8::/32
 ipv6 enable
 ipv6 eigrp 1
!
interface vmi1
 ip address 209.165.200.225 255.255.255.224
 no ip redirects
 no ip split-horizon eigrp 1
 load-interval 30
 ipv6 address 2001:0DB8::/32
 ipv6 enable
 no ipv6 redirects
 ipv6 eigrp 1
 no ipv6 split-horizon eigrp 10
 dampening-interval 30
 physical-interface FastEthernet0/0
!
router eigrp 1
 redistribute connected
 network 209.165.200.225 255.255.255.224
 network 209.165.200.226 255.255.255.224
 auto-summary
!
!
!
no ip http server
no ip http secure-server
!
ipv6 router eigrp 1
 router-id 10.9.1.1
 no shutdown
 redistribute connected
!
control-plane
!
!
```

```
line con 0
 exec-timeout 0 0
 stopbits 1
line aux 0
line vty 0 4
 login
!
end
```

Example: VMI Configuration Using Multiple Virtual Templates

The following example shows how to configure the virtual multipoint interface (VMI) by using multiple virtual templates. This example shows two VMIs, each with a different service name.

```
!
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname router1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
!
resource policy
!
clock timezone EST -5
ip cef
no ip domain lookup
!
!
subscriber authorization enable
!
subscriber profile router1_ground
 pppoe service manet_radio_ground
!
subscriber profile router1_satellite
 pppoe service manet_radio_satellite
!
ipv6 unicast-routing
policy-map FQ
 class class-default
  fair-queue
!
!
!
bba-group pppoe router1_ground
 virtual-template 1
 service profile router1_ground
!
bba-group pppoe router1_satellite
 virtual-template 2
 service profile router1_satellite
!
!
interface Ethernet0/0
 pppoe enable group router1_ground
!
interface Ethernet0/1
```

```
 pppoe enable group router1_satellite
!
interface Ethernet0/2
 no ip address
 shutdown
!
interface Ethernet0/3
 no ip address
 shutdown
!
interface Ethernet1/0
 no ip address
 shutdown
!
interface Ethernet1/1
 no ip address
 shutdown
!
interface Ethernet1/2
 no ip address
 shutdown
!
interface Ethernet1/3
 no ip address
 shutdown
!
interface Serial2/0
 no ip address
 shutdown
 serial restart-delay 0
!
interface Serial2/1
 no ip address
 shutdown
 serial restart-delay 0
!
interface Serial2/2
 no ip address
 shutdown
 serial restart-delay 0
!
interface Serial2/3
 no ip address
 shutdown
 serial restart-delay 0
!
interface Serial3/0
 no ip address
 shutdown
 serial restart-delay 0
!
interface Serial3/1
 no ip address
 shutdown
 serial restart-delay 0
!
interface Serial3/2
 no ip address
 shutdown
 serial restart-delay 0
!
interface Serial3/3
 no ip address
 shutdown
```

```
 serial restart-delay 0
!
interface Virtual-Template1
 ip unnumbered vmi1
 load-interval 30
 no peer default ip address
 no keepalive
 service-policy output FQ
!
interface Virtual-Template2
 ip unnumbered vmi1
 load-interval 30
 no peer default ip address
 no keepalive
 service-policy output FQ
!
interface vmi1
 description ground connection
 ip address 209.165.200.225 255.255.255.224
 physical-interface Ethernet0/0
!
interface vmi2
 description satellite connection
 ip address 209.165.200.225 255.255.255.224
 physical-interface Ethernet0/1
!
router eigrp 1
 network 209.165.200.225 255.255.255.224
 network 209.165.200.227 255.255.255.224
 auto-summary
!
!
no ip http server
!
!
!
!
!
control-plane
!
!
line con 0
 exec-timeout 0 0
 logging synchronous
line aux 0
line vty 0 4
 login
!
end
```

Example: PPPoE Configuration

In the following example, the subscriber profile uses a predefined string manet_radio to determine whether an inbound PPP over Ethernet (PPPoE) session is coming from a device that supports the virtual multipoint interface (VMI). All IP definitions are configured on the VMI rather than on the Fast Ethernet or virtual-template interfaces; when those interfaces are configured, do not specify either an IP address or an IPv6 address.

No IP address is specified, and IPv6 is enabled by default on the VMI:

```
subscriber profile list1
  pppoe service manet_radio
```

```
    subscriber authorization enable
!
bba-group pppoe bba1
  virtual-template 1
  service profile list1
!
interface FastEthernet0/1
  no ip address
  pppoe enable group bba1
!
interface Virtual-Template 1
  no ip address
  no peer default ip-address
!
interface vmi 1
  no ip address
  physical-interface FastEthernet0/1
```

Example: Configuring Two VMIs and Two Virtual Templates

The following example shows a configuration that includes two virtual multipoint interfaces (VMIs), two virtual templates, and two service names. You can configure multiple virtual template interfaces for your VMI PPP over Ethernet (PPPoE) connections. The selection of which virtual template to use is predicated on the service name sent by the radio during PPPoE session establishment.

In this example, any PPPoE request for a session (presentation of a PPPoE Active Discovery Initiate [PADI] packet) with the service name of "manet_radio_ground" uses Virtual-Template1 as the interface to be cloned. Conversely, any PADI presented by the radio with the service name of "manet_radio_satellite" uses Virtual-Template2.

```
!
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname router1
!
boot-start-marker
boot-end-marker
!
!
no aaa new-model
!
resource policy
!
clock timezone EST -5
ip cef
no ip domain lookup
!
!
subscriber authorization enable
!
subscriber profile router1_ground
 pppoe service manet_radio_ground
!
subscriber profile router1_satellite
 pppoe service manet_radio_satellite
!
ipv6 unicast-routing
 policy-map FQ
 class class-default
```

```
 fair-queue
!
!
!
bba-group pppoe router1_ground
 virtual-template 1
 service profile router1_ground
!
bba-group pppoe router1_satellite
 virtual-template 2
 service profile router1_satellite
!
!
interface Ethernet0/0
 pppoe enable group router1_ground
!
interface Ethernet0/1
 pppoe enable group router1_satellite
!
interface Ethernet0/2
 no ip address
 shutdown
!
interface Ethernet0/3
 no ip address
 shutdown
!
interface Ethernet1/0
 no ip address
 shutdown
!
interface Ethernet1/1
 no ip address
 shutdown
!
interface Ethernet1/2
 no ip address
 shutdown
!
interface Ethernet1/3
 no ip address
 shutdown
!
interface Serial2/0
 no ip address
 shutdown
 serial restart-delay 0
!
interface Serial2/1
 no ip address
 shutdown
 serial restart-delay 0
!
interface Serial2/2
 no ip address
 shutdown
 serial restart-delay 0
!
interface Serial2/3
 no ip address
 shutdown
 serial restart-delay 0
!
interface Serial3/0
```

```
 no ip address
 shutdown
 serial restart-delay 0
!
interface Serial3/1
 no ip address
 shutdown
 serial restart-delay 0
!
interface Serial3/2
 no ip address
 shutdown
 serial restart-delay 0
!
interface Serial3/3
 no ip address
 shutdown
 serial restart-delay 0
!
interface Virtual-Template1
 ip unnumbered vmi1
 load-interval 30
 no peer default ip address
 no keepalive
 service-policy output FQ
!
interface Virtual-Template2
 ip unnumbered vmi2
 load-interval 30
 no peer default ip address
 no keepalive
 service-policy output FQ
!
interface vmi1
 description ground connection
 ip address 209.165.200.226 255.255.255.224
 physical-interface Ethernet0/0
!
interface vmi2
 description satellite connection
 ip address 209.165.200.227 255.255.255.224
 physical-interface Ethernet0/1
!
router eigrp 1
 network 209.165.200.226 255.255.255.224
 network 209.165.200.227 255.255.255.224
 auto-summary
!
!
no ip http server
!
!
!
!
!
control-plane
!
!
line con 0
 exec-timeout 0 0
 logging synchronous
line aux 0
line vty 0 4
 login
```

```
!
end
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
PPPoE and virtual templates	*Dial Configuration Guide* Cisco IOS Dial Technologies Command Reference
PPPoE configuration and commands	*Broadband Access Aggregation and DSL Configuration Guide* Cisco IOS Broadband Access Aggregation and DSL Command Reference
IPv6 addressing and basic connectivity	*IPv6 Addressing and Basic Connectivity Configuration Guide* (part of the IPv6 Configuration Guide Library)
IPv6 commands	Cisco IOS IPv6 Command Reference
Open Shortest Path First version 3 (OSPFv3) address families	*IP Routing: OSPF Configuration Guide*

RFCs

RFC	Title
RFC 2373	*IP Version 6 Addressing Architecture*
RFC 2516	*A Method for Transmitting PPP Over Ethernet (PPPoE)*
RFC 5578	*PPP Over Ethernet (PPPoE) Extensions for Credit Flow and Link Metrics*
RFC 5838	*Support of Address Families in OSPFv3*

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for MANET Enhancements to PPPoE for Router-to-Radio Links

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

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

Table 1: Feature Information for MANET Enhancements to PPPoE for Router-to-Radio Links

Feature Name	Releases	Feature Information
MANET Enhancements to PPPoE for Router-to-Radio Links	12.4(15)XF 12.4(15)T 15.0(1)M	The MANET Enhancements to PPPoE for Router-to-Radio Links feature provides credit-based flow control and link-quality metrics over mobile radio links. Credit-based flow control provides in-band and out-of-band credit grants in each direction. Link-quality metrics report link performance statistics that are then used to influence routing. The following commands were introduced or modified: **show pppoe session**, **show vmi neighbors**.
Radio Aware Routing RFC 5578	15.1(3)T	Radio-Aware Routing incorporates RFC 5578 updates for interfacing Cisco devices to high-performance radios through PPP over Ethernet (PPPoE). The following commands were introduced or modified: **show vmi neighbors**.