Juniper Networks | Engineering Simplicity

Juniper Cloud Native Router User Guide

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CHAPTER 1

Introduction

Juniper® Cloud-Native Router Overview

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Overview

While 5G unleashes higher bandwidth, lower latency and higher capacity, it also brings in new infrastructure challenges such as increased number of base stations or cell sites, more backhaul links with larger capacity and more cell site routers and aggregation routers. Service providers are integrating cloud-native infrastructure in distributed RAN (D-RAN) topologies, which are usually small, leased spaces, with limited power, space and cooling. The disaggregation of radio access network (RAN) and the expansion of 5G data centers into cloud hyperscalers has added newer requirements for cloud-native routing.

The Juniper Cloud-Native Router provides the service providers the flexibility to roll out the expansion requirements for 5G rollouts, reducing both the CapEx and OpEx.

Juniper Cloud-Native Router (JCNR) is a containerized router that combines Juniper's proven routing technology with the Junos® containerized routing protocol daemon (cRPD) as the controller and a high-performance Contrail® Data Plane Development Kit (DPDK) vRouter forwarding plane. It is implemented in Kubernetes and interacts seemlessly with a Kubernetes container network (CNI) framework.

Use Cases

The Cloud-Native Router has the following use cases:

- **Radio Access Network (RAN)**

  The new 5G-only sites are a mix of centralized RAN (C-RAN) and distributed RAN (D-RAN). The C-RAN sites are typically large sites owned by the carrier and continue to deploy physical routers. The D-RAN sites, on the other hand, are tens of thousands of smaller sites, closer to the users.

Optimization of CapEx and OpEx is a huge factor for the large number of D-RAN sites. These sites are also typically leased, with limited space, power and cooling capacities. There is limited connectivity over leased lines for transit back to the mobile core. Juniper Cloud-Native Router is designed to work in the constraints of a D-RAN. It is integrated with the distributed unit (DU) and installable on an existing 1 U server.

- **Telco virtual private cloud (VPC)**

  The 5G data centers are expanding into cloud hyperscalers to support more radio sites. The cloud-native routing available in public cloud environments do not support the routing demands of telco VPCs, such as MPLS, quality of service (QoS), L3 VPN, and more. The Juniper Cloud-Native Router integrates directly into the cloud as a containerized network function (CNF), managed as a cloud-native Kubernetes component, while providing advanced routing capabilities.

Architecture and Key Components

The Juniper Cloud-Native Router consists of the Junos containerized routing protocol Daemon (cRPD) as the control plane (JCNR Controller), providing topology discovery, route advertisement and forwarding information base (FIB) programming, as well as dynamic underlays and overlays. It uses the Data Plane Development Kit (DPDK) enabled vRouter as a forwarding plane, providing packet forwarding for DPDK applications in a pod and host path I/O for protocol sessions. The third component is the JCNR container network interface (CNI) that interacts with Kubernetes as a secondary CNI to create pod interfaces, assign addresses and generate the cRPD configuration.

The Data Plane Development Kit (DPDK) is an open source set of libraries and drivers. DPDK enables fast packet processing by allowing network interface cards (NICs) to send direct memory access (DMA) packets directly into an application's address space. The applications poll for packets, to avoid the overhead of interrupts from the NIC. Integrating with DPDK allows a vRouter to process more packets per second than is possible when the vRouter runs as a kernel module.

In this integrated solution, the JCNR Controller uses gRPC, a high performance Remote Procedure Call, based services to exchange messages and to communicate with the vRouter, thus creating the fully functional Cloud-Native Router. This close communication allows you to:

- Learn about fabric and workload interfaces
- Provision DPDK- or kernel-based interfaces for Kubernetes pods as needed
- Configure IPv4 and IPv6 address allocation for Pods
- Install routes into routing tables
- Run routing protocols such as ISIS, BGP, and OSPF

Features

- Easy deployment, removal, and upgrade on general purpose compute devices using Helm
- Higher packet forwarding performance with DPDK-based JCNR-vRouter
- Full routing, switching, and forwarding stacks in software
- Basic L2 functionality, such as MAC learning, MAC aging, MAC limiting, and L2 statistics
- L2 reachability to Radio Units (RU) for management traffic
- L2 or L3 reachability to physical distributed units (DU) such as 5G millimeter wave DUs or 4G DUs
- VLAN tagging
- Bridge domains
- Trunk and access ports
- Support for multiple virtual functions (VF) on Ethernet NICs
- Support for bonded VF interfaces
- Configurable L2 access control lists (ACLs)
- Rate limiting of egress broadcast, unknown unicast, and multicast traffic on fabric interfaces
- IPv4 and IPv6 routing
- Out-of-the-box software-based open radio access network (O-RAN) support
- Quick spin up with containerized deployment
- Highly scalable solution

Juniper® Cloud-Native Router Components

SUMMARY

The Juniper Cloud-Native Router solution consists of several components including the JCNR controller

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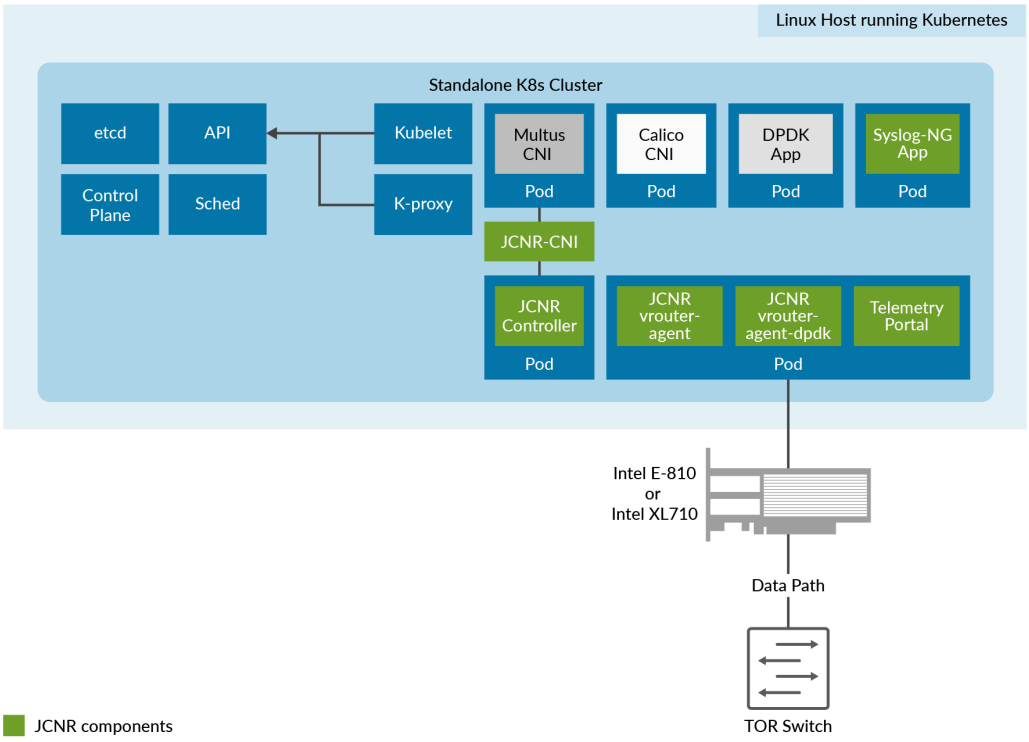
(cRPD), vRouter and the JCNR-CNI. This topic provides a brief overview of the components of the Juniper Cloud-Native Router.

JCNR Components

The Juniper Cloud-Native Router has primarily three components—JCNR Controller for control plane, the vRouter DPDK forwarding plane and a CNI for Kubernetes integration. All JCNR components are deployed as containers.

The Figure 1 on page 5 shows the components of the Juniper Cloud-Native Router inside a Kubernetes cluster

Figure 1: Components of Juniper Cloud-Native Router



JCNR Controller

The JCNR Controller (cRPD) is the control-plane of the cloud-native router solution and runs as a statefulset. The controller communicates with the other elements of the cloud-native router. Configuration, policies and rules that you set on the controller at deployment time are communicated to other components, primarily the JCNR vRouter, for implementation.

For example, firewall filters (ACLs) are supported on cRPD to configure L2 access lists with deny rules. cRPD sends the configuration information to the vRouter through the vRouter agent.

Juniper Cloud-Native Router Controller Functionality:

- Exposes Junos OS compatible CLI configuration and operation commands that are accessible to external automation and orchestration systems using the NETCONF protocol.
- Supports vRouter as the high-speed forwarding plane. This enables applications that are built using the DPDK framework to send and receive packets directly to the application and the vRouter without passing through the kernel.
- Supports configuration of VLAN-tagged sub-interfaces on physical function (PF), virtual function (VF), virtio, access, and trunk interfaces managed by the DPDK-enabled vRouter.
- Supports configuration of bridge domains, VLANs, and virtual-switches.
- Advertises DPDK application reachability to core network using routing protocols primarily with BGP and IS-IS.
- Distributes L3 network reachability information of the pods inside and outside a cluster.
- Maintains configuration for L2 firewall.
- Passes configuration information to the vRouter through the vRouter-agent.
- Stores license key information.
- Works as a BGP Speaker from release 23.2, establishing peer relationships with other BGP speakers to exchange routing information.

Configuration Options

During deployment, you can *customize JCNR using node annotations* .

After deployment, we recommend that you use the NETCONF protocol with PyEZ to configure cRPD. Alternatively, you can SSH directly into the cRPD or connect via NETCONF. Finally, you can also configure the cloud-native router by "accessing the JCNR controller (cRPD) CLI" on page 88 using Kubernetes commands.

JCNR vRouter

The JCNR vRouter is a high-performance datapath component. It is an alternative to the Linux bridge or the Open vSwitch (OVS) module in the Linux kernel. It runs as a user-space process and is integrated with the Data Plane Development Kit (DPDK) library. The vRouter pod consists of three containers—vrouter-agent, vrouter-agent-dpdk and vrouter-telemetry-exporter.

JCNR vRouter Functionality:

- Performs routing with Layer 3 virtual private networks
- Performs L2 forwarding
- Allows the use of DPDK-based forwarding
- Enforces L2 access control lists (ACLs)

Benefits of vRouter:

- Integration of the DPDK into the JCNR-vRouter
- Forwarding plane provides faster forwarding capabilities than kernel-based forwarding
- Forwarding plane is more scalable than kernel-based forwarding
- Support for the following NICs:
    - Intel E810 (Columbiaville) family
    - Intel XL710 (Fortville) family

JCNR-CNI

JCNR-CNI is a new container network interface (CNI) developed by Juniper. JCNR-CNI is a Kubernetes CNI plugin installed on each node to provision network interfaces for application pods. During pod creation, Kubernetes delegates pod interface creation and configuration to JCNR-CNI. JCNR-CNI interacts with JCNR control-plane (cRPD) and the vRouter to setup DPDK interfaces. When a pod is removed, JCNR-CNI is invoked to de-provision the pod interface, configuration, and associated state in Kubernetes and cloud-native router components. JCNR-CNI works as a secondary CNI, along with the Multus CNI to add and configure pod interfaces.

JCNR-CNI Functionality:

- Manages the networking tasks in Kubernetes pods such as:
    - assigning IP addresses

  - allocating MAC addresses
  - setting up untagged, access, and other interfaces between the pod and vRouter in a Kubernetes cluster
  - creating VLAN sub-interfaces
- Provides the virtual router functionality which enables virtual routing instances. For more information, see "Virtual Routing Instance (VRF-Lite)" on page 56.
- Acts on pod events such as add and delete
- Generates cRPD configuration

The JCNR-CNI manages the secondary interfaces that the pods use. It creates the required interfaces based on the configuration in YAML-formatted network attachment definition (NAD) files. The JCNR-CNI configures some interfaces before passing them to their final location or connection point and provides an API for further interface configuration options such as:

- Instantiating different kinds of pod interfaces.
- Creating virtio-based high performance interfaces for pods that leverage the DPDK data plane.
- Creating veth pair interfaces that allow pods to communicate using the Linux Kernei l networking stack.
- Creating pod interfaces in access or trunk mode.
- Attaching pod interfaces to bridge domains.
- Supporting IPAM plug-in for Dynamic IP address allocation.
- Allocating unique socket interfaces for virtio interfaces.
- Attaching pod interfaces to a bridge domain.
- Managing the networking tasks in pods such as assigning IP addresses and setting up of interfaces between the pod and vRouter in ai Kubernetes cluster.
- Connecting pod interface to a network including pod-to-pod and pod-to-network.
- Integrating with the vRouter for offloading packet processing.

Benefits of JCNR-CNI:

- Improved pod interface management
- Customizable administrative and monitoring capabilities
- Increased performance through tight integration with cRPD and vRouter components

The Role of JCNR-CNI in Pod Creation:

When you create a pod for use in the cloud-native router, the Kubernetes component known as **kubelet** calls the Multus CNI to set up pod networking and interfaces. Multus reads the annotations section of the **pod.yaml** file to find the NADs. If a NAD points to JCNR-CNI as the CNI plug in, Multus calls the JCNR-CNI to set up the pod interface. JCNR-CNI creates the interface as specified in the NAD. JCNR-CNI then generates and pushes a configuration into cRPD.

Syslog-NG

Juniper Cloud-Native Router uses a syslog-ng pod to gather event logs from cRPD and vRouter and transform the logs into JSON-based notifications. The notifications are logged to a file. Syslog-ng runs as a daemonset.

JCNR Deployment Modes

SUMMARY

Read this topic to know about the various modes of deploying the cloud-native router.

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Deployment Modes

Starting with Juniper Cloud-Native Router Release 23.2, you can deploy and operate Juniper Cloud-Native Router in L2, L3 and L2-L3 modes*, auto-derived based on the interface configuration in the `values.yaml` file prior to deployment. Please review the *UnResolved_keydef.xml* topic for more information.

NOTE: In the `values.yaml` file:

- When all the interfaces have an `interface_mode` key configured, then the mode of deployment would be L2.

- When one or more interfaces have an `interface_mode` key configured and some of the interfaces do not have the `interface_mode` key configured, then the mode of deployment would be L2-L3*.
- When none of the interfaces have the `interface_mode` key configured, then the mode of deployment would be L3.

In L2 mode, the cloud-native router behaves like a switch and therefore does not performs any routing functions and it doesn not run any routing protocols. The pod network uses VLANs to direct traffic to various destinations.

In L3 mode, the cloud-native router behaves like a router and therefore performs routing functions and runs routing protocols such as ISIS, BGP, OSPF, and segment routing-MPLS. In L3 mode, the pod network is divided into an IPv4 or IPv6 underlay network and an IPv4 or IPv6 overlay network. The underlay network is used for control plane traffic.

The L2-L3 mode* provides the functionality of both the switch and the router at the same time. It enables JCNR to act as both a switch and a router simultaneously by performing switching in a set of interfaces and routing in the other set of interfaces. Cell site routers in a 5G deployment need to handle both L2 and L3 traffic. DHCP packets from radio outdoor unit (RU) is an example of L2 traffic and data packets moving from outdoor unit (ODU) to central unit (CU) is an example of L3 traffic.

NOTE: *The L2-L3 deployment mode is a "Juniper Technology Previews (Tech Previews)" on page 91 feature in the Juniper Cloud-Native Router Release 23.2.

JCNR Interfaces Overview

SUMMARY

This topic provides information on the network communication interfaces provided by the JCNR-Controller. Fabric interfaces are aggregated interfaces that receive traffic from multiple interfaces. Interfaces to which different workloads are connected are called workload interfaces.

IN THIS SECTION

Read this topic to understand the network communication interfaces provided by the JCNR-Controller. We cover interface names, what they connect to, how they communicate. and the services they provide.

Juniper Cloud-Native Router Interface Types

Juniper Cloud-Native Router supports two types of interfaces:

- **Fabric interfaces**—Aggregated interfaces that receive traffic from multiple interfaces. Fabric interfaces are always physical interfaces. They can either be a physical function (PF) or a virtual function (VF). The throughput requirement for these interfaces is higher, hence multiple hardware queues are allocated to them. Each hardware queue is allocated with a dedicated CPU core . The interfaces are configured for the cloud-native router using the appropriate `values.yaml` file in the deployer helmcharts. You can view the interface mapping using the `dpdkinfo -c` command. View the Troubleshoot via the vRouter CLI topic in the Deployment Guide for more details. You also have fabric workload interfaces that have low throughput requirement. Only one hardware queue is allocated to the interface, thereby saving precious CPU resources. These interfaces can be configured using the appropriate `values.yaml` file in the deployer helmcharts.

- **Workload interfaces**—Interfaces to which different workloads are connected. They can either be software-based or hardware-based interfaces. Software-based interfaces are either high-performance interfaces using the Data Plane Development Kit (DPDK) poll mode driver (PMD) or a low-performance interfaces using the kernel driver. Typically the DPDK interfaces are used for data traffic such as the GPRS Tunneling Protocol for user data (GTP-U) traffic and the kernel-based interfaces are used for control plane data traffic such as TCP. The kernel pod interfaces are typically for the operations, administration and maintenance (OAM) traffic. The interfaces are configured as a veth-pair, with one end of the interface in the pod and the other end in the Linux kernel on the host. JCNR also supports bonded interfaces via the link bonding PMD. These interfaces can be configured using the appropriate `values.yaml` file in the deployer helmcharts.

  JCNR supports different types of VLAN interfaces including trunk, access and sub-interfaces across fabric and workload interfaces.

JCNR Interface Details

The different JCNR interfaces are provided in detail below:

- **Agent interface**

  vRouter has only one agent interface. The agent interface enables communication between the vRouter-agent and the vRouter. On the vRouter CLI when you issue the `vif --list` command, the agent interface looks like this:

```
vif0/0      Socket: unix
            Type:Agent HWaddr:00:00:5e:00:01:00
            Vrf:65535 Flags:L2 QOS:-1 Ref:3
```

```
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:0  bytes:0 errors:0
            TX packets:650  bytes:99307 errors:0
            Drops:0
```

- **DPDK VF workload interfaces (Kernel Access)**

  These interfaces connect to the radio units (RUs) or millimeter-wave distributed units (mmWave-DUs). On the vRouter CLI when you issue the `vif --list` command, the DPDK VF workload interface looks like this:

```
vif0/5      PCI: 0000:ca:19.1 (Speed 10000, Duplex 1)
            Type:Workload HWaddr:9e:52:29:9e:97:9b
            Vrf:0 Flags:L2Vof QOS:-1 Ref:9
            RX queue  packets:29087 errors:0
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            Fabric Interface: 0000:ca:19.1  Status: UP  Driver: net_iavf
            Vlan Mode: Access  Vlan Id: 1250  OVlan Id: 1250
            RX packets:29082  bytes:6766212 errors:5
            TX packets:0  bytes:0 errors:0
            Drops:29896
```

- **DPDK VF fabric interfaces (Physical Trunk)**

  DPDK VF fabric interfaces, which are associated with the physical network interface card (NIC) on the host server, accept traffic from multiple VLANs.

  The cRPD interface configuration using the `show configuration` command looks like this (the output is trimmed for brevity):

```
interfaces {
    ens786f0v0 {
        unit 0 {
            family bridge {
                interface-mode trunk;
                vlan-id-list 1001-1100;
            }
        }
    }
}
```

On the vRouter CLI when you issue the `vif --list` command, the DPDK VF fabric interface looks like this:

```
vif0/1    PCI: 0000:31:01.0 (Speed 10000, Duplex 1)
          Type:Physical HWaddr:d6:22:c5:42:de:c3
          Vrf:65535 Flags:L2Vof QOS:-1 Ref:12
          RX queue packets:11813 errors:1
          RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 1 0
          Fabric Interface: 0000:31:01.0 Status: UP Driver: net_iavf
          Vlan Mode: Trunk Vlan: 1001-1100
          RX packets:0 bytes:0 errors:49962
          TX packets:18188356 bytes:2037400554 errors:0
          Drops:49963
```

- **Active or standby bond interfaces (Bond Trunk)**

  Bond interfaces accept traffic from multiple VLANs. A bond interface runs in the active or standby mode (mode 0).

  The cRPD interface configuration using the `show configuration` command looks like this (the output is trimmed for brevity):

```
interfaces {
    bond0 {
         unit 0 {
             family bridge
             interface-mode trunk;
             vlan-id-list 1001-1100;
         }
    }
}
```

  On the vRouter CLI when you issue the `vif --list` command, the bond interface looks like this:

```
vif0/2      PCI: 0000:00:00.0 (Speed 10000, Duplex 1)
            Type:Physical HWaddr:32:f8:ad:8c:d3:bc
            Vrf:65535 Flags:L2Vof QOS:-1 Ref:8
            RX queue  packets:1882 errors:0
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0
            Fabric Interface: eth_bond_bond0  Status: UP  Driver: net_bonding
```

```
            Slave Interface(0): 0000:81:01.0  Status: UP  Driver: net_iavf
            Slave Interface(1): 0000:81:03.0  Status: UP  Driver: net_iavf
            Vlan Mode: Trunk  Vlan: 1001-1100
            RX packets:8108366000  bytes:486501960000 errors:4234
            TX packets:65083776  bytes:4949969408 errors:0
            Drops:8108370394
```

- **Pod interfaces using virtio and the DPDK data plane (Virtio Trunk)**

  The trunk interfaces accept only tagged packets. Any untagged packets are dropped. These interfaces can accept a VLAN filter to allow only specific VLAN packets. A trunk interface can be a part of multiple bridge-domains (BD). A bridge domain is a set of logical ports that share the same flooding or broadcast characteristics. Like a VLAN, a bridge domain spans one or more ports of multiple devices. Virtio interfaces are associated with pod interfaces that use virtio on the DPDK data plane.

  The cRPD interface configuration using the `show configuration` command looks like this (the output is trimmed for brevity):

```
interfaces {
    vhost242ip-93883f16-9ebb-4acf-b {
         unit 0 {
             family bridge {
                 interface-mode trunk;
                 vlan-id-list 1001;
             }
         }
    }
}
```

  On the vRouter CLI when you issue the `vif --list` command, the virtio with DPDK data plane interface looks like this:

```
vif0/3    PMD: vhost242ip-93883f16-9ebb-4acf-b
          Type:Virtual HWaddr:00:16:3e:7e:84:a3
          Vrf:65535 Flags:L2 QOS:-1 Ref:13
          RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
          Vlan Mode: Trunk Vlan: 1001-1003
          RX packets:0 bytes:0 errors:0
          TX packets:10604432 bytes:1314930908 errors:0
          Drops:0
          TX port packets:0 errors:10604432
```

- **Pod interfaces using virtual Ethernet (veth) pairs and the DPDK data plane (Kernel Access)**

  The access interfaces accept both tagged and untagged packets. Untagged packets are tagged with the access VLAN or access BD. Any tagged packets other than the ones with access VLAN are dropped. The access interfaces is a part of a single bridge-domain. It does not have any parent interface.

  The cRPD interface configuration using the `show configuration` command looks like this (the output is trimmed for brevity):

```
routing-instances {
    switch {
         instance-type virtual-switch;
         bridge-domains
{

             bd1001 {
                 vlan-id 1001;
                 interface jvknet1-eed79ff;
             }
         }
    }
}
```

  On the vRouter CLI when you issue the `vif --list` command, the veth pair interface looks like this:

```
vif0/4      Ethernet: jvknet1-88c44c3
            Type:Virtual HWaddr:02:00:00:3a:8f:73
            Vrf:0 Flags:L2Vof QOS:-1 Ref:10
            RX queue packets:524 errors:0
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            Vlan Mode: Access Vlan Id: 1001 OVlan Id: 1001
            RX packets:9 bytes:802 errors:515
            TX packets:0 bytes:0 errors:0
            Drops: 525
```

- **L2 VLAN sub-interfaces**

  The cloud-native router supports the use of VLAN sub-interfaces in L2 mode. VLAN sub-interfaces are like logical interfaces on a physical switch or router. They access only tagged packets that match the configured VLAN tag. A sub-interface has a parent interface. A parent interface can have multiple sub-interfaces, each with a VLAN ID. When you run the cloud-native router, you must associate each sub-interface with a specific VLAN.

The cRPD interface configuration viewed using the `show configuration` command is as shown below (the output is trimmed for brevity).

For **L2**:

```
routing-instances {
    switch {
         instance-type virtual-switch;
         bridge-domains
{

             bd100 {
                 vlan-id 100;
                 interface vhostnet1-1e555ee1-7d93-40.100;
             }
         }
     }
}
```

On the vRouter, a VLAN sub-interface configuration is as shown below:

```
vif0/5      Virtual: vhostnet1-71cd7db1-1a5e-49.3003 Vlan(o/i)(,S): 3003/3003 Parent:vif0/4
            Type:Virtual(Vlan) HWaddr:00:99:99:99:33:09
            Vrf:0 Flags:L2 QOS:-1 Ref:3
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:0  bytes:0 errors:0
            TX packets:0  bytes:0 errors:0
            Drops:0
```

NOTE: To see the VLAN sub-interfaces on the vRouter, connect to the vRouter agent by executing the command `kubectl exec -it -n contrail contrail-vrouter-<agent container> -- bash` command, and then run the command `vif --get`.

- **L3 Physical Interface**

```
vif0/1      PCI: 0000:17:01.1 (Speed 25000, Duplex 1) NH: 7 MTU: 9000 <- PCI
Address
            Type:Physical HWaddr:d6:93:87:91:45:6c IPaddr: 192.21.2.4 <- Physical interface
            IP6addr:2001:192:21:2::4 <- IPv6 address
```

```
            DDP: OFF SwLB: ON
            Vrf:2 Mcast Vrf:2 Flags:L3L2Vof QOS:0 Ref:16 <- L3 (only) interface, valid VRF
non-default (cannot be 65535)
            RX port   packets:423168341 errors:0
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            Fabric Interface: 0000:17:01.1  Status: UP  Driver: net_iavf
            RX packets:423168341  bytes:29123418594 errors:0
            TX packets:417508247  bytes:417226216530 errors:0
            Drops:8
            TX port   packets:417508247 errors:0
```

```
vif0/2      PMD: ens2f2 NH: 12 MTU: 9000 <- Tap interface name as seen by cRPD
            Type:Host HWaddr:d6:93:87:91:45:6c IPaddr: 192.21.2.4 <- Tap interface type
            IP6addr:2001:192:21:2::4
            DDP: OFF SwLB: ON
            Vrf:2 Mcast Vrf:65535 Flags:L3DProxyEr QOS:-1 Ref:15 TxXVif:1  <-cross-connected
to vif 1
            RX device packets:306995  bytes:25719830 errors:0
            RX queue  packets:306995 errors:0
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:306995  bytes:25719830 errors:0
            TX packets:307489  bytes:25880250 errors:0
            Drops:0
            TX queue  packets:307489 errors:0
            TX device packets:307489  bytes:25880250 errors:0
```

Corresponding interface state in the cRPD:

```
show interfaces routing ens2f2
Interface        State Addresses
ens2f2           Up    MPLS  enabled
                       ISO   enabled
                       INET  192.21.2.4
                       INET6 2001:192:21:2::4
                       INET6 fe80::c5da:7e9c:e168:56d7
                       INET6 fe80::a0be:69ff:fe59:8b58
```

L3 Bond Interface

```
vif0/3      PCI: 0000:00:00.0 (Speed 25000, Duplex 1) NH: 6 MTU: 1514 <- Bond interface (PCI
id 0)
            Type:Physical HWaddr:50:7c:6f:48:75:74 IPaddr:192.7.7.4 <- Physical interface
            IP6addr:2001:192:7:7::4
            DDP: OFF SwLB: ON
            Vrf:1 Mcast Vrf:1 Flags:TcL3L2Vof QOS:0 Ref:18
            RX port   packets:402183888 errors:0
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            Fabric Interface: eth_bond_bond34  Status: UP  Driver: net_bonding <- Bonded
master
            Slave Interface(0): 0000:5e:00.0  Status: UP  Driver: net_ice <- Bond slave - 1
            Slave Interface(1): 0000:af:00.0  Status: UP  Driver: net_ice <- Bond slave - 2
            RX packets:402183888  bytes:49519387070 errors:0
            TX packets:79226  bytes:7330912 errors:0
            Drops:1393
            TX port   packets:79226 errors:0
```

```
vif0/4      PMD: bond34 NH: 11 MTU: 9000
            Type:Host HWaddr:50:7c:6f:48:75:74 IPaddr:192.7.7.4 <- Tap interface
            IP6addr:2001:192:7:7::4
            DDP: OFF SwLB: ON
            Vrf:1 Mcast Vrf:65535 Flags:L3DProxyEr QOS:-1 Ref:15 TxXVif:3 <- Tap interface
for bond
            RX device packets:76357  bytes:7101918 errors:0
            RX queue  packets:76357 errors:0
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:76357  bytes:7101918 errors:0
            TX packets:75349  bytes:6946908 errors:0
            Drops:0
            TX queue  packets:75349 errors:0
            TX device packets:75349  bytes:6946908 errors:0
```

Corresponding interface state in the cRPD:

```
show interfaces routing bond34
Interface        State Addresses
bond34           Up    INET6 2001:192:7:7::4
                       ISO   enabled
```

```
                        INET  192.7.7.4
                        INET6 fe80::527c:6fff:fe48:7574
```

- **L3 Pod Vhost-User Interface**

```
vif0/8      PMD: vhostnet1-aa0984c7-0c1d-40a4-87 NH: 35 MTU: 9160 <- vhost-user interface of
CNF
            Type:Virtual HWaddr:00:00:5e:00:01:00 IPaddr:2.51.1.3 <- pod/ workload
            IP6addr:abcd:2:51:1::3 <- IPv6 address of the pod
            DDP: OFF SwLB: ON
            Vrf:3 Mcast Vrf:3 Flags:PL3DProxyEr QOS:-1 Ref:14
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:0  bytes:0 errors:0
            TX packets:0  bytes:0 errors:0
            Drops:0
```

Corresponding interface state in the cRPD:

```
show interfaces routing vhostnet1-aa0984c7-0c1d-40a4-87
Interface        State Addresses
vhostnet1-aa0984c7-0c1d-40a4-87 Up    INET6 enabled
                                      INET6 abcd:2:51:1::3
                                      ISO   enabled
                                      INET  enabled
                                      INET  2.51.1.3
```

- **L3 Kernel Interface**

```
vif0/13     Ethernet: jvknet1-0af476e NH: 35 MTU: 9160 <- Kernel interface (jvk) of CNF
            Type:Virtual HWaddr:00:00:5e:00:01:00 IPaddr:2.51.1.4 <- pod/ workload
            IP6addr:abcd:2:51:1::4
            DDP: OFF SwLB: ON
            Vrf:1 Mcast Vrf:1 Flags:PL3DVofProxyEr QOS:-1 Ref:11
            RX port   packets:47 errors:0
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:47  bytes:13012 errors:0
            TX packets:0  bytes:0 errors:0
            Drops:47
```

Corresponding interface state in the cRPD:

```
show interfaces routing jvknet1-0af476e
Interface        State Addresses
jvknet1-0af476e  Up    INET6 enabled
                       INET6 abcd:2:51:1::4
                       ISO   enabled
                       INET  enabled
                       INET  2.51.1.4
```

- **L3 VLAN Sub-Interfaces**

  Starting in Juniper Cloud-Native Router Release 23.2, the cloud-native router supports the use of VLAN sub-interfaces in L3 mode.

  NOTE: The VLAN sub-interfaces support specifically in L3 mode is a Technology Preview feature in the Juniper Cloud-Native Router Release 23.2.

```
vif0/2      PCI: 0000:17:01.1 (Speed 25000, Duplex 1) NH: 7 MTU: 9000
            Type:Physical HWaddr:d6:93:87:91:45:6c IPaddr:0.0.0.0
            IP6addr:fe80::d493:87ff:fe91:456c <- IPv6 address
            DDP: OFF SwLB: ON
            Vrf:2 Mcast Vrf:2 Flags:L3L2Vof QOS:0 Ref:16 <- L3 (only) interface, valid VRF
non-default (cannot be 65535)
            RX port   packets:423168341 errors:0
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            Fabric Interface: 0000:17:01.1  Status: UP  Driver: net_iavf
            RX packets:423168341  bytes:29123418594 errors:0
            TX packets:417508247  bytes:417226216530 errors:0
            Drops:8
            TX port   packets:417508247 errors:0
```

```
vif0/5      PMD: ens1f0v1 NH: 12 MTU: 9000
            Type:Host HWaddr:d6:93:87:91:45:6c IPaddr:0.0.0.0
            IP6addr:fe80::d493:87ff:fe91:456c
            DDP: OFF SwLB: ON
            Vrf:2 Mcast Vrf:65535 Flags:L3DProxyEr QOS:-1 Ref:15 TxXVif:2 <- L3 (only) tap
interface, valid default VRF (cannot be 65535)
```

```
            RX device packets:306995  bytes:25719830 errors:0
            RX queue  packets:306995 errors:0
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:306995  bytes:25719830 errors:0
            TX packets:307489  bytes:25880250
errors:0

            Drops:0
            TX queue  packets:307489 errors:0
            TX device packets:307489  bytes:25880250 errors:0
```

```
vif0/9      Virtual: ens1f0v1.201 Vlan(o/i)(,S): 201/201 Parent:vif0/2 NH: 36 MTU: 1514 <-
VLAN fabric sub-intf with parent as vif 2 and VLAN tag as 201
            Type:Virtual(Vlan) HWaddr:d6:93:87:91:45:6c IPaddr:103.1.1.2
            IP6addr:fe80::d493:87ff:fe91:456c
            DDP: OFF SwLB: ON
            Vrf:1 Mcast Vrf:1 Flags:L3DProxyEr QOS:-1 Ref:4
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:0  bytes:0 errors:0
            TX packets:0  bytes:0 errors:0
            Drops:0
```

```
vif0/10     Virtual: ens1f0v1.201 Vlan(o/i)(,S): 201/201 Parent:vif0/5 NH: 21 MTU: 9000
            Type:Virtual(Vlan) HWaddr:d6:93:87:91:45:6c IPaddr:103.1.1.2
            IP6addr:fe80::d493:87ff:fe91:456c
            DDP: OFF SwLB: ON
            Vrf:1 Mcast Vrf:65535 Flags:L3DProxyEr QOS:-1 Ref:4 TxXVif:9 <- VLAN tap sub-intf
cross connected to fabric sub-intf vif 9 and parent as tap intf vif 5
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:0  bytes:0 errors:0
            TX packets:0  bytes:0 errors:0
            Drops:0
```

Corresponding interface state in cRPD:

```
show interfaces routing ens1f0v1.201
Interface          State Addresses
ens1f0v1.201       Up    MPLS  enabled
```

```
                    ISO   enabled
                    INET6 fe80::b89c:fff:feab:e2c9
```

CHAPTER 2

Common Features (All Deployment Modes)

JCNR Common Features

SUMMARY

Read this topic to learn about the Juniper Cloud-Native Router common features for all deployment modes.

The Juniper Cloud-Native Router supports multiple "deployment modes" on page 9.

This chapter explains the common features for all deployment modes.

Enabling Dynamic Device Personalization (DDP) on Individual Interfaces

SUMMARY

Dynamic Device Personalization (DDP) is a technology that enables programmable packet processing pipeline provided by Intel as a profile to their NICs. JCNR supports enabling Dynamic Device Personalization (DDP) on individual interfaces.

Starting with Juniper Cloud-Native Router (JCNR) Release 23.2, JCNR supports enabling Dynamic Device Personalization (DDP) on individual interfaces. This feature is available on JCNR in L2, L3, and L2-L3 modes.

Dynamic Device Personalization (DDP) is a technology that enables programmable packet processing pipeline provided by Intel as a profile to their NICs. Multiple Intel NICs support this technology. The support varies based on the Intel NIC type. DDP is used in packet classification where the profiles applied to the NIC can classify multiple packet formats on the NIC enabling speeds and feeds to the Data Plane Development Kit (DPDK).

Juniper cloud native router (JCNR) provides routing and switching functionality. JCNR supports interfaces from different NIC cards. Some of the Intel NICs support DDP and some of them don’t

support DDP. Therefore, in a deployment scenario, JCNR might have one interface from one NIC that supports DDP and another interface from a different NIC that does not support DDP. JCNR supports enabling DDP per interface to overcome such issues.

A new DDP configuration is available per interface. This configuration option overrides global DDP (`ddp`) configuration for that interface. If you do not configure an interface DDP, then the global configuration value serves as the value for that interface. If you do not configure the global DDP configuration, then the default value for the global configuration which is `off` takes effect.

NOTE: In JCNR release 23.2, DDP support is available only on E810 VF NIC. DDP support is not available on subnets.

You should configure DDP in the helm chart before deployment. Configuring the DDP configurations in the helm charts for both global and at interface levels is optional. If you do not configure the DDP keys, then the default value for global DDP which is `off` takes effect.

The global DDP configuration is available in the `values.yaml` file as shown below:

```
Set ddp to true to enable Dynamic Device Personalization (DDP)
  # It provides datapath optimization at NIC for traffic like GTPU, SCTP etc.
  ddp: true
```

You can configure one of the following options for `ddp` at the interface level:

1. Auto—when set to auto, JCNR checks if the NIC supports DDP or not during deployment and configures DPDK accordingly. Detecting whether a NIC supports DDP at run time makes is easier to deploy JCNR in volumes.
2. On—option enables DDP on the interface without validating the NIC. Use this option only if you are sure that the NIC supports DDP.
3. Off—is the default option at the interface level. This option disables DDP on the interface.

For example,

```
-    eth1:
       ddp: "off" ## auto or on or off
```

NOTE: Each interface can have a different configuration for `ddp`. DDP is enabled for a bond interface only if all the slave interface NICs support DDP.

VLAN Sub-Interfaces

IN THIS SECTION

VLAN sub-interfaces are like logical interfaces on a physical switch or router. They access only tagged packets that match the configured VLAN tag. A sub-interface has a parent interface. A parent interface can have multiple sub-interfaces, each with a VLAN ID. When you run the cloud-native router, you must associate each sub-interface with a specific VLAN. Starting in Juniper Cloud-Native Router Release 23.2, the cloud-native router supports the use of VLAN sub-interfaces in L3 mode* along with the previously supported L2 mode.

NOTE: The VLAN sub-interfaces support in L3 mode is a "Technology Preview " on page 91feature in the Juniper Cloud-Native Router Release 23.2.

Configuration Example

The VLAN sub-interfaces are configured using the Netowrk Attachment Definition (NAD) and pod YAML manifests. Please see the "JCNR Use-Cases and Configuration Overview " on page 60 and relevant configuration examples for more information.

The cRPD interface configuration viewed using the `show configuration` command is as shown below (the output is trimmed for brevity).

For L2 mode:

```
routing-instances {
    switch {
         instance-type virtual-switch;
         bridge-domains
{

             bd100 {
                 vlan-id 100;
                 interface vhostnet1-1e555ee1-7d93-40.100;
             }
         }
     }
}
```

For L3 mode:

```
enp24s0f0 {
        unit 1 {
            vlan-id 10;
            family inet {
                address 172.168.20.3/24;
            }
        }
}
```

On the vRouter, a VLAN sub-interface configuration is as shown below:

For L2 mode:

```
vif0/5      Virtual: vhostnet1-71cd7db1-1a5e-49.100 Vlan(o/i)(,S): 3003/3003 Parent:vif0/4
            Type:Virtual(Vlan) HWaddr:00:99:99:99:33:09
            Vrf:0 Flags:L2 QOS:-1 Ref:3
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:0  bytes:0 errors:0
            TX packets:0  bytes:0 errors:0
            Drops:0
```

For L3 mode:

```
vif0/9      Virtual: ens1f0v1.201 Vlan(o/i)(,S): 201/201 Parent:vif0/2 NH: 36 MTU: 1514
            Type:Virtual(Vlan) HWaddr:d6:93:87:91:45:6c IPaddr:103.1.1.2
            IP6addr:fe80::d493:87ff:fe91:456c
            DDP: OFF SwLB: ON
            Vrf:1 Mcast Vrf:1 Flags:L3DProxyEr QOS:-1 Ref:4
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:0  bytes:0 errors:0
            TX packets:0  bytes:0 errors:0
            Drops:0

vif0/10     Virtual: ens1f0v1.201 Vlan(o/i)(,S): 201/201 Parent:vif0/5 NH: 21 MTU: 9000
            Type:Virtual(Vlan) HWaddr:d6:93:87:91:45:6c IPaddr:103.1.1.2
            IP6addr:fe80::d493:87ff:fe91:456c
            DDP: OFF SwLB: ON
            Vrf:1 Mcast Vrf:65535 Flags:L3DProxyEr QOS:-1 Ref:4 TxXVif:9
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:0  bytes:0 errors:0
            TX packets:0  bytes:0 errors:0
            Drops:0
```

3

CHAPTER

L2 Features

L2 Features Overview

SUMMARY

Read this topic to learn about the features available in the Juniper Cloud-Native Router when deployed in L2 (switch) mode.

The Juniper Cloud-Native Router supports multiple "deployment modes" on page 9.

In L2 mode, the cloud-native router behaves like a switch and so performs no routing functions and runs no routing protocols. The pod network uses VLANs to direct traffic to various destinations.

This chapter provides information about the various L2 features supported by JCNR.

Access Control Lists (Firewall Filters)

SUMMARY

Read this topic to learn about Layer 2 access control lists (Firewall filters) in the cloud-native router.

IN THIS SECTION

Access Control Lists (Firewall Filters)

Starting with Juniper Cloud-Native Router Release 22.2 we've included a limited firewall filter capability. You can configure the filters using the Junos OS CLI within the cloud-native router controller, using NETCONF, or the cloud-native router APIs. Starting with Juniper Cloud-Native Router Release 23.2, you can also configure firewall filters using node annotations and custom configuration template at the time of cRPD deployment. Please review the deployment guide for more details.

During deployment, the system defines and applies firewall filters to block traffic from passing directly between the router interfaces. You can dynamically define and apply more filters. Use the firewall filters to:

- Define firewall filters for bridge family traffic.
- Define filters based on one or more of the following fields: source MAC address, destination MAC address, or EtherType.
- Define multiple terms within each filter.
- Discard the traffic that matches the filter.
- Apply filters to bridge domains.

Configuration Example

Below you can see an example of a firewall filter configuration from a cloud-native router deployment:

```
root@jcnr01> show configuration firewall
firewall {
    family {
        bridge {
            filter example {
                term t1 {
                    from {
                        destination-mac-address 10:10:10:10:10:11;
                        source-mac-address 10:10:10:10:10:10;
                        ether-type arp;
                    }
                    then {
                        discard;
                    }
                }
            }
       }
    }
}
```

NOTE: The only *then* action you can configure in a firewall filter is the discard action.

After configuration, you must apply your firewall filters to a bridge domain using a cRPD configuration command similar to:`set routing-instances vswitch bridge-domains bd3001 forwarding-options filter input filter1`. Then you must commit the configuration for the firewall filter to take effect.

To see how many packets matched the filter (per VLAN), you can issue the `show firewall filter filter1` command on the cRPD CLI. For example:

```
show firewall filter filter1
 Filter : filter1    vlan-id : 3001
 Term                  Packet
  t1                   0
```

In the preceding example, we applied the filter to the bridge domain `bd3001`. The filter has not yet matched any packets.

Troubleshooting

The following table lists some of the potential problems that you might face when you implement firewall rules or ACLs in the cloud-native router. You run most of these commands on the host server.

Table 1: L2 Firewall Filter or ACL Troubleshooting

Problem	Possible Causes and Resolution	Command
Firewall filters or ACLs not working	gRPC connection (port 50052) to the vRouter is down. Check the gRPC connection.	`netstat -antp|grep 50052`
	The `ui-pubd` process is not running. Check whether `ui-pubd` is running.	`ps aux|grep ui-pubd`
Firewall filter or ACL show commands not working	The gRPC connection (port 50052) to the vRouter is down. Check the gRPC connection.	`netstat -antp|grep 50052`

Table 1: L2 Firewall Filter or ACL Troubleshooting *(Continued)*

Problem	Possible Causes and Resolution	Command
	The firewall service is not running.	`ps aux|grep firewall`
		`show log filter.log` You must run this command in the JCNR-controller (cRPD) CLI.

MAC Learning and Aging

SUMMARY

Juniper Cloud-Native Router provides automated learning and aging of MAC addresses. Read this topic for an overview of the MAC learning and aging functionality in the cloud-native router.

IN THIS SECTION

MAC Learning

MAC learning enables the cloud-native router to efficiently send the received packets to their respective destinations. The cloud-native router maintains a table of MAC addresses grouped by interface. The table includes MAC addresses, VLANs, and the interface on which the vRouter learns each MAC address and VLAN. The MAC table informs the vRouter about the MAC addresses that each interface can reach.

The cloud-native router caches the source MAC address for a new packet flow to record the incoming interface into the MAC table. The router learns the MAC addresses for each VLAN or bridge domain. The cloud-native router creates a key in the MAC table from the MAC address and VLAN of the packet. Queries sent to the MAC table return the interface associated with the key. To enable MAC learning, the cloud-native router performs these steps:

- Records the incoming interface into the MAC table by caching the source MAC address for a new packet flow.

- Learns the MAC addresses for each VLAN or bridge domain.
- Creates a key in the MAC table from the MAC address and VLAN of the packet.

If the destination MAC address and VLAN are missing (lookup failure), the cloud-native router floods the packet out all the interfaces (except the incoming interface) in the bridge domain.

By default:

- MAC table entries time out after 60 seconds.
- The MAC table size is limited to 10,240 entries.

We recommend that you do not change the default values. Please contact Juniper Support if you need to change the default values.

You can see the MAC table entries by using:

- Introspect agent at **http://*host server IP*:8085/mac_learning.xml#Snh_FetchL2MacEntry**

l2_mac_entry_list

vrf_id	vlan_id	mac	index	packets	time_since_add	last_stats_change
0	1001	00:10:94:00:00:01	5644	615123154	12:55:14.248263	00:00:00.155450
0	1001	00:10:94:00:00:65	6480	615108294	12:55:14.247765	00:00:00.155461
0	1002	00:10:94:00:00:02	5628	615123173	12:55:14.248295	00:00:00.155470

- The command **show bridge mac-table** on the cRPD CLI:

```
show bridge mac-table
Routing Instance : default-domain:default-project:ip-fabric:__default__
Bridging domain VLAN id : 3002
MAC                 MAC               Logical
address             flags             interface

00:00:5E:00:53:01      D                bond0
```

- The command **purel2cli --mac show** on the CLI of the vRouter pod:

```
purel2cli --mac show
================================================
||  MAC            vlan      port      hit_count||
================================================
00:01:01:01:01:03  1221      2          1101892
00:01:01:01:01:02  1221      2          1101819
00:01:01:01:01:04  1221      2          1101863
```

```
00:01:01:01:01:01  1221      2          1101879
5a:4c:4c:75:90:fe  1250      5          12
Total Mac entries 5
```

If you exceed the MAC address limit, the counter **pkt_drop_due_to_mactable_limit** increments. You can see this counter by using the introspect agent at **http://*host server IP*:8085/Snh_AgentStatsReq**.

If you delete or disable an interface, the cloud-native router deletes all the MAC entries associated with that interface from the MAC table.

MAC Entry Aging

The aging timeout for cached MAC entries is 60 seconds. You can configure the aging timeout at deployment time by editing the **values.yaml** file. The minimum timeout is 60 seconds and the maximum timeout is 10,240 seconds. You can see the time that is left for each MAC entry through introspect at **http://*host server IP*:8085/mac_learning.xml#Snh_FetchL2MacEntry**. We show an example of the output below:

```
l2_mac_entry_list
vrf_id          vlan_id          mac                 index          packets
time_since_add          last_stats_change
0               1001             00:10:94:00:00:01   5644           615123154
12:55:14.248785         00:00:00.155450
0               1001             00:10:94:00:00:65   6480           615108294
12:55:14.247765         00:00:00.155461
0               1002             01:10:94:00:00:02   5628           615123173
12:55:14.248295         00:00:00.155470
```

Storm Control

SUMMARY

Read this topic to understand how the broadcast rate limiting feature is implemented by the cloud-native router when deployed in L2 mode.

IN THIS SECTION

The storm control or rate limiting feature controls the rate of egress broadcast, unknown unicast, and multicast (BUM) traffic on fabric interfaces.

Configuration Example

You specify the rate limit in bytes per second by adjusting **stormControlProfiles** in the **values.yaml** file before deployment.

```
# rate limit profiles for bum traffic on fabric interfaces in bytes per second
 stormControlProfiles:
   rate_limit_pf1:
     bandwidth:
       level: 0
```

Once a profile is created, it can be assigned to the interface via the `storm-control-profile` interface attribute. For example:

```
- eth1:
      ddp: on
      interface_mode: trunk
      vlan-id-list: [100, 200, 300, 700-705]
      storm-control-profile: rate_limit_pf1
      native-vlan-id: 100
      no-local-switching: true
```

The system applies the configured profiles to all specified fabric interfaces in the cloud-native router. The maximum per-interface rate limit value you can set is 1,000,000 bytes per second.

If the unknown unicast, broadcast, or multicast traffic rate exceeds the set limit on a specified fabric interface, the vRouter drops the traffic. You can see the drop counter values by running the `dropstats` command in the vRouter CLI. You can see the per-interface rate limit drop counters by running the vRouter CLI command `vif --get` *`fabric_vif_id`* `--get-drop-stats`. For example:

```
dropstats
L2 untag pkt drop             8832
L2 Src Mac lookup fail        880
Rate limit exceeded 29312474
```

When you configure a rate limit profile on a fabric interface, you can see the configured limit in bytes per second when you run either `vif --list` or `vif --get` *`fabric_vif_id`*.

```
vif0/2          PCI: 0000: af: 01.1 (Speed 10000, Duplex 1)
                Type: Physical HWaddr: 76:5d: f5: f5: c1:7a
                Vrf:0 Flags: L2Vof QOS:-1 Ref: 8 BUM Rate Limit: 1000000
                RX port    packets:1 errors:0
                RX queue packets:1 errors:0
                RX queue errors to lore 000000000000
                Driver: net_iavf
                Fabric Interface: 0000:af:01.1 Status: UP
                Vlan Mode: Trunk Vlan: 300 500 600
                RX packets:0  bytes:0
errors:1
                TX packets:0 bytes:0 errors:0
                Drops: 1
```

NOTE:

- The rate limit is only configurable on physical interfaces and only during deployment.
- The existing global rate limit configuration *fabricBMCastRateLimit* is deprecated from release 22.4.

API to Force Bond Link Switchover

SUMMARY

Read this topic to learn about the L2 feature in the Juniper Cloud-Native Router that is used to force traffic to switch from the active interface to the standby interface in a bonded pair using REST API.

IN THIS SECTION

API to Force Bond Link Switchover

When you run cloud-native router in L2 mode with cascaded nodes you can configure those nodes to use bond interfaces. If you configure the bond interfaces in the `ACTIVE_BACKUP` mode, the vRouter-agent exposes the REST API call: `curl -X POST http://127.0.0.1:9091/bond-switch/bond0` on localhost port 9091. You can use this REST API call to force traffic to switch from the active interface to the standby interface.

Configuration Example

You can configure the bond mode in the `values.yaml` file before deployment. For example:

```
bondInterfaceConfigs:
    - name: "bond0"
      mode: 1             # ACTIVE_BACKUP MODE
      slaveInterfaces:
      - "enp59s0f0v0"
      - "enp59s0f0v1"
```

The vRouter contains two CLI commands that allow you to see the active interface in a bonded pair and to see the traffic statistics associated with your bond interfaces. These commands are: `dpdkinfo -b` and `dpdkinfo -n` respectively.

```
[[root@jcnr-01 /]# dpdkinfo -b
No. of bond slaves: 2
Bonding Mode: Active Backup
Transmit Hash Policy: Layer 2 (Ethernet MAC)
MII status: UP
```

```
MII Link Speed: 10000 Mbps
Up Delay (ms): 0
Down Delay (ms): 0
Driver: net_bonding

Slave Interface(0): 0000:17:01.0
Slave Interface Driver: net_iavf
Slave Interface (0): Active
Slave Interface Mac : 6E: BD: 45:0F: 4A:02

MII status: UP
MII Link Speed: 10000 Mbps

Slave Interface (1): 0000:17:11.0
Slave Interface Driver: net_iavf
Slave Interface Mac      6E: BD: 45:0F: 4A: C2

MII status: UP
MII Link Speed: 25000 Mbps
```

```
[root@jcnr-01 /]# dpdkinfo -n2
Master Info (eth_bond_bond0):
RX Device Packets: 72019, Bytes: 96419113, Errors:0, Nombufs:0
Dropped RX Packets: 37475
TX Device Packets:0, Bytes:0, Errors:0
Queue Rx:
Tx:
Rx Bytes:
Tx Bytes:
Errors:


Slave Info (0000:17:01.0):
Rx Device Packets: 72019, Bytes:66073908, Errors:0, Nombufs:0
Dropped RX Packets: 588
TX Device Packets:0, Bytes:0, Errors:0
Queue Rx:
Tx:
Rx Bytes:
Tx Bytes:
Errors:
```

```
Slave Info (0000:17:11.0):
RX Device Packets:0, Bytes:30345205, Errors:0, Nombufs:0
Dropped R Packets:36887
TX Device Packets:0, Bytes:0, Errors:0
Queue Rx:
Tx:
Rx Bytes:
Tx Bytes:
Errors:
```

Quality of Service (QoS)

SUMMARY

Read this topic to learn about the quality of service (QoS) feature of the Juniper Cloud-Native Router when deployed in L2 mode.

IN THIS SECTION

Starting in Juniper Cloud-Native Router Release 22.4, you can configure quality of service (QoS) parameters including classification, marking, and queuing. The cloud-native router performs classification and marking operations in vRouter and queing (scheduling) operations in the physical network interface card (NIC). Scheduling is only supported on the E810 NIC.

QoS Overview

You enable QoS prior to the deploy time by editing the `values.yaml` file in **Juniper-Cloud-Native-Router-*version-number*/helmchart** directory and changing the `qosEnable` value to `true`. The default value for the QoS feature is `false` (disabled). For example:

```
# Set true/false to Enable or Disable QOS, note: QOS is not supported on X710 NIC.
  qosEnable: true
```

NOTE: You can only enable the QoS feature if the host server on which you install your cloud-native router contains an Intel E810 NIC that is running lldp.

You enable lldp on the NIC using the `lldptool` which runs on the host server as a CLI application. Issue the following command to enable lldp on the E810 NIC. For example, you could use the following command:

```
lldptool -T -i INTERFACE -V ETS-CFG willing=no
tsa=0:strict,1:strict,2:strict,3:strict,4:strict,
5:strict,6:strict,7:strict
up2tc=0:0,1:1,2:2,3:3,4:0,5:1,6:2,7:3
```

The details of the above command are:

- **ETS**–Enhanced Transmission Selection
- **willing**–The willing attribute determines whether the system uses locally configured packet forwarding classification (PFC) or not. If you set `willing` to `no`(the default setting), the cloud-native router applies local PFC configuration. If you set willing to yes, and the cloud-native router receives TLV from the peer router, the cloud-native router applies the received values.
- **tsa**–The transmission selection algorithm is a comma seperated list of traffic class to selection algorithm maps. You can choose `ets`, `strict`, or `vendor` as selection algorithms.
- **up2tc**–Comma-separated list that maps user priorities to traffic classes

The list below provides an overview of the classification, marking, and queueing operations performed by cloud-native router.

- Classification:
  - vRouter classifies packets by examining the priority bits in the packet
  - vRouter derives traffic class and loss priority
  - vRouter can apply traffic classifiers to fabric, traffic, and workload interface types
  - vRouter maintains 16 entries in its classifier map
- Marking (Re-write):
  - vRouter performs marking operations
  - vRouter performs rewriting of p-bits in the egress path

  - vRouter derives new traffic priority based on traffic class and drop priority at egress
  - vRouter can apply marking to packets only on fabric interfaces
  - vRouter maintains 8 entries in its marking map
- Queueing (Scheduling):
  - Cloud-native router performs strict priority scheduling in hardware (E810 NIC)
  - Cloud-native router maps each traffic class to one queue
  - Cloud-native router limits the maximum number of traffic queue to 4
  - Cloud-native router maps 8 possible priorities to 4 traffic classes; It also maps each traffic class 1 hardware queue
  - Cloud-native router can apply scheduling to fabric interface only
  - Virtual functions (VFs) leverage the queues that you configure in the physical functions (interfaces)
  - vRouter maintains 8 entries in its scheduler map

Configuration Example

You configure QoS classifiers, rewrite rules, and schedulers in the cRPD using Junos set commands or remotely using NETCONF. We display a Junos-based example configuration below:

```
set class-of-service classifiers ieee-802.1 class1
    forwarding-class assured-forwarding loss-priority
    high code-points 011
set class-of-service rewrite-rules ieee-802.1 Rule_1
    forwarding-class assured-forwarding loss-priority
    high code-point 110
set class-of-service schedulers sch1 priority high
set class-of-service scheduler-maps sch1 forwarding-class
    assured-forwarding scheduler sch1
set class-of-service interfaces enp175s1 scheduler-map sch1
set class-of-service interfaces enp175s1 unit 0 rewrite-rules ieee-802.1 Rule_1
set class-of-service interfaces vhostnet123-3546aefd-7af8-4fe5 unit 0 classifiers ieee-802.1
class1
```

You view the QoS configuration by "accessing the cRPD CLI" on page 88. Use the show commands in Junos operation mode. The show commands reveal the configuration of classifiers, rewrite rules, or scheduler maps individually. For example:

Show Classifier

```
user@jcnr-01> show class-of-service classifier

Classifier: class1, Code point type: ieee802.1p
Code point             Forwarding class               Loss priority
011                    assured-forwarding             high
```

Show Rewrite-Rule

```
user@jcnr-01> show class-of-service rewrite-rule

Rewrite rule: Rule_1, Code point type: ieee802.1p
Forwarding class            Loss priority        Code point
assured-forwarding          high                 110
```

Show Scheduler-Map

```
show class-of-service scheduler-map sch1
Scheduler map: sch1
  Scheduler: sch1,  Forwarding class: assured-forwarding
    Transmit rate: unspecified, Rate Limit: none, Priority: high
```

Show Interface

```
show class-of-service interface vhostnet123-5a1e3079-d45e-4ab5
Physical interface: vhostnet123-5a1e3079-d45e-4ab5
Maximum usable queues: 4, Queues in use: 4

  Logical interface: vhostnet123-5a1e3079-d45e-4ab5.0
Object            Name               Type
Classifier        class1             ieee802.1p
```

```
show class-of-service interface enp175s1
Physical interface: enp175s1
```

```
Maximum usable queues: 4, Queues in use: 4
  Scheduler map: sch1
  Logical interface: enp175s1.0
Object            Name              Type
Rewrite-Output    Rule_1            ieee802.1p
```

Troubleshooting

You can troubleshooting the QoS configuration "by accessing the vRouter shell" on page 89. Use the purel2cli command and by viewing the interface mapping.

Display Classifier Config

```
purel2cli --qos cla class1
Classifer name: class1 Classifier Index: 0
================================================
code-points   loss priority    forwarding-class
================================================
   000           low            best-effort
   001           low            best-effort
   010           low            best-effort
   011           high           assured-forwarding
  100           low            best-effort
   101           low            best-effort
   110           low            best-effort
   111           low            best-effort
```

```
vif0/2      PMD: vhostnet123-3546aefd-7af8-4fe5
            Type:Virtual HWaddr:aa:bb:cc:dd:ee:12
            Vrf:0 Flags:L2Mon QOS:-1 Ref:13
            RX port   packets:20 errors:0
            RX queue  packets:20 errors:0
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            Vlan Mode: Trunk  Vlan: 100 200 300
            Qos classifier: class1
           RX packets:20  bytes:1200 errors:0
            TX packets:0  bytes:0 errors:0
            Drops:40
```

Display Re-write Config

```
purel2cli --qos rw Rule_1
Re-Write name: Rule_1 Re-write Index: 0
=======================================loss priority      Forwarding-class      re-write prio
========================================
   low           best-effort                 n/a
   low           expedited-forwarding        n/a
   low           assured-forwarding          n/a
   low           network-control             n/a
   high          best-effort                 n/a
   high          expedited-forwarding        n/a
   high          assured-forwarding          110
   high          network-control             n/a
```

```
vif0/1      PCI: 0000:af:01.0 (Speed 10000, Duplex 1)
            Type:Physical HWaddr:46:d5:f3:fc:fc:92
            Vrf:0 Flags:L2Vof QOS:-1 Ref:42
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            Fabric Interface: 0000:af:01.0  Status: UP  Driver: net_iavf
            Vlan Mode: Trunk  Vlan: 100 200 300 700-705 2001
                Rewrite:    Rule_1
               Scheduler:  sch1
            RX packets:0  bytes:0 errors:0
            TX packets:20  bytes:1200 errors:0
            Drops:0
            TX port   packets:20 errors:0
```

Display Scheduler Output

```
purel2cli --qos sch sch1
Scheduler name: sch1 Scheduler  Index: 0
====================================
 forwarding-class      priority_map
====================================
  best-effort                       0
  expedited-forwarding      0
```

```
  assured-forwarding          2
  network-control               0
```

```
vif0/1      PCI: 0000:af:01.0 (Speed 10000, Duplex 1)
            Type:Physical HWaddr:46:d5:f3:fc:fc:92
            Vrf:0 Flags:L2Vof QOS:-1 Ref:42
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            Fabric Interface: 0000:af:01.0  Status: UP  Driver: net_iavf
            Vlan Mode: Trunk  Vlan: 100 200 300 700-705 2001
               Rewrite:    Rule_1
               Scheduler:  sch1
            RX packets:0  bytes:0 errors:0
            TX packets:20  bytes:1200 errors:0
            Drops:0
            TX port   packets:20 errors:0
```

Native VLAN

IN THIS SECTION

Starting in Juniper Cloud-Native Router Release 23.1, JCNR supports receiving and forwarding untagged packets on a trunk interface. Typically, trunk ports accept only tagged packets, and the untagged packets are dropped. You can enable a JCNR fabric trunk port to accept untagged packets by configuring a native VLAN identifier (ID) on the interface on which you want the untagged packets to be received. When a JCNR fabric trunk port is enabled to accept untagged packets, such packets are forwarded in the native VLAN domain.

Native VLAN

Enable the `native-vlan-id` key in the Helm chart, prior to the deploy time, to configure the VLAN identifier to associate it with untagged data packets received on the fabric trunk interface. Edit the `values.yaml` file in **Juniper_Cloud_Native_Router_*<release-number>*/helmchart** directory and add the key `native-vlan-id` along with a value for it. For example:

```
fabricInterface:
  - eth1:
      ddp: on
      interface_mode: trunk
      vlan-id-list: [100, 200, 300, 700-705]
      storm-control-profile: rate_limit_pf1
      native-vlan-id: 100
      no-local-switching: true
```

NOTE: After editing the **values.yaml** file, you have to install or upgrade JCNR using the edited **values.yaml** to ensure that the `native-vlan-id` key is enabled.

To verify, if native VLAN is enabled for an interface, connect to the vRouter agent by executing the command `kubectl exec -it -n contrail contrail-vrouter-<agent container> -- bash` command, and then run the command `vif --get <interface index id>`. A sample output is shown below:

```
vif0/1      PCI: 0000:00:00.0 (Speed 10000, Duplex 1)
            Type:Physical HWaddr:6a:45:b2:a8:ce:5c
            Vrf:0 Flags:L2Vof QOS:-1 Ref:11
            RX port   packets:36550 errors:0
            RX queue  packets:36550 errors:0
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            Fabric Interface: eth_bond_bond0  Status: UP  Driver: net_bonding
            Slave Interface(0): 0000:3b:02.0  Status: UP  Driver: net_iavf
            Vlan Mode: Trunk  Vlan: 100 200 300
            Native vlan id: 100
            RX packets:36550  bytes:5875795 errors:0
            TX packets:0  bytes:0 errors:0
            Drops:613
```

Prevent Local Switching

IN THIS SECTION

Starting in Juniper Cloud-Native Router Release 23.1, JCNR provides support to prevent interfaces in a bridge domain that are a part of the same VLAN group, from transmitting ethernet frame copies in between those interfaces. The **noLocalSwitching** key provides the option to enable the functionality on the selected VLAN IDs.

To prevent interfaces in a bridge domain from transmitting and receiving ethernet frame copies, enable the **noLocalSwitching** key and assign a VLAN ID to it to ensure that the interfaces belonging to the VLAN ID do not transmit frames to one another. Note that the **noLocalSwitching** functionality is enabled only on the access interfaces. To enable **noLocalSwitching** on a trunk interface that is a part of the same VLAN ID, you have to separately enable the trunk interface by setting the **no-local-switching** key in the trunk interface to **true**. Use the **noLocalSwitching** functionality when you want to block interfaces that are a part of a VLAN group to stop transmitting traffic directly to one another.

NOTE:
no-local-switching

Configuration Example

To prevent local switching, perform the steps below prior to the deploy time:

1. Edit the **values.yaml** file in **Juniper_Cloud_Native_Router_*<release-number>*/helmchart** directory.
2. Enable the **noLocalSwitching** key and provide the VLAN IDs.

```
noLocalSwitching: [700]
```

NOTE:

a. The value for the **noLocalSwitching** key can be an indivdual VLAN ID, or multipe comma-separated VLAN ID values, or a VLAN ID range, or a combination of comma-separated VLAN ID values and a VLAN ID range. For example, **noLocalSwitching: [700, 701, 705-710]**.

b. With this step the feature is enabled for all access interfaces having the specified VLAN ID. You can skip the next step if you do not want to enable the feature on the trunk interface.

3. To enable the feature on a trunk interface, add the key **no-local-switching** and set it to **true** under the trunk interface configuration.

   . For example:

```
fabricInterface:
  - bond0:
      ddp: on
      interface_mode: trunk
      vlan-id-list: [100, 200, 300, 700-705]
      storm-control-profile: rate_limit_pf1
      #native-vlan-id: 100
      no-local-switching: true
```

4. Install or upgrade JCNR using the **values.yaml**.

Verify Configuration

To verify the configuration, you can use the `purel2cli` utility available on the vRouter. View the "Access vRouter CLI" on page 89 topic to access the vRouter shell. You can run the `purel2cli` commands from the vRouter CLI. For example:

1. Run the command `purel2cli --nolocal show` to know all the interfaces that are enabled for **noLocalSwitching** functionality on all the VLANs. A sample output is shown below:

```
[root@jcnr-01 /]# purel2cli --nolocal show
============================
vlan    no_local_switch_list
============================
100     1, 2, 4,
200
```

```
300
700
701
702
703
```

2. Run the command `purel2cli --nolocal get <VLAN ID>` to check if **noLocalSwitching** functionality is enabled on a specific VLAN ID. A sample output is shown below:

```
[root@jcnr-01 /]# purel2cli --nolocal get 100
============================
vlan    no_local_switch_list
============================
100     1, 2, 4,
```

CHAPTER 4

L3 Features

L3 Features Overview

SUMMARY

Read this topic to learn about the features available in the Juniper Cloud-Native Router when deployed in L3 (router) mode.

The Juniper Cloud-Native Router supports multiple "deployment modes" on page 9.

In L3 mode, the cloud-native router behaves like a router and so performs routing functions and runs routing protocols such as ISIS, BGP, OSPF, and segment routing-MPLS. In L3 mode, the pod network is divided into an IPv6 underlay network and an IPv4 or IPv6 overlay network. The IPv6 underlay network is used for control plane traffic.

This chapter provides information about the various L3 features supported by JCNR.

JCNR as a Transit Gateway

JCNR can act as a transit gateway for external traffic. As a transit gateway, JCNR is neither the source nor the destination for the traffic, but an intermediate hop. It acts as a vanilla router to switch traffic between multiple physical interfaces.
Starting with Juniper Cloud-Native Router (JCNR) Release 23.2, JCNR can now act as a transit gateway for external traffic. As a transit gateway, JCNR is neither the source nor the destination for the traffic, but an intermediate hop. It acts as a vanilla router to switch traffic between multiple physical interfaces. Depending on the forwarding state, JCNR can encapsulate or decapsulate the traffic between interfaces.

> **NOTE**: Starting with JCNR Release 23.2, JCNR supports multiple fabric interfaces that enable it to function as a transit gateway.

JCNR has to be deployed in the L3 mode to perform the transit router functionality. Add all physical interfaces (physical and virtual functions) as fabric interfaces in the helm chart before deploying the JCNR. The deployed JCNR does not support editing or changing the fabric interfaces during run time. However, you can create or remove pod interfaces during run time.

You need to configure an IP address on the loopback interface and use it as a tunnel endpoint for each JCNR instance. The loopback IP address is the next hop address which BGP advertises to its peers. All data packets with encapsulations like MPLSoUDP will have the outer IP address as this loopback IP address. The loopback IP address is reachable via any of the physical interfaces. The loopback IP address should be in a /32 subnet without a MAC address.

L3 Routing Protocols

SUMMARY

Read this topic to know about the L3 routing protocols that are supported by the Juniper Cloud Native Router, including BGP, IS-IS, and OSPF.

IN THIS SECTION

Supported L3 protocols

The Juniper Cloud-Native router supports the following L3 routing protocols, each of which can be configured via node annotations at the time of deployment or via the "cRPD CLI" on page 88 for a running cRPD pod. Here is an example configuration snippet from the go template with node annotations:

```
protocols {
    isis {
        interface all;
        {{if and .Env.SRGB_START_LABEL .Env.SRGB_INDEX_RANGE}}
        source-packet-routing {
            srgb start-label {{.Env.SRGB_START_LABEL}} index-range {{.Env.SRGB_INDEX_RANGE}};
            node-segment {
                {{if .Node.srIPv4NodeIndex}}
                ipv4-index {{.Node.srIPv4NodeIndex}};
                {{end}}
                {{if .Node.srIPv6NodeIndex}}
                ipv6-index {{.Node.srIPv6NodeIndex}};
                {{end}}
            }
        }
```

```
        {{end}}
        level 1 disable;
    }
}
```

- **BGP**—BGP is an exterior gateway protocol (EGP) that is used to exchange routing information among routers in different autonomous systems (ASs). BGP routing information includes the complete route to each destination. BGP uses the routing information to maintain a database of network reachability information, which it exchanges with other BGP systems. BGP uses the network reachability information to construct a graph of AS connectivity, which enables BGP to remove routing loops and enforce policy decisions at the AS level. The cloud-native router supports BGP version 4. Refer the BGP User Guide for more information.

- **IS-IS**—The IS-IS protocol is an interior gateway protocol (IGP) that uses link-state information to make routing decisions. IS-IS is a link-state IGP that uses the shortest-path-first (SPF) algorithm to determine routes. IS-IS evaluates the topology changes and determines whether to perform a full SPF recalculation or a partial route calculation (PRC). IS-IS uses hello packets that allow network convergence to occur quickly when network changes are detected. The cloud-native router supports IS-IS. Refer the IS-IS User Guide for information.

- **OSPF**—OSPF is an interior gateway protocol (IGP) that routes packets within a single autonomous system (AS). OSPF uses link-state information to make routing decisions, making route calculations using the shortest-path-first (SPF) algorithm (also referred to as the Dijkstra algorithm). Each router running OSPF floods link-state advertisements throughout the AS or area that contain information about that router's attached interfaces and routing metrics. Each router uses the information in these link-state advertisements to calculate the least cost path to each network and create a routing table for the protocol. The cloud-native router supports OSPF version 2 (OSPFv2) and OSPF version 3 (OSPFv3). Refer the OSPF User Guide for more information.

MPLS Support

The Juniper Cloud-Native Router contains support for MPLS routing protocols. You use the JCNR-controller, or cRPD, to configure MPLS using the node annotations at the time of deployment or via the "cRPD CLI" on page 88.

The cRPD then sends the configuration to the vRouter-agent, using gRPC. The vRouter-agent then converts the configuration to network policies that it imlements in the vRouter. The cloud-native router supports the following MPLS-based routing protocols:

- **L3 MPLS VPN (MPLS)**—L3 MPLS VPNs are also known as BGP/MPLS VPNs because BGP is used to distribute VPN routing information across the provider's backbone, and MPLS is used to forward

VPN traffic across the backbone to remote VPN sites. The cloud-native router can particpate as a sending, receiving or transit router using the MPLS protocol. Review the L3 VPN User Guide for more information.

- **Segment Routing-MPLS (SR-MPLS)**—Segment routing is a control-plane architecture that enables an ingress router to steer a packet through a specific set of nodes and links in the network without relying on the intermediate nodes in the network to determine the actual path it should take. SR-MPLS employs segment routing in MPLS. The cloud-native router can participate as a sending or receiving router in SR-MPLS networks. Review the Junos source packet routing topic for a configuration example.
- **MPLS over UDP (MPLSoUDP)**—MPLSoUDP is an overlay technology that encapsulates MPLS packets within UDP packets to traverse through some networks that do not support native MPLS or SR-MPLS. The cloud-native router can participate as a sending, receiving or transit router using MPLSoUDP. Review the Configuring Next-Hop-Based MPLSoUDP Tunnels topic for a configuration example.
- **Label Distribution Protocol (LDP)**—The Label Distribution Protocol (LDP) is a protocol for distributing labels in non-traffic-engineered applications. LDP allows routers to establish label-switched paths (LSPs) through a network by mapping network-layer routing information directly to data link layer-switched paths. The cloud-native router can participate as a sending, receiving or transit router using LDP. Review the LDP Overview topic for more information.

Bidirectional Forwarding Detection (BFD)

SUMMARY

Read this topic to know about the support for Bidirectional Forwarding Detection (BFD) in the Juniper Cloud-Native router.

The Bidirectional Forwarding Detection (BFD) protocol is a simple hello mechanism that detects failures in a network. A pair of routing devices exchange BFD packets. The devices send hello packets at a specified, regular interval. The device detects a neighbor failure when the routing device stops receiving a reply after a specified interval. The cloud-native router supports BFD. Review the Understanding BFD topic for more information.

Virtual Router Redundancy Protocol (VRRP)

SUMMARY

Read this topic to learn about the support for the Virtual Router Redundancy Protocol (VRRP) in Juniper Cloud-Native router.

The Virtual Router Redundancy Protocol (VRRP) enables hosts on a LAN to make use of redundant routing platforms on that LAN without requiring more than the static configuration of a single default route on the hosts. The VRRP routing platforms share the IP address corresponding to the default route configured on the hosts. At any time, one of the VRRP routing platforms is the primary (active) and the others are backups. If the primary routing platform fails, one of the backup routing platforms becomes the new primary routing platform, providing a virtual default routing platform and enabling traffic on the LAN to be routed without relying on a single routing platform. Using VRRP, a backup device can take over a failed default device within a few seconds. This is done with minimum VRRP traffic and without any interaction with the hosts. When JCNR is deployed in the containerized network function (CNF) mode in cloud deployments, the VRRP unicast can be used to decide between the active and backup JCNR nodes. Review the Understanding VRRP topic for more information.

Virtual Routing Instance (VRF-Lite)

SUMMARY

Read this topic to understand the implementation of virtual routing instances in JCNR.

Virtual routing instances allow administrators to divide a the cloud-native router into multiple independent virtual routers, each with its own routing table. Splitting a device into many virtual routing instances isolates traffic traveling across the network without requiring multiple devices to segment the network. You can use virtual routing instances to isolate customer traffic on your network and to bind customer-specific instances to customer-owned interfaces. Virtual routing and forwarding (VRF) is often used in conjunction with Layer 3 subinterfaces, allowing traffic on a single physical interface to be

differentiated and associated with multiple virtual routers. Each logical Layer 3 subinterface can belong to only one routing instance. Review the Virtual Router Instances topic for more information.

ECMP

SUMMARY

Read this topic to know about the support for ECMP with flow stickiness in the Juniper Cloud-Native Router.

Equal-cost multipath (ECMP) is a network routing strategy that allows for traffic of the same session, or flow—that is, traffic with the same source and destination—to be transmitted across multiple paths of equal cost. It is a mechanism that allows you to load balance traffic and increase bandwidth by fully utilizing otherwise unused bandwidth on links to the same destination.

When forwarding a packet, the routing technology must decide which next-hop path to use. In making a determination, the device takes into account the packet header fields that identify a flow. When ECMP is used, next-hop paths of equal cost are identified based on routing metric calculations and hash algorithms. That is, routes of equal cost have the same preference and metric values, and the same cost to the network. The ECMP process identifies a set of routers, each of which is a legitimate equal cost next hop towards the destination. The routes that are identified are referred to as an ECMP set. Because it addresses only the next hop destination, ECMP can be used with most routing protocols.

An equal-cost multipath (ECMP) set is formed when the routing table contains multiple next-hop addresses for the same destination with equal cost. (Routes of equal cost have the same preference and metric values.) If there is an ECMP set for the active route, Junos OS uses a hash algorithm to choose *one* of the next-hop addresses in the ECMP set to install in the forwarding table.

The cloud-native router supports ECMP for both Container Network Interface (CNI) and transit router modes.

BGP Unnumbered

SUMMARY

Read this topic to know about the support for BGP unnumbered in the cloud-native router.

Juniper Cloud-Native Router supports BGP unnumbered peering starting in Release 23.2. This feature allows BGP to auto-discover and to create peer neighbor sessions using the link-local IPv6 addresses of directly connected neighbors. Using BGP unnumbered peering, which dynamically discovers IPV6 neighbors, reduces the burden of manually configuring an IPv6 underlay. It is used in N-tier Clos architecture for point-to-point links. BGP unnumbered is supported in the default VRF (VRF-0) and virtual routing instances (virtual-router). Read the BGP Unnumbered topic for more information.

NOTE: When a BGP unnumbered IPv6 session is established between 2 provider edge routers (PEs) and IPv4 routes are being exchanged over that session, then the next hop for an IPv4 route is an IPv6 address. This feature is supported on PEs having Linux kernel version 5 and above. If the Linux kernel version is below 5, then the IPv4 routes are not added to the routing table.

CHAPTER 5

Configuration Examples

JCNR Use-Cases and Configuration Overview

SUMMARY

Read this chapter to review configuration examples for various Juniper Cloud-Native Router use cases when deployed in the container network interface (CNI) mode.

IN THIS SECTION

The Juniper Cloud-Native Router can be deployed as a virtual switch or a transit router, either as a pure container network function (CNF) or as a container network interface (CNI). In the CNF mode, there are no application pods running on the node and the router only performs packeting switching or forwarding through various interfaces on the system. In the CNI mode, application pods using software-based network interfaces such as veth-pairs or DPDK vhost-user based interfaces, attach to the cloud-native router. This chapter provides configuration examples for attaching different workload interface types to the cloud-native router CNI instance.

Configuration Example

The JCNR CNI is deployed as a secondary CNI along with Multus as a primary CNI, to create different types of secondary interfaces for the application pod. Multus uses a network attachment definition (NAD) file to configure a secondary interface for the application pod. The NAD specifies how to create a secondary interface, IP address allocation, network instance and more. A pod can have one or more NADs, typically one per pod interface. The `config:` field in the NAD file defines the JCNR CNI configuration. Here is a generic format of the NAD:

```
apiVersion: "k8s.cni.cncf.io/v1"
kind: NetworkAttachmentDefinition
metadata:
  name: <vrf-name>
spec:
  config: '{
    "cniVersion":"0.4.0",
    "name": "<vrf-name>",
    "plugins": [
      {
        "type": "jcnr",
        "args": {
```

```
            "key1":"value1",
            "key2","value2",
            ....
        },
        "ipam": {
          "type": "<ipam-type>",
          ....
        },
        "kubeConfig":"/etc/kubernetes/kubelet.conf"
      }
    ]
}'
```

While configuring the NAD for the JCNR plugin type, the following keys are supported:

Table 2: Supported Keys in NAD

Key	Description
instanceName	The routing-instance name
instanceType	One of: virtual-router—for non-VPN-related applications vrf—Layer 3 VPN implementations virtual-switch—Layer 2 implementations
interfaceType	Either "veth" or "virtio"
vlanId	A valid vlan id "1-4095"
bridgeVlanId	A valid vlan id "1-4095"
vlanIdList	A list of command separated vlan-id, e.g: "1, 5, 7, 10-20"
parentInterface	Valid interface name as it should appear in the pod. Child/sub-interfaces have parentInterface as their prefix followed by "." If parentInterface is specified, sub interface must be explicitly specifiied.
vrfTarget	The route-target for vrf routing instance

Table 2: Supported Keys in NAD *(Continued)*

Key	Description
bridgeDomain	Bridge Domain under which pod interface should be attached in the virtual-switch instance.
type (ipam)	static—assigns same IP to all pods, to assign a unique IP per pod define a unique NAD per pod per interface host-local—unique IP address per pod interface on the same host. IP addresses are not unique across two different nodes whereabouts—unique IP address per pod across all nodes (https://github.com/k8snetworkplumbingwg/whereabouts)

Consider the example NAD for a layer 2 kernel access mode interface:

```
apiVersion: "k8s.cni.cncf.io/v1"
kind: NetworkAttachmentDefinition
metadata:
  name: vswitch-pod1-bd100
spec:
  config: '{
    "cniVersion":"0.4.0",
    "name": "vswitch-pod1-bd100",
    "plugins": [
      {
        "type": "jcnr",
        "args": {
          "instanceName": "vswitch",
          "instanceType": "virtual-switch",
       "interfaceType": "veth",
          "bridgeDomain": "bd100",
          "bridgeVlanId": "100"
        },
        "ipam": {
          "type": "static",
          "addresses":[
            {
              "address":"99.61.0.2/16",
              "gateway":"99.61.0.1"
            },
```

```
            {
              "address":"1234::99.61.0.2/120",
              "gateway":"1234::99.61.0.1"
            }
          ]
        },
        "kubeConfig":"/etc/kubernetes/kubelet.conf"
      }
    ]
  }'
```

The pod attaches to the router instance using the `k8s.v1.cni.cncf.io/networks` annotation. For example:

```
apiVersion: v1
kind: Pod
metadata:
  name:   pod1
  annotations:
    k8s.v1.cni.cncf.io/networks: vswitch-pod1-bd100
spec:
  affinity:
    nodeAffinity:
      requiredDuringSchedulingIgnoredDuringExecution:
        nodeSelectorTerms:
          - matchExpressions:
            - key: kubernetes.io/hostname
              operator: In
              values:
                - kind-worker
  containers:
    - name: pod1
      image: ubuntu:latest
      imagePullPolicy: IfNotPresent
      securityContext:
        privileged: false
      env:
        - name: KUBERNETES_POD_UID
          valueFrom:
            fieldRef:
               fieldPath: metadata.uid
      volumeMounts:
        - name: dpdk
```

```
          mountPath: /dpdk
          subPathExpr: $(KUBERNETES_POD_UID)
    volumes:
      - name: dpdk
        hostPath:
          path: /var/run/jcnr/containers
```

The volume mount host path exposes the UNIX domain socket of the vhost-user port to the DPDK application. The DPDK interface details are stored at `/dpdk/dpdk-interfaces.json` inside the application container for the DPDK application to consume. It is also exported into the pod as a pod annotation.

When you create a pod for use in the cloud-native router, the Kubernetes component known as **kubelet** calls the Multus CNI to set up pod networking and interfaces. Multus reads the annotations section of the **pod.yaml** file to refer the corresponding NAD. If a NAD points to `jcnr` as the CNI plug in, Multus calls the JCNR-CNI to set up the pod interface. JCNR-CNI creates the interface as specified in the NAD. JCNR-CNI then generates and pushes a configuration into cRPD.

Troubleshooting

Pods main fail to come up for various reasons:

- Image not found
- CNI failed to add interfaces
- CNI failed to push configuration into cRPD
- CNI failed to invoke vRouter REST APIs
- The NAD is invalid or undefined

The following commands will be useful to troubleshooting pod issues:

```
# Check the Pod status
kubectl get pods -A
```

```
# Check pod state and CNI logs
kubectl describe pod <pod-name>
```

```
# Check the pod logs
kubectl logs pod <pod-name>
```

```
# Check the net-attach-def
kubectl get net-attach-def <net-attach-def-name> -o yaml
```

```
# Check CNI logs
tail -f /var/log/jcnr/jcnr-cni.log
```

```
# Check the cRPD config added by CNI (on the cRPD CLI)
cli> show configuration groups cni
```

L2 Kernel Access-Mode Interface Configuration Example

SUMMARY

Read this topic to learn how to add a user pod with a `kernel/veth` access-mode interface to an instance of the cloud-native router.

IN THIS SECTION

Overview

You can configure a user pod with a Layer 2 access-mode `kernel` interface and attach it to the JCNR instance. The Juniper Cloud-Native Router must have an L2 interface configured at the time of deployment. Your high-level tasks are:

- Define and apply a network attachment definition (NAD)—The NAD file defines the required configuration for Multus to invoke the JCNR-CNI and create a network to attach the pod interface to.
- Define and apply a pod YAML file to your cloud-native router cluster—The pod YAML contains the pod specifications and an annotation to the network created by the JCNR-CNI.

> **NOTE**: Please review the "JCNR Use-Cases and Configuration Overview " on page 60 topic for more information on NAD and pod YAML files.

Configuration Example

1. Here is an example NAD to create a Layer 2 `kernel/veth` access-mode interface with static IPAM:

```
apiVersion: "k8s.cni.cncf.io/v1"
kind: NetworkAttachmentDefinition
metadata:
  name: vswitch-pod1-bd100
spec:
  config: '{
    "cniVersion":"0.4.0",
    "name": "vswitch-pod1-bd100",
    "plugins": [
      {
        "type": "jcnr",
        "args": {
          "instanceName": "vswitch",
```

```
          "instanceType": "virtual-switch",
       "interfaceType": "veth",
          "bridgeDomain": "bd100",
          "bridgeVlanId": "100"
        },
        "ipam": {
          "type": "static",
          "addresses":[
            {
              "address":"99.61.0.2/16",
              "gateway":"99.61.0.1"
            },
            {
              "address":"1234::99.61.0.2/120",
              "gateway":"1234::99.61.0.1"
            }
          ]
        },
        "kubeConfig":"/etc/kubernetes/kubelet.conf"
      }
    ]
  }'
```

The NAD defines a bridge domain `bd100` under which a `veth` type pod interface should be attached in the `virtual-switch` instance.

It also defines a static IP address to be assigned to the pod interface.

2. Apply the NAD manifest to create the network.

```
kubectl apply -f nad-access_mode.yaml
networkattachmentdefinition.k8s.cni.cncf.io/vswitch-pod1-bd100 created
```

3. Verify the NAD is created.

```
[root@jcnr-01]# kubectl get net-attach-def
NAME                 AGE
vswitch-pod1-bd100   59s
```

4. Here is an example yaml to create a pod attached to the `vswitch-pod1-bd100` network:

```
apiVersion: v1
kind: Pod
metadata:
  name:   pod1
  annotations:
    k8s.v1.cni.cncf.io/networks: vswitch-pod1-bd100
spec:
  containers:
    - name: pod1
      image: ubuntu:latest
      imagePullPolicy: IfNotPresent
      securityContext:
        privileged: false
      env:
        - name: KUBERNETES_POD_UID
          valueFrom:
            fieldRef:
               fieldPath: metadata.uid
      volumeMounts:
        - name: dpdk
          mountPath: /dpdk
          subPathExpr: $(KUBERNETES_POD_UID)
  volumes:
    - name: dpdk
      hostPath:
        path: /var/run/jcnr/containers
```

The pod attaches to the router instance using the `k8s.v1.cni.cncf.io/networks` annotation

.

5. Apply the pod manifest.

```
[root@jcnr-01]# kubectl apply -f pod_access_mode.yaml
pod/pod1 created
```

6. Verify the pod is running.

```
[root@jcnr-01 ~]# kubectl get pods
NAME   READY   STATUS    RESTARTS   AGE
pod1   1/1     Running   0          2m38s
```

7. Describe the pod to verify a secondary interface is created and attached to the `vswitch-pod1-bd100` network. (The output is trimmed for brevity).

```
[root@jcnr-01 ~]# kubectl describe pod pod1
Name:         pod1
Namespace:    default
Priority:     0
Node:         jcnr-01/10.100.20.25
Start Time:   Mon, 26 Jun 2023 09:36:57 -0400
Labels:       <none>
Annotations:  cni.projectcalico.org/containerID:
5b92668a6d7580e587de951d660c99969ce98bc239502afab6f9d191653f1e9b
              cni.projectcalico.org/podIP: 10.233.91.79/32
              cni.projectcalico.org/podIPs: 10.233.91.79/32
              k8s.v1.cni.cncf.io/network-status:
                [{
                    "name": "k8s-pod-network",
                    "ips": [
                        "10.233.91.79"
                    ],
                    "default": true,
                    "dns": {}
                },{
                    "name": "default/vswitch-pod1-bd100",
                    "interface": "net1",
                    "ips": [
                        "99.61.0.2",
                        "1234::633d:2"
                    ],
                    "mac": "02:00:00:5D:74:76",
                    "dns": {}
                }]
...
```

8. Verify the vRouter has the corresponding interface created. "Access the vRouter CLI" on page 89 and issue the `vif --list` command.

```
vif0/2      Ethernet: jvknet1-7c557fe MTU: 9160
            Type:Virtual HWaddr:02:00:00:66:01:56
            DDP: OFF SwLB: ON
            Vrf:0 Flags:L2Vof QOS:-1 Ref:8
            RX port   packets:20 errors:0
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            Vlan Mode: Access  Vlan Id: 100  OVlan Id: 100
            RX packets:7  bytes:518 errors:13
            TX packets:31  bytes:2438 errors:0
            Drops:14
            TX port   packets:31 errors:0
```

Note that the interface type is `Virtual` and the Vlan mode is set to `access` with the Vlan ID set to `100`. The VRF is always 0 for L2 interfaces.

L2 virtio Trunk-Mode Interface Configuration Example

SUMMARY

Read this topic to learn how to add a user pod with a `virtio` trunk-mode interface to an instance of the cloud-native router.

IN THIS SECTION

Overview

You can configure a user pod with a Layer 2 trunk-mode virtio interface and attach it to the JCNR instance. The Juniper Cloud-Native Router must have an L2 interface configured at the time of deployment. Your high-level tasks are:

- Define and apply a network attachment definition (NAD)—The NAD file defines the required configuration for Multus to invoke the JCNR-CNI and create a network to attach the pod interface to.

- Define and apply a pod YAML file to your cloud-native router cluster—The pod YAML contains the pod specifications and an annotation to the network created by the JCNR-CNI.

> **NOTE:** Please review the "JCNR Use-Cases and Configuration Overview " on page 60 topic for more information on NAD and pod YAML files.

Configuration Example

1. Here is an example NAD to create a Layer 2 trunk-mode virtio interface interface with static IPAM:

```
apiVersion: "k8s.cni.cncf.io/v1"
kind: NetworkAttachmentDefinition
metadata:
  name: vswitch
spec:
  config: '{
    "cniVersion":"0.4.0",
    "name": "vswitch",
    "type": "jcnr",
    "args": {
      "instanceName": "vswitch",
      "instanceType": "virtual-switch",
      "vlanIdList":"201, 202, 203"
    },
    "ipam": {
        "type": "static",
        "capabilities":{"ips":true},
        "addresses":[
          {
            "address":"10.2.1.1/24",
            "gateway":"10.2.1.253"
          },
          {
            "address":"2001::10.2.1.1/120",
            "gateway":"2001::10.2.1.253"
          }
        ]
    },
```

```
    "kubeConfig":"/etc/kubernetes/kubelet.conf"
  }'
```

The NAD defines the VLAN IDs for the `virtual-switch` instance to which the pod's trunk interface will be attached.

2. Apply the NAD manifest to create the network.

```
kubectl apply -f nad_trunk_mode.yaml
networkattachmentdefinition.k8s.cni.cncf.io/vswitch created
```

3. Verify the NAD is created.

```
[root@jcnr-01]# kubectl get net-attach-def
NAME                 AGE
vswitch              57s
```

4. Here is an example yaml to create a pod attached to the `vswitch` network:

```
apiVersion: v1
kind: Pod
metadata:
  name:   pod1
  annotations:
    k8s.v1.cni.cncf.io/networks: vswitch
spec:
  containers:
    - name: pod1
      image: ubuntu:latest
      imagePullPolicy: IfNotPresent
      securityContext:
        privileged: false
      env:
        - name: KUBERNETES_POD_UID
          valueFrom:
            fieldRef:
               fieldPath: metadata.uid
      volumeMounts:
        - name: dpdk
          mountPath: /dpdk
```

```
          subPathExpr: $(KUBERNETES_POD_UID)
  volumes:
    - name: dpdk
      hostPath:
        path: /var/run/jcnr/containers
```

The pod attaches to the router instance using the `k8s.v1.cni.cncf.io/networks` annotation.

5. Apply the pod manifest.

```
[root@jcnr-01]# kubectl apply -f pod_trunk_mode.yaml
pod/pod1 created
```

6. Verify the pod is running.

```
[root@jcnr-01 ~]# kubectl get pods
NAME   READY   STATUS    RESTARTS   AGE
pod1   1/1     Running   0          38s
```

7. Describe the pod to verify a secondary interface is created and attached to the `vswitch` network. (The output is trimmed for brevity).

```
[root@jcnr-01 ~]# kubectl describe pod pod1
Name:         pod1
Namespace:    default
Priority:     0
Node:         jcnr-01/10.100.20.25
Start Time:   Mon, 26 Jun 2023 09:53:31 -0400
Labels:       <none>
Annotations:  cni.projectcalico.org/containerID:
ac6f0a26ebfe68adf3b020d0def96f09e6b2b5c6303f55c0dde277b1ce7f9d9f
              cni.projectcalico.org/podIP: 10.233.91.81/32
              cni.projectcalico.org/podIPs: 10.233.91.81/32
              jcnr.juniper.net/dpdk-interfaces:
                [
                    {
                        "name": "net1",
                        "vhost-adaptor-path": "/dpdk/vhost-net1.sock",
                        "vhost-adaptor-mode": "client",
                        "ipv4-address": "10.2.1.1/24",
```

```
                    "ipv6-address": "2001::a02:101/120",
                    "mac-address": "02:00:00:5B:C7:9F"
                }
            ]
          k8s.v1.cni.cncf.io/network-status:
            [{
                "name": "k8s-pod-network",
                "ips": [
                    "10.233.91.81"
                ],
                "default": true,
                "dns": {}
            },{
                "name": "default/vswitch",
                "interface": "net1",
                "ips": [
                    "10.2.1.1",
                    "2001::a02:101"
                ],
                "mac": "02:00:00:5B:C7:9F",
                "dns": {}
            }]
...
```

8. Verify the vRouter has the corresponding interface created. "Access the vRouter CLI" on page 89 and issue the `vif --list` command.

```
vif0/2      PMD: vhostnet1-57f38cc0-6555-4bc2-ac MTU: 9160
            Type:Virtual HWaddr:02:00:00:dc:c9:27
            DDP: OFF SwLB: ON
            Vrf:0 Flags:L2 QOS:-1 Ref:11
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            Vlan Mode: Trunk  Vlan: 201-203
            RX packets:0  bytes:0 errors:0
            TX packets:4  bytes:256 errors:0
            Drops:0
            TX port   packets:0 errors:4
```

Note that the interface type is `Virtual` and the Vlan mode is set to `trunk` with the Vlan ID set to `201-203`. The VRF is always 0 for L2 interfaces.

L2 VLAN Sub-Interface Configuration Example

SUMMARY

Read this topic to learn how to add a user pod with a Layer 2 VLAN sub-interface to an instance of the cloud-native router.

IN THIS SECTION

Overview

You can configure a user pod with a Layer 2 VLAN sub-interface and attach it to the JCNR instance. The Juniper Cloud-Native Router must have an L2 interface configured at the time of deployment. The cRPD must be configured with the valid VLAN configuration for the fabric interface. For example:

```
set interfaces eth1 unit 100 vlan-id 100
```

NOTE: Note that the unit number and the VLAN ID must match.

Your high-level tasks are:

- Define and apply a network attachment definition (NAD)—The NAD file defines the required configuration for Multus to invoke the JCNR-CNI and create a network to attach the pod interface to.
- Define and apply a pod YAML file to your cloud-native router cluster—The pod YAML contains the pod specifications and an annotation to the network created by the JCNR-CNI

NOTE: Please review the "JCNR Use-Cases and Configuration Overview " on page 60 topic for more information on NAD and pod YAML files.

Configuration Example

1. Here is an example NAD to create a Layer 2 VLAN sub-interface:

```
apiVersion: "k8s.cni.cncf.io/v1"
kind: NetworkAttachmentDefinition
metadata:
  name: vswitch-bd201-sub
spec:
  config: '{
    "cniVersion":"0.4.0",
    "name": "vswitch-bd201-sub",
    "capabilities":{"ips":true},
    "plugins": [
      {
        "type": "jcnr",
        "args": {
          "instanceName": "vswitch",
          "instanceType": "virtual-switch",
          "bridgeDomain": "bd201",
          "bridgeVlanId": "201",
          "parentInterface": "net1",
          "interface": "net1.201"
        },
        "ipam": {
          "type": "static",
          "capabilities":{"ips":true},
          "addresses":[
            {
              "address":"10.3.0.1/24",
              "gateway":"10.3.0.254"
            },
            {
              "address":"2001:db8:3003::10.3.0.1/120",
              "gateway":"2001:db8:3003::10.3.0.1"
            }
          ]
        },
        "kubeConfig":"/etc/kubernetes/kubelet.conf"
      }
```

```
    ]
  }'
```

The NAD defines a bridge domain `bd201` and a sub-interface `net1.201` with a parent interface `net1`. The pod will be attached in the `virtual-switch` instance.. It also defines a static IP address to be assigned to the pod interface.

2. Apply the NAD manifest to create the network.

```
kubectl apply -f nad_l2_vlan_subinterface.yaml
networkattachmentdefinition.k8s.cni.cncf.io/vswitch-bd201-sub created
```

3. Verify the NAD is created.

```
[root@jcnr-01]# kubectl get net-attach-def
NAME                 AGE
vswitch-bd201-sub    43s
```

4. Here is an example yaml to create a pod attached to the `vswitch-bd201-sub` network:

```
apiVersion: v1
kind: Pod
metadata:
  name:   pod1
  annotations:
    k8s.v1.cni.cncf.io/networks: "vswitch-bd201-sub"
spec:
  containers:
    - name: pod1
      image: ubuntu:latest
      imagePullPolicy: IfNotPresent
      securityContext:
        privileged: false
      resources:
        requests:
          memory: 2Gi
        limits:
          hugepages-1Gi: 2Gi
      env:
        - name: KUBERNETES_POD_UID
```

```
          valueFrom:
            fieldRef:
               fieldPath: metadata.uid
      volumeMounts:
        - name: dpdk
          mountPath: /dpdk
          subPathExpr: $(KUBERNETES_POD_UID)
        - mountPath: /dev/hugepages
          name: hugepage
  volumes:
    - name: dpdk
      hostPath:
        path: /var/run/jcnr/containers
    - name: hugepage
      emptyDir:
        medium: HugePages
```

The pod attaches to the router instance using the `k8s.v1.cni.cncf.io/networks` annotation.

5. Apply the pod manifest.

```
[root@jcnr-01]# kubectl apply -f pod_access_mode.yaml
pod/pod1 created
```

6. Verify the pod is running.

```
[root@jcnr-01 ~]# kubectl get pods
NAME   READY   STATUS    RESTARTS   AGE
pod1   1/1     Running   0          40s
```

7. Describe the pod to verify a secondary interface is created and attached to the `vswitch-bd201-sub` network. (The output is trimmed for brevity).

```
[root@jcnr-01 ~]# kubectl describe pod pod1
Name:         pod1
Namespace:    default
Priority:     0
Node:         jcnr-01/10.100.20.25
Start Time:   Mon, 26 Jun 2023 09:53:31 -0400
Labels:       <none>
```

```
Annotations:  cni.projectcalico.org/containerID:
58642dd26f85769e14d302153357e84e6900398532d1b82b50a845ac1ede051a
              cni.projectcalico.org/podIP:
              cni.projectcalico.org/podIPs:
              jcnr.juniper.net/dpdk-interfaces:
                [
                    {
                        "name": "net1",
                        "vhost-adaptor-path": "/dpdk/vhost-net1.sock",
                        "vhost-adaptor-mode": "client",
                        "ipv4-address": "10.3.0.1/24",
                        "ipv6-address": "2001:db8:3003::a03:1/120",
                        "mac-address": "02:00:00:84:DC:42",
                        "vlan-id": "201"
                    }
                ]
              k8s.v1.cni.cncf.io/network-status:
                [{
                    "name": "k8s-pod-network",
                    "ips": [
                        "10.233.91.97"
                    ],
                    "default": true,
                    "dns": {}
                },{
                    "name": "default/vswitch-bd201-sub",
                    "interface": "net1",
                    "ips": [
                        "10.3.0.1",
                        "2001:db8:3003::a03:1"
                    ],
                    "mac": "02:00:00:84:DC:42",
                    "dns": {}
                }]
...
```

8. Verify the vRouter has the corresponding interface created. "Access the vRouter CLI" on page 89 and issue the `vif --list` command.

```
vif0/2      PMD: vhostnet1-d5eee4ec-dd7c-4e MTU: 9160
            Type:Virtual HWaddr:02:00:00:84:dc:42
            DDP: OFF SwLB: ON
```

```
            Vrf:65535 Flags:L2 QOS:-1 Ref:14
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:0  bytes:0 errors:0
            TX packets:0  bytes:0 errors:0
            Drops:0
            TX port   packets:0 errors:293

vif0/3      Virtual: vhostnet1-d5eee4ec-dd7c-4e.201 Vlan(o/i)(,S): 201/201 Parent:vif0/2 MTU:
1514
            Type:Virtual(Vlan) HWaddr:02:00:00:84:dc:42
            DDP: OFF SwLB: ON
            Vrf:0 Flags:L2 QOS:-1 Ref:1
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:0  bytes:0 errors:0
            TX packets:208  bytes:17071 errors:0
            Drops:0
```

Note that the interface type is `Virtual` and the Vlan ID set to `201`. The parent interface is `vif0/2`. The VRF is always 0 for L2 sub-interfaces.

L3 VPN Interface Configuration Example

SUMMARY

Read this topic to learn how to add a user pod with a `virtio` and `kernel` interfaces attached to an L3 VPN instance on the cloud-native router.

IN THIS SECTION

Overview

You can configure a user pod with a `virtio` and `kernel` interfaces to an L3 VPN instance on the cloud-native router. The Juniper Cloud-Native Router must have an L3 interface configured at the time of deployment. Your high-level tasks are:

- Define and apply a network attachment definition (NAD)—The NAD file defines the required configuration for Multus to invoke the JCNR-CNI and create a network to attach the pod interface to.
- Define and apply a pod YAML file to your cloud-native router cluster—The pod YAML contains the pod specifications and an annotation to the network created by the JCNR-CNI.

> **NOTE**: Please review the "JCNR Use-Cases and Configuration Overview " on page 60 topic for more information on NAD and pod YAML files.

Configuration Example

1. Here is an example NAD to create a `virtio` interface attached to an L3 VPN instance:

```
apiVersion: "k8s.cni.cncf.io/v1"
kind: NetworkAttachmentDefinition
metadata:
  name: vrf100
spec:
  config: '{
    "cniVersion":"0.4.0",
    "name": "vrf100",
    "plugins": [
      {
        "type": "jcnr",
        "args": {
          "instanceName": "vrf100",
          "instanceType": "vrf",
          "vrfTarget":"100:1"
        },
        "ipam": {
          "type": "static",
          "addresses":[
            {
              "address":"99.61.0.2/16",
              "gateway":"99.61.0.1"
            },
            {
```

```
              "address":"1234::99.61.0.2/120",
              "gateway":"1234::99.61.0.1"
            }
          ]
        },
        "kubeConfig":"/etc/kubernetes/kubelet.conf"
      }
    ]
  }'
```

The NAD defines a virtual routing and forwarding (VRF) instance `vrf100` to which the pod's virtio interface will be attached. You must use the `vrf` instance type for Layer 3 VPN implementations. The NAD also defines a static IP address to be assigned to the pod interface.

2. Apply the NAD manifest to create the network.

```
kubectl apply -f nad_virtio_L3vpn.yaml
networkattachmentdefinition.k8s.cni.cncf.io/vrf100 created
```

3. Here is an example NAD to create a `kernel` interface attached to an L3VPN instance:

```
apiVersion: "k8s.cni.cncf.io/v1"
kind: NetworkAttachmentDefinition
metadata:
  name: vrf200
spec:
  config: '{
    "cniVersion":"0.4.0",
    "name": "vrf200",
    "plugins": [
      {
        "type": "jcnr",
        "args": {
          "instanceName": "vrf200",
          "instanceType": "vrf",
       "interfaceType": "veth",
          "vrfTarget":"200:1"
        },
        "ipam": {
          "type": "static",
          "addresses":[
```

```
            {
              "address":"99.62.0.2/16",
              "gateway":"99.62.0.1"
            },
            {
              "address":"1234::99.62.0.2/120",
              "gateway":"1234::99.62.0.1"
            }
          ]
        },
        "kubeConfig":"/etc/kubernetes/kubelet.conf"
      }
    ]
  }'
```

The NAD defines a virtual routing and forwarding (VRF) instance `vrf200` with a `veth` interface type to which the pod's kernel interface will be attached.

It also defines a static IP address to be assigned to the pod interface.

4. Apply the NAD manifest to create the network.

```
kubectl apply -f nad_kernel_L3vpn.yaml
networkattachmentdefinition.k8s.cni.cncf.io/vrf200 created
```

5. Verify the NADs are created.

```
[root@jcnr-01]# kubectl get net-attach-def
NAME                AGE
vrf100              8m40s
vrf200              55s
```

6. Here is an example yaml to create a pod attached to the `vrf100` and `vrf200` networks:

```
apiVersion: v1
kind: Pod
metadata:
  name:   pod1
  annotations:
    k8s.v1.cni.cncf.io/networks: vrf100, vrf200
spec:
```

```
  containers:
    - name: pod1
      image: ubuntu:latest
      imagePullPolicy: IfNotPresent
      securityContext:
        privileged: false
      env:
        - name: KUBERNETES_POD_UID
          valueFrom:
            fieldRef:
               fieldPath: metadata.uid
      volumeMounts:
        - name: dpdk
          mountPath: /dpdk
          subPathExpr: $(KUBERNETES_POD_UID)
  volumes:
    - name: dpdk
      hostPath:
        path: /var/run/jcnr/containers
```

The pod attaches to the router instance using the `k8s.v1.cni.cncf.io/networks` annotation

.

7. Apply the pod manifest.

```
[root@jcnr-01]# kubectl apply -f pod_access_mode.yaml
pod/pod1 created
```

8. Verify the pod is running.

```
[root@jcnr-01 ~]# kubectl get pods
NAME   READY   STATUS    RESTARTS   AGE
pod1   1/1     Running   0          2m38s
```

9. Describe the pod to verify two secondary interface are created and attached to the `vrf100` and `vrf200` networks. (The output is trimmed for brevity).

```
[root@jcnr-01 ~]# kubectl describe pod pod1
Name:         pod1
Namespace:    default
```

```
Priority:     0
Node:         jcnr-01/10.100.20.25
Start Time:   Mon, 26 Jun 2023 09:53:31 -0400
Labels:       <none>
Annotations:  cni.projectcalico.org/containerID:
6705c204abca5aeaa0241c1791ea911d57bd972336d969ac5d6a482c96348d95
              cni.projectcalico.org/podIP: 10.233.91.100/32
              cni.projectcalico.org/podIPs: 10.233.91.100/32
              jcnr.juniper.net/dpdk-interfaces:
                [
                    {
                        "name": "net1",
                        "vhost-adaptor-path": "/dpdk/vhost-net1.sock",
                        "vhost-adaptor-mode": "client",
                        "ipv4-address": "99.61.0.2/16",
                        "ipv6-address": "1234::633d:2/120",
                        "mac-address": "02:00:00:A9:B3:23"
                    }
                ]
              k8s.v1.cni.cncf.io/network-status:
                [{
                    "name": "k8s-pod-network",
                    "ips": [
                        "10.233.91.100"
                    ],
                    "default": true,
                    "dns": {}
                },{
                    "name": "default/vrf100",
                    "interface": "net1",
                    "ips": [
                        "99.61.0.2",
                        "1234::633d:2"
                    ],
                    "mac": "02:00:00:A9:B3:23",
                    "dns": {}
                },{
                    "name": "default/vrf200",
                    "interface": "net2",
                    "ips": [
                        "99.62.0.2",
                        "1234::633e:2"
                    ],
```

```
                    "mac": "02:00:00:E0:AC:59",
                    "dns": {}
                }]
...
```

10. Verify the vRouter has the corresponding interface created. "Access the vRouter CLI" on page 89 and issue the `vif --list` command.

```
vif0/5      PMD: vhostnet1-2464783d-1ddd-4bf5-b7 NH: 16 MTU: 9160
            Type:Virtual HWaddr:00:00:5e:00:01:00 IPaddr:99.61.0.2
            IP6addr:1234::633d:2
            DDP: OFF SwLB: ON
            Vrf:1 Mcast Vrf:1 Flags:PL3DProxyEr QOS:-1 Ref:14
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:0  bytes:0 errors:0
            TX packets:0  bytes:0 errors:0
            Drops:0

vif0/6      Ethernet: jvknet2-2464783 NH: 19 MTU: 9160
            Type:Virtual HWaddr:00:00:5e:00:01:00 IPaddr:99.62.0.2
            IP6addr:1234::633e:2
            DDP: OFF SwLB: ON
            Vrf:2 Mcast Vrf:2 Flags:PL3DVofProxyEr QOS:-1 Ref:11
            RX port   packets:28 errors:0
            RX queue errors to lcore 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
            RX packets:28  bytes:13612 errors:0
            TX packets:0  bytes:0 errors:0
            Drops:28
```

Note that the interface type is `Virtual` and the type of interface is L3. You can see the IP addresses assigned to the interfaces for the corresponding valid VRF numbers.

6
CHAPTER

Appendix

Access cRPD CLI

You can access the command-line interface (CLI) of the cloud-native router controller by accessing the shell of the running cRPD container.

NOTE: The commands below are provided as an example. The cRPD pod name must be replaced from your environment. The command outputs may differ based on your environment.

View the running pods in the cluster:

```
kubectl get pods -A
NAMESPACE         NAME                                    READY   STATUS      RESTARTS
AGE
contrail-deploy   contrail-k8s-deployer-7b5dd699b9-nd7xf   1/1     Running     0
41m
contrail          contrail-vrouter-masters-dfxgm          3/3     Running     0
41m
jcnr              kube-crpd-worker-ds-8tnf7               1/1     Running     0
41m
jcnr              syslog-ng-54749b7b77-v24hq              1/1     Running     0
41m
kube-system       calico-kube-controllers-57b9767bdb-5wbj6   1/1     Running     2 (92d ago)
129d
kube-system       calico-node-j4m5b                       1/1     Running     2 (92d ago)
129d
kube-system       coredns-8474476ff8-fpw78                1/1     Running     2 (92d ago)
129d
kube-system       dns-autoscaler-7f76f4dd6-q5vdp          1/1     Running     2 (92d ago)
129d
kube-system       kube-apiserver-5a5s5-node2              1/1     Running     3 (92d ago)
129d
kube-system       kube-controller-manager-5a5s5-node2     1/1     Running     4 (92d ago)
129d
kube-system       kube-multus-ds-amd64-4zm5k              1/1     Running     2 (92d ago)
129d
kube-system       kube-proxy-l6xm8                        1/1     Running     2 (92d ago)
129d
kube-system       kube-scheduler-5a5s5-node2              1/1     Running     4 (92d ago)
129d
```

```
kube-system       nodelocaldns-6kwg5                          1/1     Running     2 (92d ago)
129d
```

Copy the name of the cRPD pod—`kube-crpd-worker-ds-8tnf7` in this example output . You will use the pod name to connect to the running container's shell.

Connect to the cRPD CLI

Issue the `kubectl exec` command to access the running container's shell:

```
kubectl exec -n <namespace> -it <pod name> --container <container name> -- bash
```

where *<namespace>* identifies the namespace in which the pod is running, *<pod name>* specificies the name of the pod and the *<container name>* specifies the name of the container (to be specified if the pod has more than one container).

The cRPD pod has only one running container. Here is an example command:

```
Defaulted container "kube-crpd-worker" out of: kube-crpd-worker, jcnr-crpd-config (init),
install-cni (init)

===>
           Containerized Routing Protocols Daemon (CRPD)
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                                                                    <===
root@jcnr-01:/#
```

At this point, you have connected to the shell of the cRPD. Just as with other Junos-based shells, you access the operational mode of the cloud-native router the same way as if you were connected to the console of a physical Junos OS device.

```
root@jcnr-01:/# cli
root@jcnr-cni>
```

Access vRouter CLI

You can access the command-line interface (CLI) of the vRouter by accessing the shell of the running vRouter-agent container.

NOTE: The commands below are provided as an example. The vRouter pod name must be replaced from your environment. The command outputs may differ based on your environment.

List the running pods on the K8s Cluster:

```
kubectl get pods -A
NAMESPACE         NAME                                       READY   STATUS      RESTARTS
AGE
contrail-deploy   contrail-k8s-deployer-7b5dd699b9-nd7xf      1/1     Running     0
41m
contrail          contrail-vrouter-masters-dfxgm             3/3     Running     0
41m
jcnr              kube-crpd-worker-ds-8tnf7                  1/1     Running     0
41m
jcnr              syslog-ng-54749b7b77-v24hq                 1/1     Running     0
41m
kube-system       calico-kube-controllers-57b9767bdb-5wbj6   1/1     Running     2 (92d ago)
129d
kube-system       calico-node-j4m5b                          1/1     Running     2 (92d ago)
129d
kube-system       coredns-8474476ff8-fpw78                   1/1     Running     2 (92d ago)
129d
kube-system       dns-autoscaler-7f76f4dd6-q5vdp             1/1     Running     2 (92d ago)
129d
kube-system       kube-apiserver-5a5s5-node2                 1/1     Running     3 (92d ago)
129d
kube-system       kube-controller-manager-5a5s5-node2        1/1     Running     4 (92d ago)
129d
kube-system       kube-multus-ds-amd64-4zm5k                 1/1     Running     2 (92d ago)
129d
kube-system       kube-proxy-l6xm8                           1/1     Running     2 (92d ago)
129d
kube-system       kube-scheduler-5a5s5-node2                 1/1     Running     4 (92d ago)
129d
kube-system       nodelocaldns-6kwg5                         1/1     Running     2 (92d ago)
129d
```

Copy the name of the vRouter pod—`contrail-vrouter-masters-dfxgm` in this example output . You will use the pod name to connect to the running container's shell.

Issue the `kubectl exec` command to access the running container's shell:

```
kubectl exec -n <namespace> -it <pod name> --container <container name> -- bash
```

where *<namespace>* identifies the namespace in which the pod is running, *<pod name>* specificies the name of the pod and the *<container name>* specifies the name of the container (to be specified if the pod has more than one container).

The vRouter pod has three containers. When the container name is not specified, the command will default to the vrouter-agent container shell. Here is an example:

```
[root@jcnr-01]# kubectl exec -n contrail -it contrail-vrouter-masters-dfxgm -- bash
Defaulted container "contrail-vrouter-agent" out of: contrail-vrouter-agent, contrail-vrouter-
agent-dpdk,
contrail-vrouter-telemetry-exporter, contrail-init (init), contrail-vrouter-kernel-init-dpdk
(init)
[root@jcnr-01 /]#
```

At this point, you have connected to the vRouter's CLI.

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