

CISCO VALIDATED DESIGN

Intelligent WAN Public Key Infrastructure Deployment Guide

September 2017



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Deploying the Cisco Intelligent WAN

This guide is one in a series of IWAN advanced deployment guides that focus on how to deploy the advanced features of the Cisco Intelligent WAN (IWAN). These guides build on the configurations deployed in the [Intelligent WAN Deployment Guide](#) and are optional components of its base IWAN configurations.

The advanced guides are as follows:

- [IWAN High Availability and Scalability Deployment Guide](#)
- [IWAN Multiple Data Center Deployment Guide](#)
- [IWAN Multiple Transports Deployment Guide](#)
- [IWAN Multiple VRF Deployment Guide](#)
- [IWAN Public Key Infrastructure Deployment Guide \(this guide\)](#)
- [IWAN NetFlow Monitoring Deployment Guide](#)
- [IWAN Remote Site 4G LTE Deployment Guide](#)

For design details, see [Intelligent WAN Design Summary](#).

For configuration details, see [Intelligent WAN Configuration Files Guide](#).

For an automated way to deploy IWAN, use the APIC-EM IWAN Application. For more information, see the [Cisco IWAN Application on APIC-EM User Guide](#).

If want to use TrustSec with your IWAN deployment, see “Configuring SGT Propagation” in the [User-to-Data-Center Access Control Using TrustSec Deployment Guide](#).

DEPLOYMENT DETAILS

How to Read Commands

This guide uses the following conventions for commands that you enter at the command-line interface (CLI).

Commands to enter at a CLI prompt:

```
configure terminal
```

Commands that specify a value for a variable:

```
ntp server 10.10.48.17
```

Commands with variables that you must define:

```
class-map [highest class name]
```

Commands at a CLI or script prompt:

```
Router# enable
```

Long commands that line wrap are underlined.

Enter them as one command:

```
police rate 10000 pps burst 10000  
packets conform-action
```

Noteworthy parts of system output (or of device configuration files) are highlighted:

```
interface Vlan64  
ip address 10.5.204.5 255.255.255.0
```

Deploying IWAN Public Key Infrastructure

Use this guide to add Public Key Infrastructure (PKI) to an existing IWAN deployment.

PROCESS

Deploying an IOS Certificate Authority

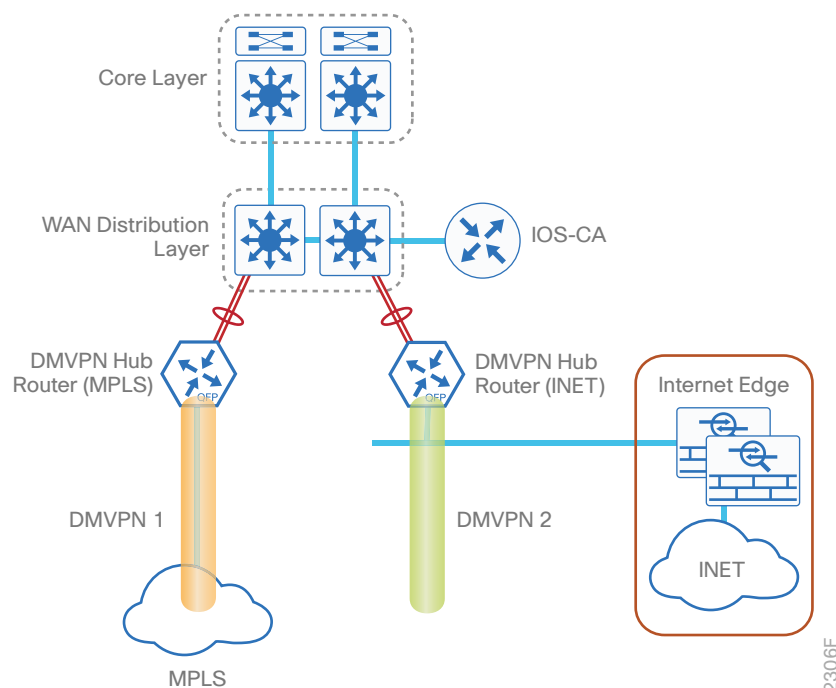
1. Configuring the IOS CA platform
2. Configuring connectivity to the network
3. Configuring the certificate authority

Use this optional process if you want to deploy an IOS Certificate Authority (IOS CA) on a router with access from the internal network. Skip this process if you plan to use a different certificate authority. You can create a more complex CA environment, but the same basic reachability principles will apply for an IWAN enabled solution.

For this process, you configure an IOS CA by using a single internal LAN interface, which allows access from the hub routers and the remote sites. The remote sites access the IOS CA for authentication and for obtaining their certificate after a DMVPN tunnel has been established with pre-shared keys.

After the remote site has obtained the PKI certificate, it can be re-configured to use PKI certificates instead of PSKs for IKEV2 authentication to build the DMVPN encrypted tunnels with the hubs and other remote sites. It no longer needs direct access to the IOS CA, except when it needs a new PKI certificate before the current PKI certificate times out (usually at least 1 year lifetime). At that point, the remote site will use the current DMVPN tunnel to access the IOS CA for the new PKI certificate.

Figure 1 IOS CA with internal LAN interface



Procedure 1 Configuring the IOS CA platform

To complete the base configuration for this router, follow the steps in “Configure the platform base features” in the [IWAN Deployment Guide](#).

Procedure 2 Configuring connectivity to the network

Step 1: The internal address is an inside address that can be accessed from the hub site or a remote site if the site is already up and running with a DMVPN tunnel.

```
interface GigabitEthernet0/0
  description Internal
  ip address 10.6.24.11 255.255.255.224
  no shutdown
```

Step 2: Configure IP routing using a static route.

```
ip route 0.0.0.0 0.0.0.0 10.6.24.1
```

Procedure 3 Configuring the certificate authority

The following commands configure the CA on the router. This CA can be part of a PKI hierarchy, but only of IOS authorities, and the certificate from the root CA must be issued via SCEP.

Step 1: Configure the server.

```
crypto pki server IWAN-IOS-CA
  database level complete
  no database archive
  issuer-name CN=IWAN-IOS-CA.cisco.local L=SanJose St=CA C=US
```

Step 2: Configure the server to use SCEP for issuing certificates.

```
grant auto
```

Step 3: Configure the lifetime for the issued certificates at 2 years. The time is in days.

```
lifetime certificate 730
```

Step 4: Configure the lifetime for the certificate server signing certificate at 3 years. The time is in days.

```
lifetime ca-certificate 1095
```

Step 5: Configure the location for certificate revocation lists.

Tech Tip

In order to force the parser to retain the embedded question mark within the specified location, enter CTRL+V prior to the question mark. If this action is not taken, CRL retrieval through HTTP returns an error message.

```
cdp-url http://10.6.24.11/cgi-bin/pkiclient.exe?operation=GetCRL
database url crl nvram:
```

Step 6: Start the server with the **no shutdown** command.

```
crypto pki server IWAN-IOS-CA
no shutdown
%Some server settings cannot be changed after CA certificate generation.
% Please enter a passphrase to protect the private key
% or type Return to exit
Password: c1sco123

Re-enter password: c1sco123
% Generating 1024 bit RSA keys, keys will be non-exportable...
[OK] (elapsed time was 2 seconds)

% Certificate Server enabled.
IWAN-IOS-CA(cs-server)#
Dec 15 13:19:49.254: %PKI-6-CS_ENABLED: Certificate server now enabled.
```

The following trustpoint and rsa keypair are automatically generated when you start the server:

```
crypto pki trustpoint IWAN-IOS-CA
revocation-check crl
rsakeypair IWAN-IOS-CA
```

Reader Tip

For more information, including options for configuring certificates, see the following document:

http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/sec_conn_pki/configuration/15-mt/sec-pki-15-mt-book.pdf

PROCESS

Deploying PKI for a DMVPN border router

1. Configuring IKEv2 and IPsec with PKI

This section is for DMVPN border routers only.

The parameters in the table below are used in this section.

Table 1 *Crypto parameters*

Parameter	Public Key Infrastructure
crypto ikev2 profile	DMVPN-PKI-IKEv2-PROFILE
crypto ipsec profile	DMVPN-PKI-IPSEC-PROFILE

IPsec uses a key exchange between the routers in order to encrypt/decrypt the traffic. These keys can be exchanged using pre-shared keys or PKI certificates with a certificate authority. It is also possible to use a combination of the two, which is useful during a migration from one method to the other.

Procedure 1 Configuring IKEv2 and IPsec with PKI

If you do not have a certificate authority in your network, you may follow the optional section “IOS Certificate Authority” to deploy an IOS certificate authority using a Cisco router.

To use a certificate authority, you will have to configure a pre-shared key on one of the hub border routers in order to allow each remote site to establish a DMVPN tunnel to the WAN aggregation site. After the first DMVPN tunnel at a remote site is established, the router will be able to authenticate to the CA and obtain a certificate. After obtaining the certificate, you can configure the remote site to use PKI.

The **crypto pki trustpoint** is the method of specifying the parameters associated with a CA. The router must authenticate to the CA first and then enroll with the CA to obtain its own identity certificate.

Step 1: The fingerprint command limits the responding CA. You can find this fingerprint by using **show crypto pki server** on the IOS CA.

```
IWAN-IOS-CA#show crypto pki server
Certificate Server IWAN-IOS-CA:
  Status: enabled
  State: enabled
  Server's configuration is locked (enter "shut" to unlock it)
  Issuer name: CN=IWAN-IOS-CA.cisco.local L=SanJose St=CA C=US
  CA cert fingerprint: 75BEF625 9A9876CF 6F341FE5 86D4A5D8
  Granting mode is: auto
```

```
Last certificate issued serial number (hex): 59
CA certificate expiration timer: 13:19:42 PST Dec 24 2017
CRL NextUpdate timer: 14:55:59 PDT Sep 12 2016
Current primary storage dir: nvram:
Current storage dir for .crl files: nvram:
Database Level: Complete - all issued certs written as <serialnum>.cer
```

Step 2: Configure the PKI trust point.

```
crypto pki trustpoint [name]
  enrollment url [URL of IOS CA]
  serial-number none
  fqdn [fully qualified domain name of this router]
  ip-address [Loopback IP address of this router]
  fingerprint [fingerprint from IOS CA]
  revocation-check crl none
  rsakeypair [name] 2048 2048
```

Tech Tip

With the **revocation-check crl none** command, the router will do a CRL check as long as the CA server is reachable. If the CA server is not reachable, then the router checks the signature.

Example: Hybrid hub border router– HY-INET1-ASR1002X-2

This example is from the secondary WAN hub router in the hybrid design model. It can reach the IOS CA through the internal network at 10.6.24.11 using the default VRF.

```
crypto pki trustpoint IWAN-CA
  enrollment url http://10.6.24.11:80
  serial-number none
  fqdn HY-INET1-ASR1002X-2.cisco.local
  ip-address 10.6.32.242
  fingerprint 75BEF6259A9876CF6F341FE586D4A5D8
  revocation-check crl none
  rsakeypair IWAN-CA-KEYS 2048 2048
```


Step 3: Authenticate to the CA and obtain the CA's certificate

Exit the trustpoint configuration mode on the hub router and issue the following command to authenticate to the CA and get its certificate.

```
(config)# crypto pki authenticate IWAN-CA
Certificate has the following attributes:
    Fingerprint MD5: 75BEF625 9A9876CF 6F341FE5 86D4A5D8
    Fingerprint SHA1: 9C14D6F4 D1F08023 17A85669 52922632 C6B02928
Trustpoint Fingerprint: 75BEF625 9A9876CF 6F341FE5 86D4A5D8
Certificate validated - fingerprints matched.
```

Step 4: When the trustpoint CA certificate is accepted, enroll with the CA, enter a password for key retrieval, and obtain a certificate for this hub router.

```
(config)# crypto pki enroll IWAN-CA

% Start certificate enrollment ..
% Create a challenge password. You will need to verbally provide this
password to the CA Administrator in order to revoke your certificate.
For security reasons your password will not be saved in the configuration.
Please make a note of it.

Password: clsco123
Re-enter password: clsco123

% The subject name in the certificate will include: HY-INET1-ASR1002X-2.cisco.
local
% The IP address in the certificate is 10.6.32.242

Request certificate from CA? [yes/no]: yes
% Certificate request sent to Certificate Authority
% The 'show crypto pki certificate verbose IWAN-CA' command will show the finger-
print.
```

Step 5: Configure the IKEv2 proposal.

The user-defined IKEv2 proposal includes only the following:

- Encryption with AES cipher and a 256-bit key
- Pseudo-random function with SHA and a 512-bit digest
- Diffie-Hellman group: 19

```
crypto ikev2 proposal [proposal name]
  encryption [encryption algorithm]
  prf [pseudo-random function algorithm]
  group [Diffie-Hellman group]
```

Example

```
crypto ikev2 proposal AES/GCM/256
  encryption aes-gcm-256
  prf sha512
  group 19
```

The default IKEv2 proposal is also used.

A **show crypto ikev2 proposal** displays the details of the two proposals.

```
show crypto ikev2 proposal
IKEv2 proposal: AES/GCM/256
  Encryption : AES-GCM-256
  Integrity  : none
  PRF       : SHA512
  DH Group   : DH_GROUP_256_ECP/Group 19
IKEv2 proposal: default
  Encryption : AES-CBC-256 AES-CBC-192 AES-CBC-128
  Integrity  : SHA512 SHA384 SHA256 SHA96 MD596
  PRF       : SHA512 SHA384 SHA256 SHA1 MD5
  DH Group   : DH_GROUP_1536_MODP/Group 5 DH_GROUP_1024_MODP/Group 2
```

Step 6: Configure the IKEv2 policy.

The crypto policy includes the proposal you created in the previous step. This policy will match any FVRF defined on the router.

```
crypto ikev2 policy [policy name]
  match fvrf any
  proposal [proposal name]
```

Example

```
crypto ikev2 policy AES/GCM/256
  match fvrf any
  proposal AES/GCM/256
```

The default IKEv2 policy is also used.

A **show crypto ikev2 policy** displays the details of the two policies.

```
show crypto ikev2 policy

IKEv2 policy : AES/GCM/256
  Match fvrf : any
  Match address local : any
  Proposal   : AES/GCM/256

IKEv2 policy : default
  Match fvrf : any
  Match address local : any
  Proposal   : default
```

Step 7: Configure the IKEv2 profile.

The IKEv2 profile creates an association between an identity address and a VRF. A wildcard address within a VRF is referenced with 0.0.0.0. The **identity local address** must match the crypto pki trustpoint's **ip-address** value from the step above.

Tech Tip

Use the **identity local address** in the ikev2 profile in order to avoid repeated CRYPTO-6-IKMP_NO_ID_CERT_ADDR_MATCH warning messages on the router.

The profile also defines what method of key sharing will be used on this router with **authentication local** and what methods will be accepted from remote locations with **authentication remote**. The **rsa-sig** keyword is used when certificates contain the encryption key.

```
crypto ikev2 profile [profile name]
  description [profile description]
  match fvrf [vrf name]
  match identity remote address [IP address]
  identity local address [Loopback IP address of this router]
  authentication remote rsa-sig
  authentication local rsa-sig
  pki trustpoint [trustpoint name]
```

Example: Hybrid hub border router– HY-INET1-ASR1002X-2

```
crypto ikev2 profile DMVPN-PKI-IKEv2-PROFILE
  description PKI Profile
  match fvrf any
  match identity remote address 0.0.0.0
  identity local address 10.6.32.242
  authentication remote rsa-sig
  authentication local rsa-sig
```

Step 8: Define the IPsec transform set.

A transform set is an acceptable combination of security protocols, algorithms, and other settings to apply to IPsec-protected traffic. Peers agree to use a particular transform set when protecting a particular data flow.

The IPsec transform set for DMVPN uses ESP with the 256-bit GCM encryption algorithm.

Because the DMVPN hub router is behind a NAT device, the IPsec transform must be configured for transport mode.

```
crypto ipsec transform-set [transform set] esp-gcm 256
  mode transport
```

Example

```
crypto ipsec transform-set AES256/GCM/TRANSFORM esp-gcm 256
  mode transport
```

Step 9: Configure the IPsec profile.

The IPsec profile creates an association between an IKEv2 profile and an IPsec transform-set.

```
crypto ipsec profile [profile name]
  set transform-set [transform set]
  set ikev2-profile [ikev2 profile name]
```

Example

```
crypto ipsec profile DMVPN-PKI-IPSEC-PROFILE
  set transform-set AES256/GCM/TRANSFORM
  set ikev2-profile DMVPN-PKI-IKEv2-PROFILE
```

Step 10: Configure the tunnel.

Enable encryption using PKI on the tunnel interface of an existing IWAN configuration by applying the IPsec profile configured in the previous procedure.

Example: Hybrid hub border router– HY-INET1-ASR1002X-2

```
interface Tunnel200
  tunnel protection ipsec profile DMVPN-PKI-IPSEC-PROFILE
```

PROCESS

Deploying PKI for a remote site router

1. Configuring with a certificate authority

This section is for remote site routers only.

The parameters in the table below are used in this section. The crypto configurations have been simplified in this version of the guide in order to minimize the variations from previous guides. Use the values in the table that represent the design you are configuring.

Table 2 *Crypto parameters*

Parameter	Public Key Infrastructure
crypto ikev2 profile	DMVPN-PKI-IKEv2-PROFILE
crypto ipsec profile	DMVPN-PKI-IPSEC-PROFILE

IPsec uses a key exchange between the routers in order to encrypt/decrypt the traffic. These keys can be exchanged using pre-shared keys or PKI certificates with a certificate authority. It is also possible to use a combination of the two, which is useful during a migration from one method to the other.

Procedure 1 Configuring with a certificate authority

If you do not have a certificate authority in your network, you may follow the optional section “IOS Certificate Authority” to deploy an IOS certificate authority using a Cisco router.

To use a certificate authority, you will have to configure a pre-shared key on one of the hub border routers in order to allow each remote site to establish a DMVPN tunnel to the WAN aggregation site. After the first DMVPN tunnel at a remote site is established, the router will be able to authenticate to the CA and obtain a certificate. After obtaining the certificate, you can configure the remote site to use PKI.

The **crypto pki trustpoint** is the method of specifying the parameters associated with a CA. The router must authenticate to the CA first and then enroll with the CA in order to obtain its own identity certificate.

Step 1: The fingerprint command limits the responding CA. You can find this fingerprint by using **show crypto pki server** on the IOS CA.

```
IWAN-IOS-CA#show crypto pki server
Certificate Server IWAN-IOS-CA:
  Status: enabled
  State: enabled
  Server's configuration is locked (enter "shut" to unlock it)
  Issuer name: CN=IWAN-IOS-CA.cisco.local L=SanJose St=CA C=US
  CA cert fingerprint: 75BEF625 9A9876CF 6F341FE5 86D4A5D8
  Granting mode is: auto
  Last certificate issued serial number (hex): 59
  CA certificate expiration timer: 13:19:42 PST Dec 24 2017
  CRL NextUpdate timer: 14:55:59 PDT Sep 12 2016
  Current primary storage dir: nvram:
  Current storage dir for .crl files: nvram:
  Database Level: Complete - all issued certs written as <serialnum>.cer
```

Step 2: Configure the PKI trust point.

```
crypto pki trustpoint [name]
  enrollment url [URL of IOS CA]
  serial-number none
  fqdn [fully qualified domain name of this router]
  ip-address [loopback IP address of this router]
  fingerprint [fingerprint from IOS CA]
  revocation-check crl none
  rsakeypair [name] 2048 2048
```

Example: Second router of dual-router site for hybrid–RS14-2921-2

This example is from the primary WAN remote site router in the hybrid design model. After the DMVPN tunnel is established with pre-shared keys, it can reach the IOS CA through the internal network at 10.6.24.11 using the default VRF.

```
crypto pki trustpoint IWAN-CA
  enrollment url http://10.6.24.11:80
  serial-number none
  fqdn RS14-2921-2.cisco.local
  ip-address 10.255.247.14
  fingerprint 75BEF6259A9876CF6F341FE586D4A5D8
  revocation-check crl none
  rsakeypair IWAN-CA-KEYS 2048 2048
```

Tech Tip

With the `revocation-check crl none` command, the router will do a CRL check as long as the CA server is reachable. If the CA server is not reachable, then the router checks the signature.

Step 3: Authenticate to the CA and obtain the CA's certificate

Exit the trustpoint configuration mode on the hub router and issue the following command to authenticate to the CA and get its certificate.

```
(config)# crypto pki authenticate IWAN-CA
Certificate has the following attributes:
  Fingerprint MD5: 75BEF625 9A9876CF 6F341FE5 86D4A5D8
  Fingerprint SHA1: 9C14D6F4 D1F08023 17A85669 52922632 C6B02928
Trustpoint Fingerprint: 75BEF625 9A9876CF 6F341FE5 86D4A5D8
Certificate validated - fingerprints matched.
```

Step 4: When the trustpoint CA certificate is accepted, enroll with the CA, enter a password for key retrieval, and obtain a certificate for this hub router.

```
(config)# crypto pki enroll IWAN-CA
% Start certificate enrollment ..
% Create a challenge password. You will need to verbally provide this
password to the CA Administrator in order to revoke your certificate.
For security reasons your password will not be saved in the configuration.
Please make a note of it.

Password: c1sco123
```

Re-enter password: **clisco123**

% The subject name in the certificate will include: RS14-2921-2.cisco.local

% The IP address in the certificate is 10.255.247.14

Request certificate from CA? [yes/no]: **yes**

% Certificate request sent to Certificate Authority

% The `'show crypto pki certificate verbose IWAN-CA'` command will show the fingerprint.

Step 5: Configure the IKEv2 proposal. The user-defined IKEv2 proposal includes only the following:

- Encryption with AES cipher and a 256-bit key
- Pseudo-random function with SHA and a 512-bit digest
- Diffie-Hellman group: 19

```
crypto ikev2 proposal [proposal name]
  encryption [encryption algorithm]
  prf [pseudo-random function algorithm]
  group [Diffie-Hellman group]
```

Example

```
crypto ikev2 proposal AES/GCM/256
  encryption aes-gcm-256
  prf sha512
  group 19
```

The default IKEv2 proposal is also used.

A `show crypto ikev2 proposal` displays the details of the two proposals.

show crypto ikev2 proposal

```
IKEv2 proposal: AES/GCM/256
  Encryption : AES-GCM-256
  Integrity  : none
  PRF       : SHA512
  DH Group   : DH_GROUP_256_ECP/Group 19
IKEv2 proposal: default
  Encryption : AES-CBC-256 AES-CBC-192 AES-CBC-128
  Integrity  : SHA512 SHA384 SHA256 SHA96 MD596
  PRF       : SHA512 SHA384 SHA256 SHA1 MD5
  DH Group   : DH_GROUP_1536_MODF/Group 5 DH_GROUP_1024_MODF/Group 2
```


Step 6: Configure the IKEv2 policy.

The crypto policy includes the proposal you created in the previous step. This policy will match any FVRF defined on the router.

```
crypto ikev2 policy [policy name]
  match fvrf any
  proposal [proposal name]
```

Example

```
crypto ikev2 policy AES/GCM/256
  match fvrf any
  proposal AES/GCM/256
```

The default IKEv2 policy is also used.

A **show crypto ikev2 policy** displays the details of the two policies.

```
show crypto ikev2 policy
IKEv2 policy : AES/GCM/256
  Match fvrf : any
  Match address local : any
  Proposal    : AES/GCM/256

IKEv2 policy : default
  Match fvrf : any
  Match address local : any
  Proposal    : default
```

Step 7: Configure the IKEv2 profile.

The IKEv2 profile creates an association between an identity address and a VRF. A wildcard address within a VRF is referenced with 0.0.0.0. The **identity local address** must match the crypto pki trustpoint's **ip-address** value from the step above.

Tech Tip

Use the **identity local address** in the ikev2 profile in order to avoid repeated CRYPTO-6-IKMP_NO_ID_CERT_ADDR_MATCH warning messages on the router.

The profile also defines what method of key sharing will be used on this router with **authentication local** and what methods will be accepted from remote locations with **authentication remote**. The **rsa-sig** keyword is used when certificates contain the encryption key.

DPD is essential in order to facilitate fast reconvergence and for spoke registration to function properly in case a DMVPN hub is restarted. The IWAN design recommends you set the remote site DPD timer to 40 seconds with a 5 second retry.

```

crypto ikev2 profile [profile name]
  description [profile description]
  match fvrfr [vrf name]
  match identity remote address [IP address]
  identity local address [Loopback IP address of this router]
  authentication remote rsa-sig
  authentication local rsa-sig
  pki trustpoint [trustpoint name]
  dpd [interval in seconds] [retry interval] on-demand

```

Example: Second router of dual-router site for hybrid-RS14-2921-2

```

crypto ikev2 profile DMVPN-PKI-IKEv2-PROFILE
  description PKI Profile
  match fvrfr any
  match identity remote address 0.0.0.0
  identity local address 10.255.247.14
  authentication remote rsa-sig
  authentication local rsa-sig
  pki trustpoint IWAN-CA
  dpd 40 5 on-demand

```

Step 8: Define the IPsec transform set.

A transform set is an acceptable combination of security protocols, algorithms, and other settings to apply to IPsec-protected traffic. Peers agree to use a particular transform set when protecting a particular data flow.

The IPsec transform set for DMVPN uses ESP with the 256-bit GCM encryption algorithm.

Because the DMVPN hub router is behind a NAT device, the IPsec transform must be configured for transport mode.

```

crypto ipsec transform-set [transform set] esp-gcm 256
  mode transport

```

Example

```

crypto ipsec transform-set AES256/GCM/TRANSFORM esp-gcm 256
  mode transport

```

Step 9: Configure the IPsec profile.

The IPsec profile creates an association between an IKEv2 profile and an IPsec transform-set.

```
crypto ipsec profile [profile name]
  set transform-set [transform set]
  set ikev2-profile [ikev2 profile name]
```

Example

```
crypto ipsec profile DMVPN-PKI-IPSEC-PROFILE
  set transform-set AES256/GCM/TRANSFORM
  set ikev2-profile DMVPN-PKI-IKEv2-PROFILE
```

Step 10: Configure the tunnel.

Enable encryption using PKI on the tunnel interface of an existing IWAN configuration by applying the IPsec profile configured in the previous procedure.

Example: Second router of dual-router site for hybrid-RS14-2921-2

```
interface Tunnel200
  tunnel protection ipsec profile DMVPN-PKI-IPSEC-PROFILE
```

Appendix A: Product List

To view the full list of IWAN-supported routers for this version of the CVD, see [Supported Cisco Platforms and Software Releases](#). All master controllers and border router devices at a common site must use the same version of software.

This guide was validated using the software detailed in this appendix. When deploying, you should always use the Cisco IOS Software Checker tool to see if there are software vulnerabilities applicable for your environment. This tool is available at the following location:

<https://tools.cisco.com/security/center/selectIOSVersion.x>

Appendix B: Changes

This appendix summarizes the changes Cisco made to this guide since its last edition.

- Public Key Infrastructure update:
 - Added the final tunnel configuration for clarity



You can use the [feedback form](#) to send comments and suggestions about this guide.



Americas Headquarters
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San Jose, CA

Asia Pacific Headquarters
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Singapore

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Cisco Systems International BV Amsterdam,
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