



Radio Aware Routing

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Feature history for RAR

This table describes the developments of this feature, by release.

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 uses radio signals to interact with the OSPFv3 routing protocol. Through these signals it can indicate the appearance, disappearance, and link conditions of one-hop routing neighbors. In large mobile networks, connections to routing neighbors may be interrupted by distance and radio obstructions. RAR addresses the challenges that arise when integrating IP routing with radio communications in mobile networks.

RAR for Cisco IOS XE Catalyst SD-WAN devices

Radio-Aware Routing (RAR) is a mechanism that leverages radio interfaces to communicate directly with the Open Shortest Path First version 3 (OSPFv3) protocol, enabling real-time signaling of the presence and link conditions of one-hop routing neighbors.

- RAR improves routing responsiveness in mobile environments by allowing immediate link state updates.
- Standard protocol timers may be too slow for rapidly changing mobile network conditions.
- PPPoE provides the underlying connectivity, with support for OSPFv3 and EIGRP.
- An AX license is required to enable this feature.

In large mobile networks, factors such as distance and radio obstructions can frequently disrupt connections to routing neighbors. If these disruptions are not reported directly to the routing protocols, the protocols rely on their built-in timers to update neighbor status. However, these protocol timers are typically lengthy, which is not ideal for the dynamic conditions of mobile networks.

Connectivity between two Cisco IOS XE Catalyst SD-WAN devices is established over a PPPoE connection, which features variable bandwidth and limited buffering capacity. OSPFv3 and EIGRP are the supported routing protocols for this deployment.

Mobile Ad Hoc Networks (MANETs)

MANETs facilitate device-to-radio communications by addressing the challenges of integrating IP routing with mobile radio technologies in ad hoc networking environments. MANET routing protocols enable signaling between MANET routers, supporting features such as scope-limited flooding and point-to-point delivery of routing protocol messages within the network.

System components of RAR

The RAR feature uses the MANET infrastructure and includes several components: 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

In the Cisco IOS implementation of PPPoE, each session is represented by a virtual access interface, which connects to a radio neighbor. QoS can be applied on these interfaces using 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 most of the setup to communicate between a router and a radio, VMI addresses the need to manage and translate events that higher layers (for example, routing protocols) consume.

In bypass mode, every Virtual Access Interface (VAI) representing a radio neighbor is exposed to the 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 (such as OSPF) so these protocols can optimize 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 aggregates the multiple virtual access interfaces created from PPPoE. VMI provides a single, multi-access Layer 2 interface with broadcast capability. Using a single interface for

the routing protocol reduces the size of the topology database without impacting network integrity. The VMI layer:

- Redirects unicast routing protocol traffic to the appropriate P2P link (Virtual-Access interface)
- Replicates multicast or broadcast traffic as needed

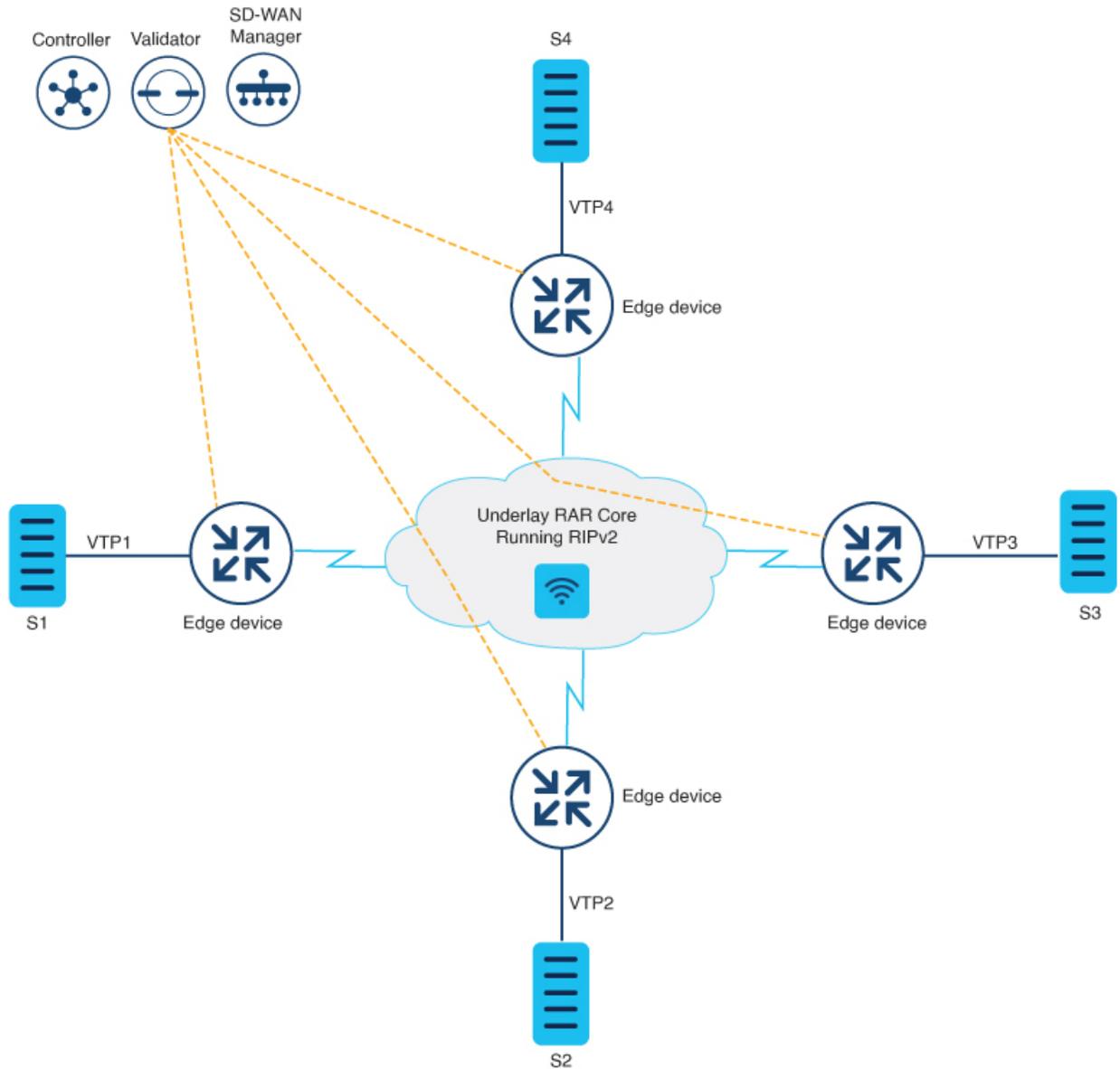
RAR architecture

Summary

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

Workflow

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.

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- The Cisco Catalyst SD-WAN Cisco SD-WAN Manager 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.

Benefits of RAR

The RAR feature offers these 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.

Supported devices for RAR

These 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

Restrictions for RAR

The Radio Aware Routing feature has these 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 technology is not supported.

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.

Configure RAR

To configure RAR using 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 vmi1
  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 vmi1
  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 RAR in bypass mode

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.

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
!

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

Configuration in bypass mode:

This example shows 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
```

This example shows 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 RAR in aggregate mode

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.

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

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
```

```
!
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
```

