



# Radio Aware Routing

**Table 1: Feature History**

Feature Name	Release Information	Description
Radio-Aware Routing Support	Cisco IOS XE Catalyst SD-WAN Release 17.6.1a Cisco vManage Release 20.6.1	This feature enables Radio-Aware Routing (RAR) support on Cisco IOS XE Catalyst SD-WAN devices. RAR is a mechanism that uses radio signals to interact with the routing protocol OSPFv3 to signal the appearance, disappearance, and link conditions of one-hop routing neighbors. In large mobile networks, connections to the routing neighbors are interrupted due to distance and radio obstructions. RAR addresses the challenges faced by merging IP routing and radio communications in mobile networks.

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## Supported Devices for RAR

The following platforms support RAR:

- Cisco 4000 Series Integrated Services Routers
- Cisco 1000 Series Integrated Services Routers
- Cisco ASR 1000 Series Aggregation Services Routers
- Cisco CSR 1000 Series Cloud Service Routers
- Cisco CSR 8000 Series Cloud Service Routers

## Prerequisites for RAR

The RAR configuration requires Mobile Ad-hoc Networks (MANETs) support. To use the PPP over Ethernet (PPPoE) and virtual multipoint interface (VMI) features for RAR, a unified representation of the MANET to routing protocols (OSPFv3 or EIGRP) is required.

## Benefits of RAR

The Radio Aware Routing feature offers the following benefits:

- Provides faster network convergence through immediate recognition of changes.
- Enables routing for failing or fading radio links.
- Allows easy routing between line-of-sight and non-line-of-sight paths.
- Provides faster convergence and optimal route selection so that delay-sensitive traffic, such as voice and video, is not disrupted
- Provides efficient radio resources and bandwidth usage.
- Reduces impact on the radio links by performing congestion control in the router.
- Allows route selection based on radio power conservation.
- Enables decoupling of the routing and radio functionalities.
- Provides simple Ethernet connection to RFC 5578, R2CP, and DLEP compliant radios.

## Restrictions for RAR

The Radio Aware Routing feature has the following restrictions:

- The Dynamic Link Exchange Protocol (DLEP) and Router to Radio Control Protocol (R2CP) protocols are not supported.
- Multicast traffic is not supported in aggregate mode.
- Cisco High Availability (HA) technology is not supported.

## Information about RAR

Radio-Aware Routing (RAR) is a mechanism that uses radio interfaces to interact with the Open Shortest Path First (OSPFv3) protocol to signal the appearance and link conditions of one-hop routing neighbors.

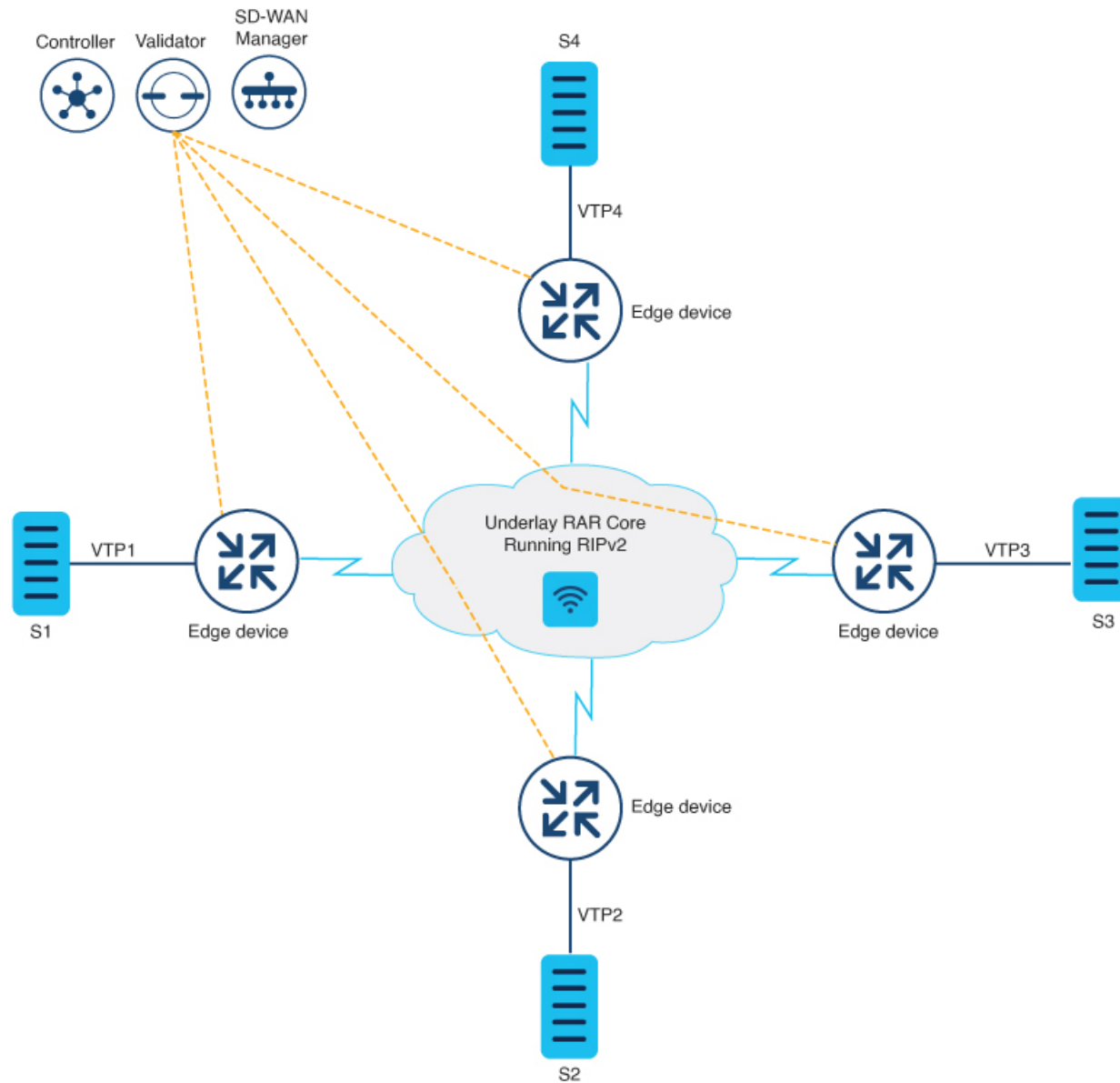
In large mobile network, distance and radio obstructions often interrupt the connections to the routing neighbors. When these signals do not reach the routing protocols, protocol timers are used to update the status of a neighbor. Routing protocols have lengthy timer, which is not recommended in mobile networks.

The connectivity between two Cisco IOS XE Catalyst SD-WAN devices happen over a PPPoE connection using variable bandwidth and a limited buffering. OSPFv3 and EIGRP are the supported routing protocols.

## Overview of RAR

The following topology shows the RAR deployment on Cisco IOS XE Catalyst SD-WAN devices.

**Figure 1: RAR Architecture**



- The four Cisco IOS XE Catalyst SD-WAN devices connect to each other through a radio connected to a physical interface on the device
- PPPoE-RAR configurations happen on all three routers and once the underlay RAR network is established, the Cisco Catalyst SD-WAN tunnels form on the network.

- The loopback interface acts as a WAN interface and binds to the Virtual Multipoint interface (VMI). The VMI interface in turn binds to the physical interface
- The PPP connections between any two devices act as the underlay network.
- The Cisco Catalyst SD-WAN tunnels are established over the PPPoE-RAR underlay network.
- Cisco SD-WAN Manager, Cisco SD-WAN Controller, and Cisco SD-WAN Validator connect through a radio connection in the deployment scenario.

### Mobile Ad Hoc Networks (MANETs)

MANETs for device-to-radio communications address the challenges faced when merging IP routing and mobile radio communications in ad hoc networking applications. MANET-routing protocols provide signaling among MANET routers, including scope-limited flooding and point-to-point delivery of MANET routing protocol signaling in a network.

## System Components of RAR

The Radio Aware Routing (RAR) feature is implemented using the MANET (Mobile ad hoc network) infrastructure comprising of different components such as PPPoE, Virtual multipoint interface (VMI), QoS, routing protocol interface and RAR protocols.

### Point-to-Point Protocol over Ethernet PPPoE or PPPoE

PPPoE is a well-defined communication mechanism between the client and the server. In the RAR implementation, radio takes the role of the PPPoE client and router takes the role of the PPPoE server. This allows a loose coupling of radio and router, while providing a well-defined and predictable communication mechanism.

As PPPoE is a session or a connection oriented protocol, it extends the point-to-point radio frequency (RF) link from an external radio to an IOS router.

### PPPoE Extensions

PPPoE extensions are used when the router communicates with the radio. In the Cisco IOS implementation of PPPoE, each individual session is represented by virtual access interface (connectivity to a radio neighbor) on which, QoS can be applied with these PPPoE extensions.

RFC5578 provides extensions to PPPoE to support credit-based flow control and session-based real time link metrics, which are very useful for connections with variable bandwidth and limited buffering capabilities (such as radio links).

### Virtual Multipoint Interface (VMI)

Though PPPoE Extensions provides the most of the setup to communicate between a router and a radio, VMI addresses the need to manage and translate events that higher layers (example, routing protocols) consume. In addition, VMI operates in the Bypass mode.

In Bypass mode, every Virtual Access Interface (VAI) representing a radio neighbor is exposed to routing protocols OSPFv3 and EIGRP, so that, the routing protocol directly communicates with the respective VAI for both unicast and multicast routing protocol traffic.

In Aggregate mode, VMI is exposed to the routing protocols (OSPF) so that the routing protocols can leverage VMI for their optimum efficiency. When the network neighbors are viewed as a collection of networks on a point-to-multipoint link with broadcast and multicast capability at VMI, VMI helps in aggregating the multiple virtual access interfaces created from PPPoE. VMI presents a single multi access layer 2 broadcast capable interface. The VMI layer handles re-directs unicast routing protocol traffic to the appropriate P2P link (Virtual-Access interface), and replicates any Multicast/Broadcast traffic that needs to flow. Since the routing protocol communicates to a single interface, the size of the topology database is reduced, without impacting the integrity of the network.

## Configure RAR

To configure RAR using Cisco SD-WAN Manager, [Create a CLI add-on feature template and attach it to the device template](#).

This section provides examples of RAR configurations that you can add to the CLI add-on template.

### Configure a Service for RAR

```
policy-map type service rar-lab
  pppoe service manet_radio //note: Enter the pppoe service policy name as manet_radio
!
```

### Configure OSPF Routing

```
router ospfv3 1
  router-id 10.0.0.1
  !
  address-family ipv4 unicast
    redistribute connected metric 1 metric-type 1
    log-adjacency-changes
  exit-address-family
  !
  address-family ipv6 unicast
    redistribute connected metric-type 1
    log-adjacency-changes
  exit-address-family
  !
ip local pool PPPoEpool2 192.0.2.0 192.0.2.1
```

### Configuration of RAR

```
interface GigabitEthernet0/0/0
  no shutdown
  no mop enabled
  no mop sysid
  negotiation auto
  pppoe enable group PPPOE_RAR

interface vml1
  ip address 10.0.0.0 255.255.255.0
  ipv6 enable
  physical-interface GigabitEthernet0/0/0
  mode bypass
  exit
```

```

interface Virtual-Template1
no shutdown
ip unnumbered vm1
ipv6 enable
ospfv3 1 network manet
ospfv3 1 ipv4 area 0
ospfv3 1 ipv6 area 0
exit

interface Tunnel100
no shutdown
ip unnumbered Loopback100
tunnel source Loopback100
tunnel mode sdwan
exit

interface Loopback100
tunnel-interface
encapsulation ipsec
color mpls
no allow-service bgp
allow-service dhcp
exit

router ospfv3 1
router-id 10.0.0.1
address-family ipv4 unicast
log-adjacency-changes
redistribute connected
redistribute connected metric 1 metric-type 1
exit-address-family
!
address-family ipv6 unicast
log-adjacency-changes
redistribute connected
redistribute connected metric-type 1
exit-address-family

```

The following example describes QoS provisioning on PPPoE extension session:

```

policy-map rar_policer
class class-default
  police 10000 2000 1000 conform-action transmit exceed-action drop violate-action drop
policy-map rar_shaper
class class-default
  shape average percent 1

interface Virtual-Template2
ip address 192.0.2.255 255.255.255.0
no peer default ip address
no keepalive
service-policy input rar_policer
end

```

## Configure the RAR Feature in Bypass Mode

The following example is an end-to-end configuration of RAR in the bypass mode:




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**Note** Before you begin the RAR configuration, you must first configure the **subscriber authorization enable** command to bring up the RAR session. Without enabling authorization, the Point-to-Point protocol does not recognize this as a RAR session and may not tag *manet\_radio* in PPPoE protocol. By default, bypass mode does not appear in the configuration. It appears only if the mode is configured as bypass.

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### Configure a Service for RAR

```
policy-map type service rar-lab
  pppoe service manet_radio //note: Enter the pppoe service policy name as manet_radio
!
```

### Configure Broadband

```
interface pppoe VMI2
  virtual-template 2
  service profile rar-lab
!
interface GigabitEthernet0/0/0
  description Connected to Client1
  negotiation auto
  pppoe enable group VMI2
!
```

### Configure a Service for RAR

```
policy-map type service rar-lab
  pppoe service manet_radio //note: Enter the pppoe service policy name as manet_radio
!
```

### Configuration in Bypass Mode

- IP Address Configured under Virtual-Template Explicitly

```
interface Virtual-Template2
  ip address 192.0.2.255 255.255.255.0
  no ip redirects
  peer default ip address pool PPPoEpool2
  ipv6 enable
  ospfv3 1 network manet
  ospfv3 1 ipv4 area 0
  ospfv3 1 ipv6 area 0
  no keepalive
  service-policy input rar_policer Or/And
  service-policy output rar_shaper
```

- VMI Unnumbered Configured under Virtual Template

```

interface Virtual-Template2
ip unnumbered vmi2
no ip redirects
peer default ip address pool PPPoEpool2
ipv6 enable
ospfv3 1 network manet
ospfv3 1 ipv4 area 0
ospfv3 1 ipv6 area 0
no keepalive
service-policy input rar_policer Or/And
service-policy output rar_shaper

```

### Configure the Virtual Multipoint Interface in Bypass Mode

```

interface vmi2 //configure the virtual multi interface
ip address 192.0.2.255 255.255.255.0
physical-interface GigabitEthernet0/0/0
mode bypass

interface vmi3//configure the virtual multi interface
ip address 192.0.2.255 255.255.255.0
physical-interface GigabitEthernet0/0/1
mode bypass

```

## Configure the RAR Feature in Aggregate Mode

The following example is an end-to-end configuration of RAR in the aggregate mode:




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**Note** Before you configure RAR, you must first configure the **subscriber authorization enable** command to bring up the RAR session. Without enabling authorization, the Point-to-Point protocol does not recognize this as a RAR session and may not tag `manet_radio` in PPPoE.

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### Configure a Service for RAR

```

policy-map type service rar-lab
_pppoe service manet_radio //note: Enter the pppoe service policy name as manet_radio
!

```

### Configure Broadband

```

bba-group pppoe VMI2
virtual-template 2
service profile rar-lab

!
interface GigabitEthernet0/0/0
description Connected to Client1
negotiation auto
pppoe enable group VMI2

!

```



### Configure a Service for RAR

```
policy-map type service rar-lab
  pppoe service manet_radio //note: Enter the pppoe service policy name as manet_radio
!
```

### Configuration in Aggregate Mode

```
interface Virtual-Template2
ip unnumbered vmi2
no ip redirects
no peer default ip address
ipv6 enable
no keepalive
service-policy input rar_policer Or/And
service-policy output rar_shaper
```

