# Overview

This chapter contains the following sections:

## Licensing Requirements

For a complete explanation of Cisco NX-OS licensing recommendations and how to obtain and apply licenses, see the *Cisco NX-OS Licensing Guide* and the *Cisco NX-OS Licensing Options Guide*.

## Supported Platforms

Starting with Cisco NX-OS release 7.0(3)I7(1), use the Nexus Switch Platform Support Matrix to know from which Cisco NX-OS releases various Cisco Nexus 9000 and 3000 switches support a selected feature.

## VXLAN Overview

Virtual Extensible LAN (VXLAN) provides a way to extend Layer 2 networks across a Layer 3 infrastructure using MAC-in-UDP encapsulation and tunneling. This feature enables virtualized and multitenant data center fabric designs over a shared common physical infrastructure.

VXLAN has the following benefits:

- Flexible placement of workloads across the data center fabric.

It provides a way to extend Layer 2 segments over the underlying shared Layer 3 network infrastructure so that tenant workloads can be placed across physical pods in a single data center. Or even across several geographically divers data centers.

- Higher scalability to allow more Layer 2 segments.

  VXLAN uses a 24-bit segment ID, the VXLAN network identifier (VNID). This allows a maximum of 16 million VXLAN segments to coexist in the same administrative domain. In comparison, traditional VLANs use a 12-bit segment ID that can support a maximum of 4096 VLANs.

- Optimized utilization of available network paths in the underlying infrastructure.

  VXLAN packets are transferred through the underlying network based on their Layer 3 headers. They use equal-cost multipath (ECMP) routing and link aggregation protocols to use all available paths. In contrast, a Layer 2 network might block valid forwarding paths in order to avoid loops.

# Cisco Nexus 9000 as Hardware-Based VXLAN Gateway

A Cisco Nexus 9000 Series switch can function as a hardware-based VXLAN gateway. It seamlessly connects VXLAN and VLAN segments as one forwarding domain across the Layer 3 boundary without sacrificing forwarding performance. The Cisco Nexus 9000 Series hardware-based VXLAN encapsulation and de-encapsulation provide line-rate performance for all frame sizes.

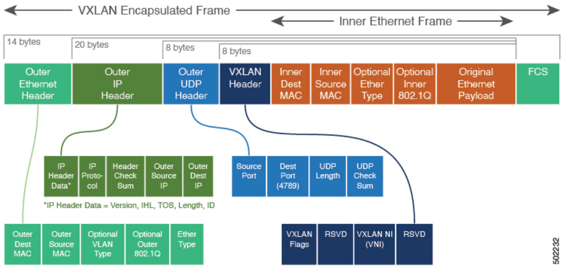
# VXLAN Encapsulation and Packet Format

VXLAN is a Layer 2 overlay scheme over a Layer 3 network. It uses a MAC Address-in-User Datagram Protocol (MAC-in-UDP) encapsulation to provide a means to extend Layer 2 segments across the data center network. VXLAN is a solution to support a flexible, large-scale multitenant environment over a shared common physical infrastructure. The transport protocol over the physical data center network is IP plus UDP.

VXLAN defines a MAC-in-UDP encapsulation scheme where the original Layer 2 frame has a VXLAN header added and is then placed in a UDP-IP packet. With this MAC-in-UDP encapsulation, VXLAN tunnels Layer 2 network over Layer 3 network.

VXLAN uses an 8-byte VXLAN header that consists of a 24-bit VNID and a few reserved bits. The VXLAN header, together with the original Ethernet frame, go inside the UDP payload. The 24-bit VNID is used to identify Layer 2 segments and to maintain Layer 2 isolation between the segments. With all 24 bits in the VNID, VXLAN can support 16 million LAN segments.

***Figure 1:***



# VXLAN Tunnel

A VXLAN encapsulated communication between two devices where they encapsulate and decapsulate an inner Ethernet frame, is called a VXLAN tunnel. VXLAN tunnels are stateless since they are UDP encapsulated.

# VXLAN Tunnel Endpoint

VXLAN tunnel endpoints (VTEPs) are devices that terminate VXLAN tunnels. They perform VXLAN encapsulation and de-encapsulation. Each VTEP has two interfaces. One is a Layer 2 interface on the local LAN segment to support a local endpoint communication through bridging. The other is a Layer 3 interface on the IP transport network.

The IP interface has a unique address that identifies the VTEP device in the transport network. The VTEP device uses this IP address to encapsulate Ethernet frames and transmit the packets on the transport network. A VTEP discovers other VTEP devices that share the same VNIs it has locally connected. It advertises the locally connected MAC addresses to its peers. It also learns remote MAC Address-to-VTEP mappings through its IP interface.

# Underlay Network

The VXLAN segments are independent of the underlying physical network topology. Conversely, the underlying IP network, often referred to as the underlay network, is independent of the VXLAN overlay. The underlay network forwards the VXLAN encapsulated packets based on the outer IP address header. The outer IP address header has the initiating VTEP's IP interface as the source IP address and the terminating VTEP's IP interface as the destination IP address.

The primary purpose of the underlay in the VXLAN fabric is to advertise the reachability of the Virtual Tunnel Endpoints (VTEPs). The underlay also provides a fast and reliable transport for the VXLAN traffic.

# Overlay Network

In broadcast terms, an overlay is a virtual network that is built on top of an underlay network infrastructure. In a VXLAN fabric, the overlay network is built of a control plane and the VXLAN tunnels. The control plane is used to advertise MAC address reachability. The VXLAN tunnels transport the Ethernet frames between the VTEPs.

# Distributed Anycast Gateway

Distributed Anycast Gateway refers to the use of default gateway addressing that uses the same IP and MAC address across all the leafs that are a part of a VNI. This ensures that every leaf can function as the default gateway for the workloads directly connected to it. The distributed Anycast Gateway functionality is used to facilitate flexible workload placement, and optimal traffic forwarding across the VXLAN fabric.

# Control Plane

There are two widely adopted control planes that are used with VXLAN:

### Flood and Learn Multicast-Based Learning Control Plane

Cisco Nexus 9000 Series switches support the flood and learn multicast-based control plane method.

- When configuring VXLAN with a multicast based control plane, every VTEP configured with a specific VXLAN VNI joins the same multicast group. Each VNI could have its own multicast group, or several VNIs can share the same group.
- The multicast group is used to forward broadcast, unknown unicast, and multicast (BUM) traffic for a VNI.
- The multicast configuration must support Any-Source Multicast (ASM) or PIM BiDir.
- Initially, the VTEPs only learn the MAC addresses of devices that are directly connected to them.
- Remote MAC address to VTEP mappings are learned via conversational learning.

### VXLAN MPBGP EVPN Control Plane

A Cisco Nexus 9000 Series switch can be configured to provide a Multiprotocol Border Gateway Protocol (MPBGP) ethernet VPN (EVPN) control plane. The control plane uses a distributed Anycast Gateway with Layer 2 and Layer 3 VXLAN overlay networks.

For a data center network, an MPBGP EVPN control plane provides:

- Flexible workload placement that is not restricted with physical topology of the data center network.
    - Place virtual machines anywhere in the data center fabric.
- Optimal East-West traffic between servers within and across data centers
    - East-West traffic between servers, or virtual machines, is achieved by most specific routing at the first hop router. First hop routing is done at the access layer. Host routes must be exchanged to ensure most specific routing to and from servers or hosts. Virtual machine (VM) mobility is supported by detecting new endpoint attachment when a new MAC address/IP address is seen directly connected to the local switch. When the local switch sees the new MAC/IP, it signals the new location to rest of the network.
- Eliminate or reduce flooding in the data center.
    - Flooding is reduced by distributing MAC reachability information via MP-BGP EVPN to optimize flooding relating to L2 unknown unicast traffic. Optimization of reducing broadcasts associated with ARP/IPv6 Neighbor solicitation is achieved by distributing the necessary information via MPBGP EVPN. The information is then cached at the access switches. Address solicitation requests can be responded locally without sending a broadcast to the rest of the fabric.
- A standards-based control plane that can be deployed independent of a specific fabric controller.
    - The MPBGP EVPN control plane approach provides:

        - IP reachability information for the tunnel endpoints associated with a segment and the hosts behind a specific tunnel endpoint.
        - Distribution of host MAC reachability to reduce/eliminate unknown unicast flooding.
        - Distribution of host IP/MAC bindings to provide local ARP suppression.
        - Host mobility.
        - A single address family (MPBGP EVPN) to distribute both L2 and L3 route reachability information.

- Segmentation of Layer 2 and Layer 3 traffic
    - Traffic segmentation is achieved with using VXLAN encapsulation, where VNI acts as segment identifier.