



Configuring Secure VXLAN EVPN Multi-Site Using CloudSec

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About Secure VXLAN EVPN Multi-Site Using CloudSec

Secure VXLAN EVPN Multi-Site using CloudSec ensures data security and data integrity for VXLAN-based Multi-Site fabrics. Using the cryptographic machinery of IEEE MACsec for UDP packets, this feature provides a secure tunnel between authorized VXLAN EVPN endpoints.

The CloudSec session is point to point over DCI between border gateways (BGWs) on two different sites. All communication between sites uses Multi-Site PIP instead of VIP. For migration information, see [Migrating from Multi-Site with VIP to Multi-Site with PIP, on page 21](#).

Secure VXLAN EVPN Multi-Site using CloudSec is enabled on a per-peer basis. Peers that do not support CloudSec can operate with peers that do support CloudSec, but the traffic is unencrypted. We recommend allowing unencrypted traffic only during migration from non-CloudSec-enabled sites to CloudSec-enabled sites.

CloudSec key exchange uses BGP while MACsec uses the MACsec Key Agreement (MKA). The CloudSec control plane uses the BGP IPv4 address family to exchange the key information. CloudSec keys are carried as part of Tunnel Encapsulation (tunnel type 18) attribute with BGP IPv4 routes using underlay BGP session.

Key Lifetime and Hitless Key Rollover

A CloudSec keychain can have multiple pre-shared keys (PSKs), each configured with a key ID and an optional lifetime. Pre-shared keys are seed keys used to derive further keys for traffic encryption and integrity validation. A list of pre-shared keys can be configured in a keychain with different lifetimes.

A key lifetime specifies when the key expires. CloudSec rolls over to the next configured pre-shared key in the keychain after the lifetime expires. The time zone of the key can be local or UTC. The default time zone is UTC. In the absence of a lifetime configuration, the default lifetime is unlimited.

To configure the CloudSec keychain, see [Configuring a CloudSec Keychain and Keys, on page 7](#).

When the lifetime of the first key expires, it automatically rolls over to the next key in the list. If the same key is configured on both sides of the link at the same time, the key rollover is hitless. That is, the key rolls over without traffic interruption. The lifetime of the keys must be overlapped in order to achieve hitless key rollover.

Certificate Expiration and Replacement

Certificates are used for exchanging Master Session Keys. When certificates expire, no further MSK rekeys will happen. The current secured sessions will continue to stay up and SAK rekeys will happen as configured. The certificate will have to be deleted from under the trustpoint and a new certificate needs to be imported for further MSK rekeys to occur.

Guidelines and Limitations for Secure VXLAN EVPN Multi-Site Using CloudSec

Secure VXLAN EVPN Multi-Site using CloudSec has the following guidelines and limitations:

- Beginning with Cisco NX-OS Release 10.2(2)F, vPC Border Gateway is supported on Cisco Nexus 9300-FX2, -FX3 switches.
- Secure VXLAN EVPN Multi-Site using CloudSec is supported on Cisco Nexus 9300-FX2 platform switches beginning with Cisco NX-OS Release 9.3(5).
- Secure VXLAN EVPN Multi-Site using CloudSec (VXLAN Tunnel Encryption feature) is supported on Cisco Nexus 9300-FX3 platform switches from Cisco NX-OS Release 10.1(1) onwards.
- L3 interfaces and L3 port channels are supported as DCI links.
- CloudSec traffic that is destined for the switch must enter the switch through the DCI uplinks.
- Secure VXLAN EVPN Multi-Site using CloudSec is supported for sites that are connected through a route server or sites that are connected using full mesh (without a route server). For sites that are connected through a route server, upgrade the server to Cisco NX-OS Release 9.3(5) or a later release and follow the instructions in [Enabling CloudSec VXLAN EVPN Tunnel Encryption, on page 4](#).
- VXLAN Tunnel Encryption feature is not supported on Cisco Nexus 9348GC-FX3, 9348GC-FX3PH, and 9332D-H2R, 93400LD-H1, 9364C-H1 switches.
- ICV is disabled by default in Cisco NX-OS Release 9.3(7). ICV should be disabled on the node when forming cloudsec tunnel sessions with node from the previous release (Cisco NX-OS Release 9.3(6)).

- Beginning with Cisco NX-OS Release 10.3.3, VXLAN Tunnel Encryption feature can be configured using Pre Shared Keys (PSK) or certificates using the Public Key Infrastructure(PKI).
- All of the BGWs on the same site should be configured for Secure VXLAN EVPN Multi-Site using CloudSec.
- Secure VXLAN EVPN Multi-Site using CloudSec on DCI links and MACsec on the internal fabric can coexist. However, they can't be enabled simultaneously on the same port or port group (MAC ID).
- Secure VXLAN EVPN Multi-Site using CloudSec peers must have the same keychain configuration in order to decrypt the secure traffic between them.
- A maximum of 60 peers are supported in the BGP IPv4 update of security key distribution in the Cisco Nexus 9300-FX2 family switches.
- Beginning with Cisco NX-OS Release 10.2(3), BGP IPv4 update of security key distribution is supported on Cisco Nexus 9300-FX3 platform switches.
- In order to keep a session alive when all keys with an active timer expire, configure no more than one key per keychain without a lifetime. As a best practice, we recommend configuring a lifetime for each key.
- CloudSec keys are exchanged between BGWs using Tunnel Encapsulation attribute with BGP IPv4 routes using underlay BGP session.
If this attribute do not get propagated by intermediate nodes, you have to configure direct BGP IPv4 unicast session between the CloudSec end point nodes i.e., BGWs.

- Direct eBGP peering must be established between BGWs in each site if:
 - BGP is used as the IPv4 unicast routing protocol, but the Tunnel Encryption attribute is not propagated through DCI.
 - A routing protocol other than BGP is used for IPv4 unicast routing in the DCI (e.g., OSPF).
- eBGP peering is to be established over a Loopback interface that is different from the following interface:
 - The tunnel-encryption source-interface
 - The nve source-interface
- eBGP peering must filter the loopback IP used as the source of the adjacency. For example, if Loopback10 is used to establish eBGP peering for CloudSec, the IP of Lo10 should not be advertised over this adjacency.
- Secure VXLAN EVPN Multi-Site using CloudSec doesn't support the following:
 - Directly connected L2 hosts on border gateways
 - IP unnumbered configurations on the DCI interface
 - Multicast underlay
 - OAM pathtrace
 - TRM
 - VIP-only model on border gateways

- VXLAN EVPN with downstream VNI
- If CloudSec is enabled, non-disruptive ISSU is not supported.
- Different certificate types (SUDI, 3rd party RSA, 3rd party ECC) cannot be mixed in Cloudsec PKI deployments. All nodes should have the same type of certificates
- Nodes with different RSA key sizes are compatible for encryption/decryption.
- PSK and PKI sessions cannot coexist in deployments.
- Size of certificates should not exceed 1.5KB (2048 bit key size).
- MCT-less VPC BGWs is not supported.
- Migration between different certificate types can be done by moving to should-secure, removing trustpoint config from all participating nodes and then, configuring the new trustpoint on all nodes.
- When Cloudsec is initially enabled with the **feature tunnel-encryption** command, the vPC peer-link port-channel and its physical member interfaces will flap.
- Feature **dci-advertise-pip** is not supported on Cisco Nexus 9700-FX/FX3 line cards, and 9500 Series switches with FM-E/FM-E2 fabric modules.

Configuring Secure VXLAN EVPN Multi-Site Using CloudSec

Follow these procedures to configure Secure VXLAN EVPN Multi-Site using CloudSec:

Enabling CloudSec VXLAN EVPN Tunnel Encryption

Follow these steps to enable CloudSec VXLAN EVPN Tunnel Encryption.

Before you begin

Configure BGP peers in the IPv4 unicast address family. Make sure that the IPv4 prefix is propagated with the tunnel community attribute that carries CloudSec keys.

Configure VXLAN EVPN Multi-Site and use the following commands to ensure that peer IP addresses are advertised for CloudSec VXLAN EVPN Tunnel Encryption:

```
evpn multisite border-gateway ms-id
dci-advertise-pip
```



Caution Configuring VXLAN EVPN Multi-Site without **dci-advertise-pip** reverts border gateways to VIP-only mode, which is not supported for CloudSec VXLAN EVPN Tunnel Encryption.

You have two options for sites that are connected through a route server:

- Keep dual RDs enabled – This default behavior ensures that the memory scale remains the same from previous releases in order to handle leaf devices with limited memory. All same-site BGWs use the same RD value for reoriginated routes while advertising EVPN routes to the remote BGW.

- Disable dual RDs – If you don't have memory limitations on leaf devices, you can configure the **no dual rd** command on the BGW. Different RD values are used for reoriginated routes on the same BGWs while advertising EVPN routes to the remote BGW.

Perform one of the following actions, depending on whether dual RDs are enabled on the BGW:

- If dual RDs are configured on the BGWs, follow these steps:

1. Apply BGP additional paths on the BGW.

```
router bgp as-num
  address-family l2vpn evpn
    maximum-paths number
  additional-paths send
  additional-paths receive
```

2. Configure multipath for each L3VNI VRF on the BGW.

```
vrf evpn-tenant-00001
  address-family ipv4 unicast
    maximum-paths 64
  address-family ipv6 unicast
    maximum-paths 64
```

3. Apply BGP additional paths on the route server.

```
router bgp as-num
  address-family l2vpn evpn
    retain route-target all
  additional-paths send
  additional-paths receive
  additional-paths selection route-map name

route-map name permit 10
  set path-selection all advertise
```

- If **no dual rd** is configured on the BGWs or full mesh is configured, follow these steps:

1. Configure the address family and maximum paths on the BGW.

```
router bgp as-num
  address-family l2vpn evpn
    maximum-paths number
```

2. Configure multipath for each L3VNI VRF on the BGW.

```
vrf evpn-tenant-00001
  address-family ipv4 unicast
    maximum-paths 64
  address-family ipv6 unicast
    maximum-paths 64
```



Note BGP additional paths are not required on the route server.

SUMMARY STEPS

1. **configure terminal**
2. **[no] feature tunnel-encryption**
3. **[no] tunnel-encryption source-interface loopback *number***
4. **tunnel-encryption icv**
5. (Optional) **copy running-config startup-config**

DETAILED STEPS**Procedure**

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	[no] feature tunnel-encryption Example: <pre>switch(config)# feature tunnel-encryption</pre>	Enables CloudSec VXLAN EVPN Tunnel Encryption.
Step 3	[no] tunnel-encryption source-interface loopback <i>number</i> Example: <pre>switch(config)# tunnel-encryption source-interface loopback 2</pre>	<p>Specifies the BGP loopback as the tunnel-encryption source interface. The IP address of the configured source interface is used as the prefix to announce CloudSec VXLAN EVPN Tunnel Encryption key routes.</p> <p>Note Enter the BGP loopback interface and not the NVE source interface.</p> <p>Note Any changes in the MTU should be done before the tunnel-encryption configuration on the interface. This will avoid the CRC drop errors.</p>
Step 4	tunnel-encryption icv Example: <pre>switch(config)# tunnel-encryption icv</pre>	Enables the Integrity Check Value (ICV). ICV provides integrity check for the frame arriving on the port. If the generated ICV is the same as the ICV in the frame, then the frame is accepted; otherwise it is dropped. This is supported from Cisco NX-OS Release 9.3(7) onwards.
Step 5	(Optional) copy running-config startup-config Example: <pre>switch(config)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

What to do next

After enabling CloudSec VXLAN EVPN tunnel encryption, you can follow any of the following procedure for authentication.

[Configuring a CloudSec Keychain and Keys.](#)

or

[Configuring CloudSec Certificate Based Authentication Using PKI, on page 8](#)

Configuring a CloudSec Keychain and Keys

You can create a CloudSec keychain and keys on the device.

Before you begin

Make sure that Secure VXLAN EVPN Multi-Site using CloudSec is enabled.

SUMMARY STEPS

1. **configure terminal**
2. **[no] key chain *name* tunnel-encryption**
3. **[no] key *key-id***
4. **[no] key-octet-string *octet-string* cryptographic-algorithm {AES_128_CMAC | AES_256_CMAC}**
5. **[no] send-lifetime *start-time* duration *duration***
6. (Optional) **show key chain *name***
7. (Optional) **copy running-config startup-config**

DETAILED STEPS**Procedure**

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	[no] key chain <i>name</i> tunnel-encryption Example: <pre>switch(config)# key chain kc1 tunnel-encryption switch(config-tunnelencryptkeychain)#</pre>	Creates a CloudSec keychain to hold a set of CloudSec keys and enters tunnel-encryption keychain configuration mode.
Step 3	[no] key <i>key-id</i> Example: <pre>switch(config-tunnelencryptkeychain)# key 2000 switch(config-tunnelencryptkeychain-tunnelencryptkey)#</pre>	Creates a CloudSec key and enters tunnel-encryption key configuration mode. The range is from 1 to 32 octets, and the maximum size is 64. Note The key must consist of an even number of characters.

	Command or Action	Purpose
Step 4	<p>[no] key-octet-string <i>octet-string</i> cryptographic-algorithm {AES_128_CMAC AES_256_CMAC}</p> <p>Example:</p> <pre>switch(config-tunnelencryptkeychain-tunnelencryptkey)# key-octet-string abcdef0123456789abcdef0123456789 abcdef0123456789abcdef0123456789 cryptographic-algorithm AES_256_CMAC</pre>	Configures the octet string for the key. The <i>octet-string</i> argument can contain up to 64 hexadecimal characters. The octet key is encoded internally, so the key in clear text does not appear in the output of the show running-config tunnel-encryption command.
Step 5	<p>[no] send-lifetime <i>start-time duration duration</i></p> <p>Example:</p> <pre>switch(config-tunnelencryptkeychain-tunnelencryptkey)# send-lifetime 00:00:00 May 06 2020 duration 100000</pre>	Configures a send lifetime for the key. By default, the device treats the start time as UTC. The <i>start-time</i> argument is the time of day and date that the key becomes active. The <i>duration</i> argument is the length of the lifetime in seconds. The range is from 1800 seconds to 2147483646 seconds (approximately 68 years).
Step 6	<p>(Optional) show key chain <i>name</i></p> <p>Example:</p> <pre>switch(config-tunnelencryptkeychain-tunnelencryptkey)# show key chain kcl</pre>	Displays the keychain configuration.
Step 7	<p>(Optional) copy running-config startup-config</p> <p>Example:</p> <pre>switch(config-tunnelencryptkeychain-tunnelencryptkey)# copy running-config startup-config</pre>	Copies the running configuration to the startup configuration.

What to do next

[Configuring a CloudSec Policy.](#)

Configuring CloudSec Certificate Based Authentication Using PKI

This chapter contains the following sections:

Attaching a Certificate to CloudSec

You may associate the Cisco NX-OS device with a trust point CA. Cisco NX-OS supports RSA algorithm and ECC (224 and 521 bit) algorithm certificates. Follow the below steps to associate trustpoint or Secure Unique Device Identifier (SUDI) to cloudsec. User need to execute any one of the following commands.

Before you begin

See [Configuring PKI](#) to know how to configure a trustpoint and install or import a valid certificate.

SUMMARY STEPS

1. **tunnel-encryption pki trustpoint** *name*
2. **tunnel-encryption pki sudi** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	tunnel-encryption pki trustpoint <i>name</i> Example: <pre>switch# tunnel-encryption pki trustpoint myCA_2K switch(config)#</pre>	Associate trustpoint to cloud security. Or execute the command in Step 2. Dynamic change of trustpoint labels cannot be done because it will disrupt data traffic.
Step 2	tunnel-encryption pki sudi <i>name</i> Example: <pre>switch(config)# tunnel-encryption pki sudi switch(config-trustpoint)#</pre>	Associate SUDI to cloud security. Note Cisco devices have a unique identifier known as the Secure Unique Device Identifier (SUDI) Certificate. This hardware Certificate may be leveraged in lieu of Step 1.

Separate Loopback

Execute any one of the following steps to configure PKI loopback.

SUMMARY STEPS

1. **tunnel-encryption pki source-interface *loopback***
2. **tunnel-encryption pki source-interface cloudsec-loopback**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	tunnel-encryption pki source-interface <i>loopback</i> Example: <pre>switch# tunnel-encryption pki source-interface loopback0 switch(config)#</pre>	Configures a separate loopback. Or execute the command in Step 2.
Step 2	tunnel-encryption pki source-interface cloudsec-loopback Example: <pre>switch(config)# tunnel-encryption pki source-interface cloudsec-loopback</pre>	Uses the same loopback as cloudsec source interface loopback.

Configuring a CloudSec Policy

You can create multiple CloudSec policies with different parameters. However, only one policy can be active on an interface.

Before you begin

Make sure that Secure VXLAN EVPN Multi-Site using CloudSec is enabled.

SUMMARY STEPS

1. **configure terminal**
2. (Optional) **[no] tunnel-encryption must-secure-policy**
3. **[no] tunnel-encryption policy name**
4. (Optional) **[no] cipher-suite name**
5. (Optional) **[no] window-size number**
6. (Optional) **[no] sak-rekey-time time**
7. (Optional) **show tunnel-encryption policy**
8. (Optional) **copy running-config startup-config**

DETAILED STEPS**Procedure**

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	(Optional) [no] tunnel-encryption must-secure-policy Example: <pre>switch(config)# tunnel-encryption must-secure-policy</pre>	Ensures that no unencrypted packets are sent over the wire for the session. Packets that are not carrying CloudSec headers are dropped. The no form of this command allows unencrypted traffic. We recommend allowing unencrypted traffic only during migration from non-CloudSec-enabled sites to CloudSec-enabled sites. By default, Secure VXLAN EVPN Multi-Site using CloudSec operates in "should secure" mode.
Step 3	[no] tunnel-encryption policy name Example: <pre>switch(config)# tunnel-encryption policy p1 switch(config-tunenc-policy)#</pre>	Creates a CloudSec policy.
Step 4	(Optional) [no] cipher-suite name Example: <pre>switch(config-tunenc-policy)# cipher-suite GCM-AES-XPB-256</pre>	Configures one of the following ciphers: GCM-AES-XPB-128 or GCM-AES-XPB-256. The default value is GCM-AES-XPB-256.
Step 5	(Optional) [no] window-size number Example: <pre>switch(config-tunenc-policy)# window-size 134217728</pre>	Configures the replay protection window such that the interface will not accept any packet that is less than the configured window size. The range is from 134217728 to 1073741823 IP packets. The default value is 268435456.

	Command or Action	Purpose
Step 6	(Optional) <code>[no] sak-rekey-time time</code> Example: <code>switch(config-tunenc-policy)# sak-rekey-time 1800</code>	Configures the time in seconds to force an SAK rekey. This command can be used to change the session key to a predictable time interval. The range is from 1800 to 2592000 seconds. There is not a default value. We recommend using the same rekey value for all the peers.
Step 7	(Optional) <code>show tunnel-encryption policy</code> Example: <code>switch(config-tunenc-policy)# show tunnel-encryption policy</code>	Displays the CloudSec policy configuration.
Step 8	(Optional) <code>copy running-config startup-config</code> Example: <code>switch(config-tunenc-policy)# copy running-config startup-config</code>	Copies the running configuration to the startup configuration.

What to do next

[Configuring CloudSec Peers.](#)

Configuring CloudSec Peers

This chapter contains the following sections.

Configuring CloudSec Peers

You can configure the CloudSec peers.

Before you begin

Enable Secure VXLAN EVPN Multi-Site using CloudSec.

SUMMARY STEPS

1. `configure terminal`
2. `[no] tunnel-encryption peer-ip peer-ip-address`
3. `[no] keychain name policy name`
4. `pki policy policy name`

DETAILED STEPS**Procedure**

	Command or Action	Purpose
Step 1	<code>configure terminal</code> Example:	Enters global configuration mode.

	Command or Action	Purpose
	switch# configure terminal switch(config)#	
Step 2	[no] tunnel-encryption peer-ip <i>peer-ip-address</i> Example: switch(config)# tunnel-encryption peer-ip 33.1.33.33	Specifies the IP address of the NVE source interface on the peer.
Step 3	[no] keychain <i>name</i> policy <i>name</i> Example: switch(config)# keychain kcl policy p1	Attaches a policy to a CloudSec peer. Step 4 is an alternative to this step.
Step 4	pki policy <i>policy name</i> Example: switch(config)# pki policy p1	Attaching cloudsec policy to peer with PKI.

What to do next

[Enabling Secure VXLAN EVPN Multi-Site Using CloudSec on DCI Uplinks.](#)

Enabling Secure VXLAN EVPN Multi-Site Using CloudSec on DCI Uplinks

Follow these steps to enable Secure VXLAN EVPN Multi-Site using CloudSec on all DCI uplinks.



Note This configuration cannot be applied on Layer 2 ports.



Note When CloudSec is applied or removed from an operational DCI uplink, the link will flap. The flap may not be instantaneous as the link may remain down for several seconds.

Before you begin

Make sure that Secure VXLAN EVPN Multi-Site using CloudSec is enabled.

SUMMARY STEPS

1. **configure terminal**
2. [no] **interface ethernet** *port/slot*
3. [no] **tunnel-encryption**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	configure terminal Example: <pre>switch# configure terminal switch(config)#</pre>	Enters global configuration mode.
Step 2	[no] interface ethernet <i>port/slot</i> Example: <pre>switch(config)# interface ethernet 1/1 switch(config-if)#</pre>	Enters interface configuration mode.
Step 3	[no] tunnel-encryption Example: <pre>switch(config-if)# tunnel-encryption</pre>	Enables Secure VXLAN EVPN Multi-Site using CloudSec on the specified interface.

Verifying the Secure VXLAN EVPN Multi-Site Using CloudSec

To display Secure VXLAN EVPN Multi-Site using CloudSec configuration information, perform one of the following tasks:

Command	Purpose
show tunnel-encryption info global	Displays configuration information for Secure VXLAN EVPN Multi-Site using CloudSec.
show tunnel-encryption policy [<i>policy-name</i>]	Displays the configuration for a specific CloudSec policy or for all CloudSec policies.
show tunnel-encryption session [peer-ip <i>peer-ip-address</i>] [detail]	Displays information about CloudSec sessions, including whether sessions are secure between endpoints.
show running-config tunnel-encryption	Displays the running configuration information for Secure VXLAN EVPN Multi-Site using CloudSec.
show bgp ipv4 unicast <i>ip-address</i>	Displays the tunnel encryption information for BGP routes.
show bgp l2vpn evpn	Displays the Layer 2 VPN EVPN address family and routing table information.
show ip route <i>ip-address</i> vrf <i>vrf</i>	Displays the VRF routes.
show l2route evpn mac evi <i>evi</i>	Displays Layer 2 route information.

Command	Purpose
show nve interface <i>interface</i> detail	Displays the NVE interface detail.
show running-config rpm	Displays the key text in the running configuration. Note If you enter the key-chain tunnelencrypt-psk no-show command prior to running this command, the key text is hidden (with asterisks) in the running configuration. If you enter the reload ascii command, the key text is omitted from the running configuration.
show running-config cert-enroll	Shows the trustpoint and keypair configuration.
show crypto ca certificates <trustpoint_label>	Shows the certificate contents under a trustpoint.

The following example displays configuration information for Secure VXLAN EVPN Multi-Site using CloudSec:

```
switch# show tunnel-encryption info global
Global Policy Mode: Must-Secure
SCI list: 0000.0000.0001.0002 0000.0000.0001.0004
No. of Active Peers      : 1
```

The following example displays all configured CloudSec policies. The output shows the cipher, window size, and SAK retry time for each policy.

```
switch# show tunnel-encryption policy
Tunnel-Encryption Policy      Cipher      Window      SAK Rekey time
-----
cloudsec                      GCM-AES-XPN-256  134217728  1800
p1                            GCM-AES-XPN-256  1073741823
system-default-tunenc-policy  GCM-AES-XPN-256  268435456
```

The following example displays information about CloudSec sessions. The output shows the peer IP address and policy, the keychain available, and whether the sessions are secure.

```
switch# show tunnel-encryption session
Tunnel-Encryption Peer Policy Keychain RxStatus TxStatus
-----
33.1.33.33          p1      kc1      Secure (AN: 0) Secure (AN: 2)
33.2.33.33          p1      kc1      Secure (AN: 0) Secure (AN: 2)
33.3.33.33          p1      kc1      Secure (AN: 0) Secure (AN: 2)
44.1.44.44          p1      kc1      Secure (AN: 0) Secure (AN: 0)
44.2.44.44          p1      kc1      Secure (AN: 0) Secure (AN: 0)
```

The following example displays information about Cloudsec sessions based on PKI Certificate Trustpoint.

```
switch# sh tunnel-encryption session
Tunnel-Encryption Peer Policy Keychain
RxStatus TxStatus
-----
20.20.20.2          p1      PKI: myCA (RSA)
Secure (AN: 0) Secure (AN: 0)
```

```
32.11.11.4          p1          PKI: myCA (RSA)
Secure (AN: 0)     Secure (AN: 0)
```

The following example shows the tunnel encryption information for BGP routes:

```
switch# show bgp ipv4 unicast 199.199.199.199 □ Source-loopback configured on peer BGW for
CloudSec
BGP routing table information for VRF default, address family IPv4 Unicast
BGP routing table entry for 199.199.199.199/32, version 109
Paths: (1 available, best #1)
Flags: (0x8008001a) (high32 0x000200) on xmit-list, is in urib, is best urib route, is in
HW
Multipath: eBGP

  Advertised path-id 1
  Path type: external, path is valid, is best path, no labeled nexthop, in rib
  AS-Path: 1000 200 , path sourced external to AS
           89.89.89.89 (metric 0) from 89.89.89.89 (89.89.89.89)
           Origin IGP, MED not set, localpref 100, weight 0
           Tunnel Encapsulation attribute: Length 120

  Path-id 1 advertised to peers:
  2.2.2.2
```

The following example shows if the MAC is attached with the virtual ESI:

```
switch(config)# show bgp l2vpn evpn 0012.0100.000a
BGP routing table information for VRF default, address family L2VPN EVPN
Route Distinguisher: 110.110.110.110:32876
BGP routing table entry for [2]:[0]:[0]:[48]:[0012.0100.000a]:[0]:[0.0.0.0]/216, version
13198
Paths: (1 available, best #1)
Flags: (0x000202) (high32 00000000) on xmit-list, is not in l2rib/evpn, is not in HW
Multipath: eBGP

  Advertised path-id 1
  Path type: external, path is valid, is best path, no labeled nexthop
           Imported to 1 destination(s)
           Imported paths list: 12-10109
  AS-Path: 1000 200 , path sourced external to AS
           10.10.10.10 (metric 0) from 89.89.89.89 (89.89.89.89)
           Origin IGP, MED not set, localpref 100, weight 0
           Received label 10109
           Extcommunity: RT:100:10109 ENCAP:8
           ESI: 0300.0000.0000.0200.0309

  Path-id 1 not advertised to any peer

Route Distinguisher: 199.199.199.199:32876
BGP routing table entry for [2]:[0]:[0]:[48]:[0012.0100.000a]:[0]:[0.0.0.0]/216, version
24823
Paths: (1 available, best #1)
Flags: (0x000202) (high32 00000000) on xmit-list, is not in l2rib/evpn, is not in HW
Multipath: eBGP

  Advertised path-id 1
  Path type: external, path is valid, is best path, no labeled nexthop
           Imported to 1 destination(s)
           Imported paths list: 12-10109
  AS-Path: 1000 200 , path sourced external to AS
           9.9.9.9 (metric 0) from 89.89.89.89 (89.89.89.89)
           Origin IGP, MED not set, localpref 100, weight 0
           Received label 10109
           Extcommunity: RT:100:10109 ENCAP:8
```

```
ESI: 0300.0000.0000.0200.0309
```

```
Path-id 1 not advertised to any peer
```

The following example shows the ECMP created for EVPN type-5 routes received from the remote site:

```
switch(config)# show ip route 205.205.205.9 vrf vrf903
IP Route Table for VRF "vrf903"
'*' denotes best ucast next-hop
'***' denotes best mcast next-hop
'[x/y]' denotes [preference/metric]
'%<string>' in via output denotes VRF <string>

205.205.205.9/32, ubest/mbest: 2/0
  *via 9.9.9.9%default, [20/0], 11:06:32, bgp-100, external, tag 1000, segid: 900003
  tunnelid: 0x9090909 encap: VXLAN

  *via 10.10.10.10%default, [20/0], 3d05h, bgp-100, external, tag 1000, segid: 900003
  tunnelid: 0xa0a0a0a encap: VXLAN
```

The following example shows if ESI-based MAC multipath is configured for MACs received from the remote site:

```
switch(config)# show l2route evpn mac evi 109 mac 0012.0100.000a detail

Flags -(Rmac):Router MAC (Stt):Static (L):Local (R):Remote (V):vPC link
(Dup):Duplicate (Spl):Split (Rcv):Recv (AD):Auto-Delete (D):Del Pending
(S):Stale (C):Clear, (Ps):Peer Sync (O):Re-Originated (Nho):NH-Override
(Pf):Permanently-Frozen, (Orp): Orphan

Topology Mac Address      Prod   Flags  Seq No  Next-Hops
-----
109      0012.0100.000a BGP    SplRcv 0          9.9.9.9 (Label: 10109)
                               10.10.10.10 (Label: 10109)

Route Resolution Type: ESI
Forwarding State: Resolved (PL)
Resultant PL: 9.9.9.9, 10.10.10.10
Sent To: L2FM
ESI : 0300.0000.0000.0200.0309
Encap: 1
```

The following example shows that VXLAN EVPN Multi-Site with PIP is configured:

```
switch(config)# show nve interface nve1 detail
Interface: nve1, State: Up, encapsulation: VXLAN
VPC Capability: VPC-VIP-Only [not-notified]
Local Router MAC: 700f.6a15.c791
Host Learning Mode: Control-Plane
Source-Interface: loopback0 (primary: 14.14.14.14, secondary: 0.0.0.0)
Source Interface State: Up
Virtual RMAC Advertisement: No
NVE Flags:
Interface Handle: 0x49000001
Source Interface hold-down-time: 180
Source Interface hold-up-time: 30
Remaining hold-down time: 0 seconds
Virtual Router MAC: N/A
Virtual Router MAC Re-origination: 0200.2e2e.2e2e
Interface state: nve-intf-add-complete
Multisite delay-restore time: 180 seconds
Multisite delay-restore time left: 0 seconds
Multisite dci-advertise-pip configured: True
```



```
Multisite bgw-if: loopback1 (ip: 46.46.46.46, admin: Up, oper: Up)
Multisite bgw-if oper down reason:
```

The following example shows the key text in the running configuration. If you enter the **key-chain tunnelencrypt-psk no-show** command, the key text is hidden.

```
switch# show running-config rpm
!Command: show running-config rpm
!Running configuration last done at: Mon Jun 15 14:41:40 2020
!Time: Mon Jun 15 15:10:27 2020

version 9.3(5) Bios:version 05.40
key chain inter tunnel-encryption
  key 3301
    key-octet-string 7 075f79696a58405441412e2a577f0f077d6461003652302552040a0b76015a504e370c
7972700604755f0e22230c03254323277d2f5359741a6b5d3a5744315f2f cryptographic-algorithm
AES_256_CMAC
key chain kcl tunnel-encryption
  key 3537
    key-octet-string 7
072c746f172c3d274e33592e22727e7409106d003725325758037800777556213d4e0c7c00770576772
d08515e0804553124577f5a522e046d6a5f485c35425f59 cryptographic-algorithm AES_256_CMAC
send-lifetime local 09:09:40 Apr 15 2020 duration 1800
  key 2001
    key-octet-string 7
075f79696a58405441412e2a577f0f077d6461003652302552040a0b76015a504e370c7972700604755
f0e22230c03254323277d2f5359741a6b5d3a5744315f2f cryptographic-algorithm AES_256_CMAC
  key 2065
    key-octet-string 7
0729791f6f5e3d213347292d517308730c156c7737223554270f787c07722a513e450a0a0703070c062
e0256210d0e204120510d29222a051f1e594c2135375359 cryptographic-algorithm AES_256_CMAC
  key 2129
    key-octet-string 7
075c796f6f2a4c2642302f5c56790e767063657a4b564f2156777c0a020228564a32780e0472007005530
c5e560f04204056577f2a222d056d1f5c4c533241525d cryptographic-algorithm AES_256_CMAC
  key 2193
    key-octet-string 7
07577014195b402336345a5f260f797d7d6264044b50415755047a7976755a574d350b7e720a0202715d7
a50530d715346205d0c2d525c001f6b5b385046365a29 cryptographic-algorithm AES_256_CMAC

switch# configure terminal
switch(config)# key-chain tunnelencrypt-psk no-show
switch(config)# show running-config rpm

!Command: show running-config rpm
!Running configuration last done at: Mon Jun 15 15:10:44 2020
!Time: Mon Jun 15 15:10:47 2020

version 9.3(5) Bios:version 05.40
key-chain tunnelencrypt-psk no-show
key chain inter tunnel-encryption
  key 3301
    key-octet-string 7 ***** cryptographic-algorithm AES_256_CMAC
key chain kcl tunnel-encryption
  key 3537
    key-octet-string 7 ***** cryptographic-algorithm AES_256_CMAC
send-lifetime local 09:09:40 Apr 15 2020 duration 1800
  key 2001
    key-octet-string 7 ***** cryptographic-algorithm AES_256_CMAC
  key 2065
    key-octet-string 7 ***** cryptographic-algorithm AES_256_CMAC
  key 2129
    key-octet-string 7 ***** cryptographic-algorithm AES_256_CMAC
```

```
key 2193
  key-octet-string 7 ***** cryptographic-algorithm AES_256_CMAC
```

The following example shows the trustpoint and keypair configuration.

```
switch# show running-config cert-enroll
!Command: show running-config cert-enroll
!Running configuration last done at: Fri Apr 21 10:53:30 2023
!Time: Fri Apr 21 12:07:31 2023

version 10.3(3) Bios:version 05.47
crypto key generate rsa label myRSA exportable modulus 1024
crypto key generate rsa label myKey exportable modulus 1024
crypto key generate rsa label tmpCA exportable modulus 2048
crypto key generate ecc label src15_ECC_key exportable modulus 224
crypto ca trustpoint src15_ECC_CA
  ecckeypair switch_ECC_key and so on
  revocation-check  crl
crypto ca trustpoint myRSA
  rsakeypair myRSA
  revocation-check  crl
crypto ca trustpoint tmpCA
  rsakeypair tmpCA
  revocation-check  crl
crypto ca trustpoint myCA
  rsakeypair myKey
  revocation-check  crl
```

The following example shows the certificate contents under a trustpoint.

```
switch(config)# show crypto ca certificates myCA
Trustpoint: myCA
certificate:
subject=CN = switch, serialNumber = FBO22411ABC
issuer=C = US, ST = CA, L = San Jose, O = Org, OU = EN, CN = PKI, emailAddress = abc@xyz.com
serial=2F24FCE6823FCBE5A8AC72C82D0E8E24EB327BOC
notBefore=Apr 19 19:43:48 2023 GMT
notAfter=Aug 31 19:43:48 2024 GMT
SHA1 Fingerprint=D0:F8:1E:32:6E:6D:44:21:6B:AE:92:69:69:AD:88:73:69:76:B9:18
purposes: sslserver sslclient

CA certificate 0:
subject=C = US, ST = CA, L = San Jose, O = Org, OU = EN, CN = PKI, emailAddress = abc@xyz.com
issuer=C = US, ST = CA, L = San Jose, O = Cisco, OU = EN, CN = PKI, emailAddress = ca@ca.com
serial=1142A22DDDE63A047DE0829413359362042CCC31
notBefore=Jul 12 13:25:59 2022 GMT
notAfter=Jul 12 13:25:59 2023 GMT
SHA1 Fingerprint=33:37:C6:D5:F1:B3:E1:79:D9:5A:71:30:FD:50:E4:28:7D:E1:2D:A3
purposes: sslserver sslclient
```

Displaying Statistics for Secure VXLAN EVPN Multi-Site Using CloudSec

You can display or clear Secure VXLAN EVPN Multi-Site using CloudSec statistics using the following commands:

Command	Purpose
<code>show tunnel-encryption statistics [peer-ip peer-ip-address]</code>	Displays statistics for Secure VXLAN EVPN Multi-Site using CloudSec.
<code>clear tunnel-encryption statistics [peer-ip peer-ip-address]</code>	Clears statistics for Secure VXLAN EVPN Multi-Site using CloudSec.

The following example shows sample statistics for Secure VXLAN EVPN Multi-Site using CloudSec:

```
switch# show tunnel-encryption statistics
Peer 16.16.16.16 SecY Statistics:

SAK Rx Statistics for AN [0]:
Unchecked Pkts: 0
Delayed Pkts: 0
Late Pkts: 0
OK Pkts: 8170598
Invalid Pkts: 0
Not Valid Pkts: 0
Not-Using-SA Pkts: 0
Unused-SA Pkts: 0
Decrypted In-Pkts: 8170598
Decrypted In-Octets: 4137958460 bytes
Validated In-Octets: 0 bytes

SAK Rx Statistics for AN [3]:
Unchecked Pkts: 0
Delayed Pkts: 0
Late Pkts: 0
OK Pkts: 0
Invalid Pkts: 0
Not Valid Pkts: 0
Not-Using-SA Pkts: 0
Unused-SA Pkts: 0
Decrypted In-Pkts: 0
Decrypted In-Octets: 0 bytes
Validated In-Octets: 0 bytes

SAK Tx Statistics for AN [0]:
Encrypted Protected Pkts: 30868929
Too Long Pkts: 0
Untagged Pkts: 0
Encrypted Protected Out-Octets: 15758962530 bytes
```



Note In tunnel encryption statistics, if you observe a traffic drop coinciding with an increase in late packets, it could be due to any of the following reasons:

- The packets are being discarded because they are received outside the replay window.
- The tunnel encryption peers are out of sync.
- There is a valid security risk.

In these situations, you should reset the peer session by removing and then reconfiguring the tunnel-encryption peer on the corresponding remote peer, in order to synchronize them again.

Configuration Examples for Secure VXLAN EVPN Multi-Site Using CloudSec

The following example shows how to configure Secure VXLAN EVPN Multi-Site using keychain:

```

key chain kc1 tunnel-encryption
key 2006
key-octet-string 7 075f79696a58405441412e2a577f0f077d6461003652302552040
a0b76015a504e370c7972700604755f0e22230c03254323277d2f5359741a6b5d3a5744315f2f
cryptographic-algorithm AES_256_CMAC

feature tunnel-encryption
tunnel-encryption source-interface loopback4
tunnel-encryption must-secure-policy

tunnel-encryption policy p1
  window-size 1073741823

tunnel-encryption peer-ip 11.1.11.11
  keychain kc1 policy p1
tunnel-encryption peer-ip 11.2.11.11
  keychain kc1 policy p1
tunnel-encryption peer-ip 44.1.44.44
  keychain kc1 policy p1
tunnel-encryption peer-ip 44.2.44.44
  keychain kc1 policy p1

interface Ethernet1/1
  tunnel-encryption

interface Ethernet1/7
  tunnel-encryption

interface Ethernet1/55
  tunnel-encryption

interface Ethernet1/59
  tunnel-encryption

evpn multisite border-gateway 111
  dci-advertise-pip

router bgp 1000
  router-id 12.12.12.12
  no rd dual
  address-family ipv4 unicast
    maximum-paths 10
  address-family l2vpn evpn
    maximum-paths 10
  vrf vxlan-900101
    address-family ipv4 unicast
      maximum-paths 10
    address-family ipv6 unicast
      maximum-paths 10

show tunnel-encryption session
Tunnel-Encryption Peer Policy Keychain RxStatus TxStatus
-----
11.1.11.11 p1 kc1 Secure (AN: 0) Secure (AN: 2)
11.2.11.11 p1 kc1 Secure (AN: 0) Secure (AN: 2)

```

```

44.1.44.44          p1    kc1    Secure (AN: 0)  Secure (AN: 2)
44.2.44.44          p1    kc1    Secure (AN: 0)  Secure (AN: 2)

```

The following example shows how to configure Certificate based Secure VXLAN EVPN Multi-site using Clousec Certificate based Authentication.

```

feature tunnel-encryption

tunnel-encryption must-secure-policy
tunnel-encryption pki trustpoint myCA
tunnel-encryption pki source-interface loopback3
tunnel-encryption source-interface loopback2
tunnel-encryption policy with-rekey
    sak-rekey-time 1800
tunnel-encryption peer-ip 7.7.7.7
    pki policy system-default-tunenc-policy

interface Ethernet1/20
    tunnel-encryption

interface Ethernet1/21
    tunnel-encryption

interface Ethernet1/25/1
    tunnel-encryption

```

The following example shows how to configure outbound route-map to make BGW's path as the best path. This configuration is done when vPC BGW learns peer vPC BGW's PIP address in BGP.

```

ip prefix-list pip_ip seq 5 permit 44.44.44.44/32 <<PIP2 address>>
route-map pip_ip permit 5
    match ip address prefix-list pip_ip
    set as-path prepend last-as 1
neighbor 45.10.45.10 <<R1 neighbor - Same route-map required for every DCI side underlay
BGP peer>>
    inherit peer EBGW-PEERS
    remote-as 12000
    address-family ipv4 unicast
        route-map pip_ip out

```

Migrating from Multi-Site with VIP to Multi-Site with PIP

Follow these steps for a smooth migration from Multi-Site with VIP to Multi-Site with PIP. The migration needs to be done one site at a time. You can expect minimal traffic loss during the migration.

1. Upgrade all BGWs on all sites to Cisco NX-OS Release 9.3(5) or a later release.
2. Configure BGP maximum paths on all BGWs. Doing so is required for ESI-based MAC multipath and BGP to download all of the next-hops for EVPN Type-2 and Type-5 routes.
3. Pick one site at a time for the migration.
4. Shut down the same-site BGWs except for one BGW. You can use the NVE **shutdown** command to shut down the BGWs.
5. To avoid traffic loss, wait a few minutes before enabling Multi-Site with PIP on the active BGW. Doing so allows the same-site shutdown BGWs to withdraw EVPN routes so remote BGWs send traffic to only the active BGW.

6. Enable Multi-Site with PIP on the active BGW by configuring the **dci-advertise-pip** command.

The Multi-Site with PIP-enabled BGW advertises the EVPN EAD-per-ES route for the virtual ESI.

The Multi-Site with PIP-enabled BGW advertises EVPN Type-2 routes with a virtual ESI, using the PIP address as the next-hop and the PIP interface MAC as the RMAC (if applicable) towards the DCI. For Type-5 routes, no virtual ESI is carried. There is no change in the advertisement of EVPN Type-2 and Type-5 routes towards the fabric.

The remote BGW performs ESI-based MAC multipathing as MAC routes are received with ESI.

7. Unshut the same-site BGWs one at a time and enable Multi-Site with PIP by entering the **dci-advertise-pip** command.

The remote BGW performs ESI-based MAC multipathing for MAC routes as ESI is the same from all same-site BGWs.

On the remote BGW, BGP selects paths as multipath and downloads all next-hops for EVPN Type-5 routes.

Migration of Existing vPC BGW

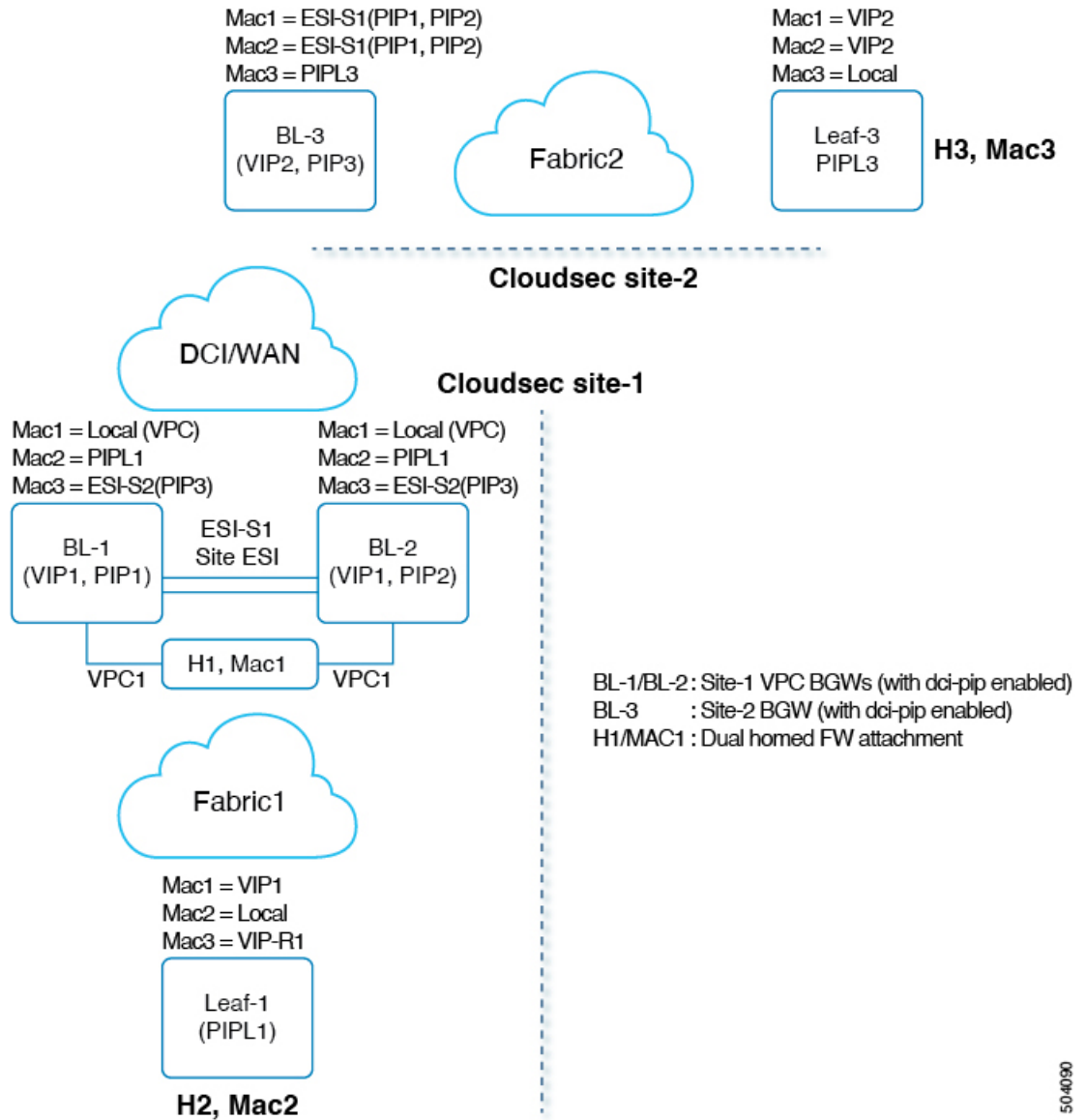
Follow these steps for a smooth migration of the existing vPC BGWs so that they can use Cloudsec. The migration needs to be done one site at a time. You can expect minimal traffic loss during the migration.

1. Upgrade both vPC BGWs to the latest image which has the vPC Cloudsec updates.
2. Shutdown interface nve1 on the vPC secondary.
3. Enable **dci-advertise-pip** on vPC primary.
4. With interface nve1 still in shut mode on vPC secondary, configure **dci-advertise-pip** on vPC secondary.
5. Unshut interface nve1 on vPC secondary.

vPC Border Gateway Support for Cloudsec

The following topology illustrates the vPC Border Gateway (BGW) support for Cloudsec.

Figure 1: vPC BGW Support for Cloudsec



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vPC is a dual-homed attachment/connection to the BGW. BGWs act virtually as a single VXLAN end point for redundancy and both switches function in active mode by sharing a common emulated/virtual ip-address (VIP). The VXLAN encapsulation over DCI is based on primary IP addresses of the BGW VTEPs.

In the above topology, Host H1/MAC1 is dually homed to Cloudsec enabled vPC BGWs BL-1/BL-2. H1 continues to be advertised with secondary loopback IP address of the vPC BGWs (VIP1) towards the fabric. However, towards the DCI, both BL-1/BL-2 advertise H1 with next-hop as PIP and site-ESI is also added to the Type-2 NLRI.

For Cloudsec feature on Anycast and vPC BGWs, dci-advertise-pip is configured to change the BGP procedures of how the Type-2/Type-5 routes are advertised to the DCI. All Type-2/Type-5 routes received from the site-internal network are advertised to the DCI with next-hop as PIP of the vPC BGW.

Both vPC BGWs advertise the routes with their primary IP address respectively. Site-ESI attribute is added to the Type-2 NLRI. All dual attached hosts on the vPC BGWs are advertised with next-hop as PIP and site-ESI attribute is attached over DCI. All orphan hosts are advertised with next-hop as PIP towards DCI and the site-ESI attribute is not attached.

If vPC BGW learns peer vPC BGW's PIP address and advertises on DCI side, BGP path attributes from both vPC BGW will be same. Hence the DCI intermediate nodes may end up choosing the path from vPC BGW which does not own the PIP address. In this scenario MCT link is used for encrypted traffic coming from the remote site. The vPC BGW BGP learns the peer vPC BGW's PIP address when:

- iBGP is configured between vPC BGWs.
- BGP is used as underlay routing protocol on fabric side.
- IGP used as underlay routing protocol, and IGP routes are redistributed into BGP.

When vPC BGW learns peer vPC BGW's PIP address in BGP, you need to configure the outbound route-map to make BGW's path as the best path.

On a remote site BGW, directly connected L3 host is learnt from both vPC BGWs. The path from directly connected BGW is usually preferred due to lower AS-path. If L3 host or L3 network is dually connected to vPC pair BGW, the local path is selected in both vPC pair.

Enhanced Convergence for vPC BGW CloudSec Deployments

Traditionally, single loopback interface is configured as NVE source interface, where both PIP and VIP of vPC complex are configured. Beginning with Cisco NX-OS Release 10.3(2)F, you can configure a separate loop back for CloudSec enabled vPC BGW. It is recommended to use separate loopback interfaces for source and anycast IP addresses under NVE for better convergence in vPC deployments. The IP address configured on the source-interface is the PIP of the vPC node, and the IP address configured on the anycast interface is the VIP of that vPC complex. Note that the secondary IP configured on the NVE source-interface will have no effect if the NVE anycast interface is also configured.

With separate loopbacks, the convergence for dual-attached EVPN Type-2 and Type-5 routes traffic destined for DCI side will be improved.

Migration to Anycast Interface

If a user wants to specify an anycast interface, the user needs to unconfigure the existing source-interface and reconfigure with both source and anycast interfaces. This will lead to temporary traffic loss. For all green field deployments, it is recommended to configure both the source and anycast interface to avoid the convergence problem specified.

NVE Interface Configuration with Enhanced Convergence for vPC BGW CloudSec Deployments

The user needs to specify anycast interface along with NVE source-interface on vPC BGW. In today's VxLANv6 deployments, the provision to specify both source-interface and anycast interface is already present. In order to improve vPC convergence for VxLANv4, the anycast option is mandatory.

Configuration Example:

```
interface nve <number>
    source-interface <interface> [anycast <anycast-intf>]
```


iBGP Session Requirement

Underlay IPv4/IPv6 unicast iBGP session must be configured between vPC BGW peer nodes. This is to accommodate key propagation during the DCI isolation on any vPC BGW.

Migration from PSK CloudSec Configuration to Certificate Based Authentication CloudSec Configuration

During migration to Auto keying, it is expected to send or receive clear traffic on a VTEP-to-VTEP session while the sites are still migrating to new configuration or functionalists. During this time, policy should be configured as **should-secure** to make sure unencrypted traffic is not dropped for the session.

1. Change tunnel-encryption config to **should-secure** on all nodes.
2. Perform migration one node at a time.
3. Remove the keychain and cloudsec policy from peer.
4. Configure trust point and certificate using a valid CA if using SSL certificates OR configure for SUDI certificates.
5. Attach the trust point to Cloudsec.
6. Apply the cloudsec policy back to the peer.
7. After all the nodes have been changed to autokeying, change the configuration to **must-secure** if needed.

