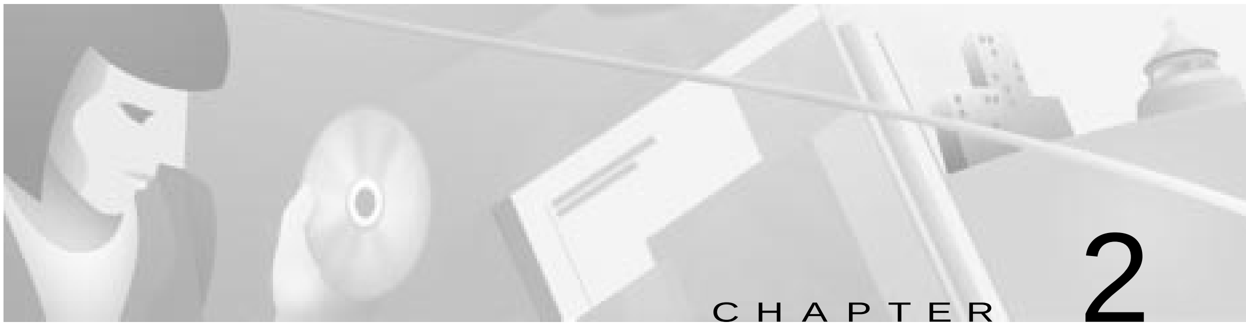


CHAPTER 2

# Case Study for Layer 3 Authentication and Encryption

This chapter explains the basic tasks for configuring a multi-service, extranet Virtual Private Network (VPN) between a Cisco Secure VPN Client (VPN Client) and a Cisco IOS networking device (gateway). This case study describes IP Security Protocol (IPSec) tunnelling. This chapter includes the following sections:

- Case Study Overview
- Site Profile Characteristics

**Note** Throughout this chapter, there are numerous configuration examples that include unusable IP addresses, passwords, and public key examples. Be sure to use your own IP addresses, passwords, and public keys when configuring your VPN Clients and gateway.

## Case Study Overview

This case study describes how an enterprise plans, designs, and implements remote access VPNs using IPSec tunneling protocol. IPSec tunneling protocol authenticates and encrypts point-to-point (PPP) sessions from one device to another across a shared network infrastructure. This case study describes how a VPN Client is authenticated and encrypts an IPSec tunnel to the corporate enterprise. This case study contains following topics:

- IPSec Tunneling Protocol
- Authentication and Encryption Features
- Building an Access VPN

### IPSec Tunneling Protocol

This section includes the following topics:

- Description of IPSec Tunneling
- Function of IPSec Tunneling
- Benefits of IPSec Tunneling
- Roles in IPSec Tunneling

### Description of IPSec Tunneling

IPSec tunneling protocol is based on the IPSec Security Protocol feature, which is framework of open standards developed by the Internet Engineering Task Force (IETF). IPSec provides data confidentiality, data integrity, and data authentication between participating peers. IPSec provides these security services at the IP layer; it uses IKE to handle negotiation of protocols and algorithms based on local policy and to generate the encryption and authentication keys to be used by IPSec. IPSec can be used to protect one or more data flows between a pair of hosts, between a pair of security gateways, or between a security gateway and a host.

### Function of IPSec Tunneling

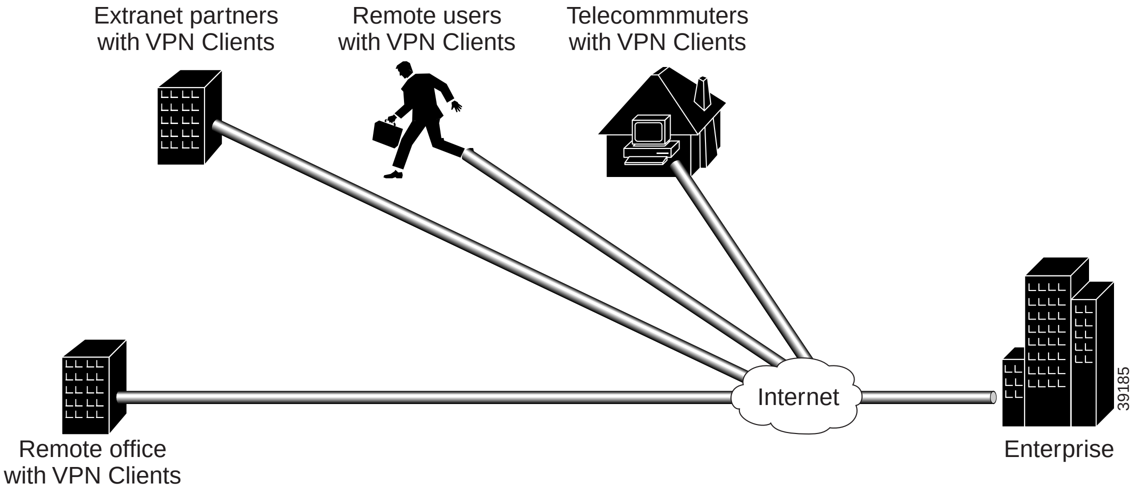
In IPSec tunnel mode, the remote users' VPN Clients encrypt the entire original IP datagrams. These encryptions become the payload in new IP packets. The VPN Clients initiate IPSec tunnels with a network device, such as a Cisco IOS router or a Cisco Secure PIX Firewall (gateway). The gateway acts as an IPSec proxy, performing encryption on behalf of all the hosts. The VPN Clients encrypt packets and forward them along the IPSec tunnel. The gateway decrypts the original IP datagrams and forwards them to their destination.

### Benefits of IPSec Tunneling

The major advantage of IPSec tunnel mode is that the end systems do not need to be modified to receive the benefits of IPSec. IPSec tunnel mode also protects against traffic analysis; with IPSec tunnel mode an attacker can only determine the tunnel endpoints and not the true source and destination of the tunneled packets, even if they are the same as the tunnel endpoints.

Figure 2-1 shows an enterprise with a specific business objective. The enterprise must provide secured access to multiple remote users (such as telecommuters, travelling remote users, remote offices, and extranet partners). To do this, remote users use VPN Clients to authenticate a connection to the corporate internal network, then to encrypt tunnels for data to the corporate internal network using IPSec tunneling protocol.

*Figure 2-1 End-to-End Client-Initiated Access VPN Scenario*


Extranet partners with VPN Clients
Remote users with VPN Clients
Telecommmuters with VPN Clients
Internet
Remote office with VPN Clients
Enterprise
39185

### Roles in IPSec Tunneling

- The extranet partner purchases, configures and maintains the PC and the VPN Client software.
- The remote users, telecommuters and remote offices all obtain equipment from the enterprise.
- The enterprise network administrator purchases, configures, and maintains the VPN Client software, the remote access PCs on which the VPN Client software is to be installed, the home gateway, a public web server, and the private corporate server.

## Authentication and Encryption Features

For the enterprise, there are several business considerations when configuring Layer 3 Encryption:

- Will each remote user’s VPN Client use manual pre-shared keys or scalable digital certificates for authentication?
- Will each remote user’s VPN Client use its own pre-shared key for authentication or will a group of remote users’ VPN Client share a wildcard pre-shared key for authentication?
- Will each remote user’s VPN Client be manually configured for individual device authentication or will each group of remote users’ VPN Clients be dynamically configured for authentication?

These considerations affect the overall VPN architecture of the enterprise network. Based on the features you choose to configure your VPN network, your network will be more or less secure and scalable. This section provides a brief introduction of the encryption features, their limitations and restrictions, and their role in a VPN solution. Depending on your network topology, one or more of the following encryption features may be a requirement in your VPN network.

- Manual Configuration (Static IP Addressing)
- IKE Mode Configuration (Dynamic IP Addressing)
- Pre-Shared Keys
- Wildcard Pre-Shared Keys
- Digital Certification

**Note** For information about which features are supported on a specific Cisco IOS software release or version of the VPN Client, refer to the release notes for your version of the VPN Client. For more details, refer to “Cisco Secure VPN Client Documentation” in the Preface.

## Manual Configuration (Static IP Addressing)

This section includes the following topics:

- Description of Manual Configuration
- Function of Manual Configuration
- Benefits of Manual Configuration
- Limitations and Restrictions of Manual Configuration
- Alternatives to Manual Configuration

### Description of Manual Configuration

The manual configuration feature addresses the enterprise requirement to allow for a more secure method of assigning IP addresses to a small number of VPN Clients by assigning static internal IP addresses. A static IP address is a unique IP address that is assigned to a client for an extended period of time, to be used by only that client.

### Function of Manual Configuration

Without the manual configuration feature, it is difficult for the gateway to authenticate a VPN Client with an IP address dynamically-assigned through an ISP. A local ISP assigns the VPN Client a routable IP address from its pool. The VPN Client creates an encrypted tunnel to the gateway. The tunnel source IP address, which is the IP address of the client as the IPSec peer, matches the original source IP address, which is the IP address assigned to the client by the ISP for communications with the ISP. Because both source IP addresses match, the gateway cannot determine which source IP address belongs to the trusted peer.

### Benefits of Manual Configuration

For an enterprise with a small number of VPN Clients, manual configuration is a simple method of assigning internal corporate IP addresses to each remote VPN Client, making it easier to set up IPSec policy on each VPN Client. IKE Mode Configuration is the alternative to manually configuring internal IP addresses on each remote access VPN Client.

### Limitations and Restrictions of Manual Configuration

For a large number of VPN Clients, manual configuration is not a very secure method. The IP address on the VPN Client is static, and remains configured on the VPN Client even when a remote user is not logged on. The static IP address or IKE security parameters on the VPN Client can be viewed, then used by an untrusting party. The untrusting party can masquerade as the remote user. For this reason, manual configuration is less secure than IKE Mode Configuration in that it is more sensitive to IP spoofing attacks. Should an attacker get access to the IKE security parameters on a VPN Client, that attacker can masquerade as the remote user authorized to connect to the corporate network.

For a large number of VPN Clients, manual configuration is also not very scalable because each VPN Client must be manually configured. Each time the network grows, configuring and maintaining additional VPN Clients can be time-consuming and complex. Each time the gateway is reconfigured to permit access to more VPN Clients, each VPN Client has to be reconfigured to match the new gateway configuration.

To prevent attacks, the following instructions should be a part of your enterprise security policy:

- The gateway administrator *must* manually configure each client. Each time a VPN Client is added to the network, the gateway administrator must configure another **access-list** global configuration command on the gateway to permit traffic from that static IP address on the VPN Client. Also, the gateway administrator must ensure all traffic destined for the VPN Clients' subnet is routed back to the gateway to be encrypted, using the **crypto map local-address** global configuration command with interface **loopback0**. A loopback interface is a virtual interface that is always up and allows routing protocols to stay up even if the physical interface is down.
- On the gateway, the gateway administrator *must* configure an access-list rule matching each VPN Client IP address because of the source proxy definitions—which are IP addresses instead of subnets—on the VPN Clients.
- The gateway administrator *must* ensure all traffic destined for the VPN Clients' IP address pool on the enterprise subnet is routed back to the gateway for encryption, because the gateway does not automatically route to the VPN Clients. To do this, the gateway administrator *must* define a static route between the gateway and all VPN Clients.

### Alternatives to Manual Configuration

The alternative to static IP addressing with manual configuration is dynamic IP addressing with IKE Mode Configuration.

## IKE Mode Configuration (Dynamic IP Addressing)

This section includes the following topics:

- Description of IKE Mode Configuration
- Function of IKE Mode Configuration
- Benefits of IKE Mode Configuration
- Alternatives to IKE Mode Configuration

### Description of IKE Mode Configuration

The IKE Mode Configuration feature addresses the enterprise requirement to issue scalable, dynamic IP addresses to one or more clients by configuring scalable IPSec policy on the gateway. A dynamic IP address is an IP address that is temporarily assigned as part of a login session, to be returned to an IP pool at the end of the session. IKE Mode Configuration is a gateway-initiated IKE negotiation that occurs between IKE phase 1 and IKE phase 2. The gateway assigns a dynamic IP address to the VPN Clients, replacing any current IP address configuration on the VPN Clients. IKE Mode Configuration secures the connection between the VPN Clients and ISPs with an IPSec tunnel, and allows for dynamic IP addressing of VPN Clients from the gateway. With IKE Mode Configuration, you can download IP addresses (and other network level configuration, such as your IPSec policy) to VPN Clients as part of an IKE negotiation. The gateway administrator can add VPN Clients to the network without having to reconfigure the gateway or the VPN clients.

### Function of IKE Mode Configuration

Without the IKE Mode Configuration feature, it is difficult for the gateway to administer scalable IPSec policy on many VPN Clients. A new IPSec policy is required for each VPN Client because each has a dynamic IP address, each dynamic IP address is assigned by the VPN Client's local ISP, and each of these dynamic IP addresses will not be within the enterprise subnet's IP address range.

When a remote user wants to connect to an corporate gateway, the remote user's VPN Client must first establish a point-to-point (PPP) connection to the ISP's NAS (network access server). The NAS authenticates the PPP connection. Then, the VPN Client initiates ISAKMP SA with the untrusted peer at the gateway. After the ISAKMP SA is created and authenticated, the gateway initiates IKE Mode Configuration with the VPN Client. After the VPN Client receives the dynamic IP address from the gateway, the VPN Client loads the IPSec SA from the gateway.

### Benefits of IKE Mode Configuration

For corporations with large numbers of VPN Clients, IKE Mode Configuration is a scalable approach to assigning dynamic IP addresses and administering IPSec policy for VPNs between multiple remote access VPN clients and corporate networks. Gateway administrators do not have to manually configure each VPN Client, because no VPN Client configuration is required. With IKE Mode Configuration, the gateway can set up a scalable IPSec policy for a very large set of VPN Clients, replacing pre-existing IP addresses on VPN Clients with dynamic IP addresses within the IP range of the corporate subnet.

IKE Mode Configuration uses dynamic IP addressing, which is more secure than manual configuration with static IP addressing. The IPSec policy set up on the gateway uses dynamic crypto maps. With IKE Mode Configuration, each time a remote user forms a tunnel to the gateway using a VPN Client, a new IP address from within the corporate subnet's IP address pool is assigned to the VPN Client. Also, unlike manual configuration, IKE Mode Configuration does not rely on an access list because the gateway administrator can easily define the local address pool on the gateway. In addition, the gateway automatically defines a static route to the VPN Clients and inserts the static route into the routing table during IKE Mode Configuration. When all IKE and IPSec negotiations are completed, IKE Mode Configuration automatically removes the dynamic IP address, returns it to the corporate subnet's IP address pool, and removes the static route.

### Alternatives to IKE Mode Configuration

The alternative to dynamic IP addressing with IKE Mode Configuration is static IP addressing with manual configuration.

## Pre-Shared Keys

This section includes the following topics:

- Description of Pre-Shared Keys
- Function of Pre-Shared Keys
- Benefits of Pre-Shared Keys
- Limitations and Restrictions of Pre-Shared Keys
- Alternatives to Pre-Shared Keys

### Description of Pre-Shared Keys

The pre-shared key feature addresses the enterprise requirement to allow for one or more clients to use individual shared secrets to authenticate encrypted tunnels to a gateway using IKE. The Diffie-Hellman key exchange combines public and private keys to create a shared secret to be used for authentication between IPSec peers. The shared secret can be shared between two or more peers. At each participating peer, you would specify a shared secret as part of an IKE policy. Distribution of this pre-shared key usually takes place through a secure out-of-band channel.

**Note** When using a pre-shared key, if one of the participating peers is not configured with the same pre-shared key, the IKE SA cannot be established. An IKE SA is a prerequisite to an IPSec SA. You *must* configure the pre-shared key at all peers.

### Function of Pre-Shared Keys

The pre-shared key feature requires that each client has its own pre-shared key, which must match a pre-shared key configured on the gateway for authentication. Use pre-shared keys for VPN Clients with static or dynamic IP addresses.

### Benefits of Pre-Shared Keys

Pre-shared keys are commonly used in small networks of up to 10 clients. With pre-shared keys, there is no need to involve a CA for security.

### Limitations and Restrictions of Pre-Shared Keys

To prevent attacks, the following instructions should be a part of your security policy:

- The gateway administrated *must* initially configure each client with a separate and distinct key for secure authentication.
- Each time another client or remote user is added, the gateway administrator *must* configure that client with a new key, and reconfigure the gateway to permit that new key.
- Each time a client or remote user is removed, the gateway administrator *must* reconfigure the gateway to deny the key that client used.

### Alternatives to Pre-Shared Keys

Without a method of client authentication, you cannot establish an encrypted tunnel between a client and gateway. Digital certification and wildcard pre-shared keys are alternatives to pre-shared keys. Both digital certification and wildcard pre-shared keys are more scalable than pre-shared keys.

## Wildcard Pre-Shared Keys

This section includes the following topics:

- Description of Wildcard Pre-Shared Keys
- Function of Wildcard Pre-Shared Keys
- Benefits of Wildcard Pre-Shared Keys
- Limitations and Restrictions of Wildcard Pre-Shared Keys
- Alternatives to Wildcard Pre-Shared Keys

### Description of Wildcard Pre-Shared Keys

The wildcard pre-shared key feature addresses the enterprise requirement to allow for one or more clients to use a shared secret to authenticate encrypted tunnels to a gateway. With a wildcard pre-shared key configured on a router, any peer using the same pre-shared key is a valid peer to the router.

The key that you configure on one peer is identical to the values assigned to prospective peers. With wildcard pre-shared keys, a peer is no longer a static IP address, but a subnet that is dynamically assigned by the router.

### Function of Wildcard Pre-Shared Keys

The wildcard pre-shared feature allows a group of clients with the same level of authentication to share a pre-shared key, which also must match a pre-shared key configured on the gateway for authentication. Use wildcard pre-shared keys for VPN Clients with static or dynamic IP addresses.

### Benefits of Wildcard Pre-Shared Keys

Because a group of VPN Clients with the same level of authentication share a key, the wildcard pre-shared key method scales better than pre-shared keys. Each time another VPN Client is added, that client only needs to be configured with the group key—no gateway reconfiguration is required. Each time a client is removed, the gateway and all VPN Clients must be reconfigured with a new group key to prevent attacks. The *wildcard* aspect of wildcard pre-shared keys means that any IPSec peer with the pre-shared key can access the enterprise network, regardless of the IPSec peer's IP address assignment.

### Limitations and Restrictions of Wildcard Pre-Shared Keys

The wildcard pre-shared key feature is vulnerable to IP spoofing, specifically the *man-in-the-middle* attack. An attacker can potentially redirect all traffic between the IPSec peers to go through an IKE proxy. If an attacker knows the pre-shared key and can redirect all traffic between the IPSec peers to go through an IKE proxy, the attacker can read and modify the IPSec-protected data without detection.

To prevent attacks to one or more parties using wildcard pre-shared key(s), the following instructions should be a part of your enterprise security policy:

- The gateway administrator *must* initially configure each client with the group key for secure authentication.
- For different groups of remote users requiring varying levels of authorization, the gateway administrator *must* use a distinctly different key for each peer. The gateway administrator *must* configure a key for each level of trust, and assign the correct keys to the correct parties.
- Each time another client or remote user is added to a group, the gateway administrator or remote user *must* configure that client with the pre-existing group key.

- Each time a client or remote user is removed from a group, the gateway administrator *must* reconfigure the gateway for a new group key. The remote user whose client is removed becomes an untrusted peer. The remaining trusted remote users *must* reconfigure their clients for a new key. The gateway administrator should distribute the new group key and instructions to remote users through a secure channel.

### Alternatives to Wildcard Pre-Shared Keys

Without a method of client authentication, you cannot establish an encrypted tunnel between a client and gateway. Digital certification and pre-shared keys are alternatives to wildcard pre-shared keys.

## Digital Certification

This section includes the following topics:

- Description of Digital Certification
- Function of Digital Certification
- Benefits of Digital Certification
- Limitations and Restrictions of Digital Certification
- Alternatives to Digital Certification

### Description of Digital Certification

The digital certification feature addresses the enterprise requirement to allow one or more clients to use digital certificates to authenticate encrypted tunnels to a gateway. Digital certification is supported on the Cisco Secure VPN Client in certification authority (CA) and Registration Authority (RA) modes.

Simple Certificate Enrollment Protocol (SCEP) is a certificate enrollment protocol based on common and well understood PKCS #10/7 standards using HTTP transport methods. SCEP provides a standard way to enroll network devices with a CA, as well as to lookup and retrieve CRL information from LDAP or HTTP methods. Version 1.1 of the VPN Client supports the Registration Authority (RA) mode for SCEP enrollment. RA SCEP is currently supported by the Entrust and Microsoft CAs.

**Note** See to the latest release notes of your specific version of the VPN Client and networking devices for CA support.

#### Entrust VPN Connector or Microsoft Certificate Services

These CAs require that both IPSec peers transact with a Registration Authority (RA), which then forwards the requests through to the CA. Both the remote IPSec peer and the local IPSec peer must be configured with both the CA and RA public keys. The CA and RA public keys are signature and encryption key pairs, which must be generated and enrolled for authentication to occur.

- For more details, refer to Appendix A, “Configuring Entrust Digital Certificates.”
- For more details, refer to Appendix B, “Configuring Microsoft Certificate Services.”

#### VeriSign Onsite Management Service

This CA provides certificate processing, backup, key recovery, and customer support. The enterprise gateway administrator handles approval, enrollment, validation, issuance, and renewal of digital certificates.

For more details, refer to Appendix C, “Configuring VeriSign Digital Certificates.”

**Note** Cisco Secure VPN Client may be interoperable with other digital certificates, however, Cisco does not currently support these and you would have to do your own troubleshooting. Cisco recommends using the Cisco-supported digital certificates, as they have been thoroughly tested and have been deemed deployable for customers.

### Function of Digital Certification

The digital certification feature requires that each IPSec peer has its own digital certificate, which is issued and validated by the certification authority (CA). To authenticate itself to the gateway, the client sends a certificate that performs public key cryptography with the gateway. Each peer's certificate encapsulates that peer’s public key, each certificate is authenticated by the CA, and all participating IPSec peers recognize the CA as an authenticating authority. This is called IKE with an RSA signature.

Essentially, the steps to signing on with a CA are as follows:

1. The VPN Client must generate a public/private key pair for the CA to sign. The VPN Client first signs outbound data with its private key. Then, the CA uses the VPN Client’s public key to validate that this data was originated by the VPN Client.
2. The VPN Client requests the CA’s public key. Only after the VPN Client has the CA’s public key can the VPN Client validate data coming from the CA.
3. The VPN Client sends an enrollment request to the CA. The CA ties the VPN Client’s personal certificate to its public key, then signs the personal certificate.
4. The VPN Client accepts the signed personal certificate. The VPN Client validates this certificate by decrypting the signed personal certificate with its private key.

### Benefits of Digital Certification

Because each VPN Client and each router has its own digital certificate and authentication is handled by the CA, a network is more scalable and provides a more secure authentication with digital certificates than with pre-shared keys or wildcard pre-shared keys. With digital certification, you can configure unlimited numbers of VPN Clients without having to change the gateway configuration.

### Limitations and Restrictions of Digital Certification

To prevent attacks to one or more parties using digital certification, the following instructions should be a part of your enterprise security policy:

- An IPSec peer can send its own certificate for multiple IPSec sessions with multiple IPSec peers.
- When an IPSec peer’s certificate expires periodically, the gateway administrator *must* obtain new digital certificates from the CAs, and reconfigure the devices with these new digital certificates.
- The gateway administrator *must* ensure that all digital certificates obtained are interoperable with all the devices in the network.

### Alternatives to Digital Certification

Without a method of client authentication, you cannot establish an encrypted tunnel between a client and gateway. Digital certification and pre-shared keys are the alternative to wildcard pre-shared keys.

# Building an Access VPN

This section covers the following topics:

- Enterprise Network Equipment
- Enterprise Access VPN Description
- Protocol Negotiation Sequence

## Enterprise Network Equipment

Figure 2-2 shows the specific network devices used by the enterprise to build the access VPN in this case study.

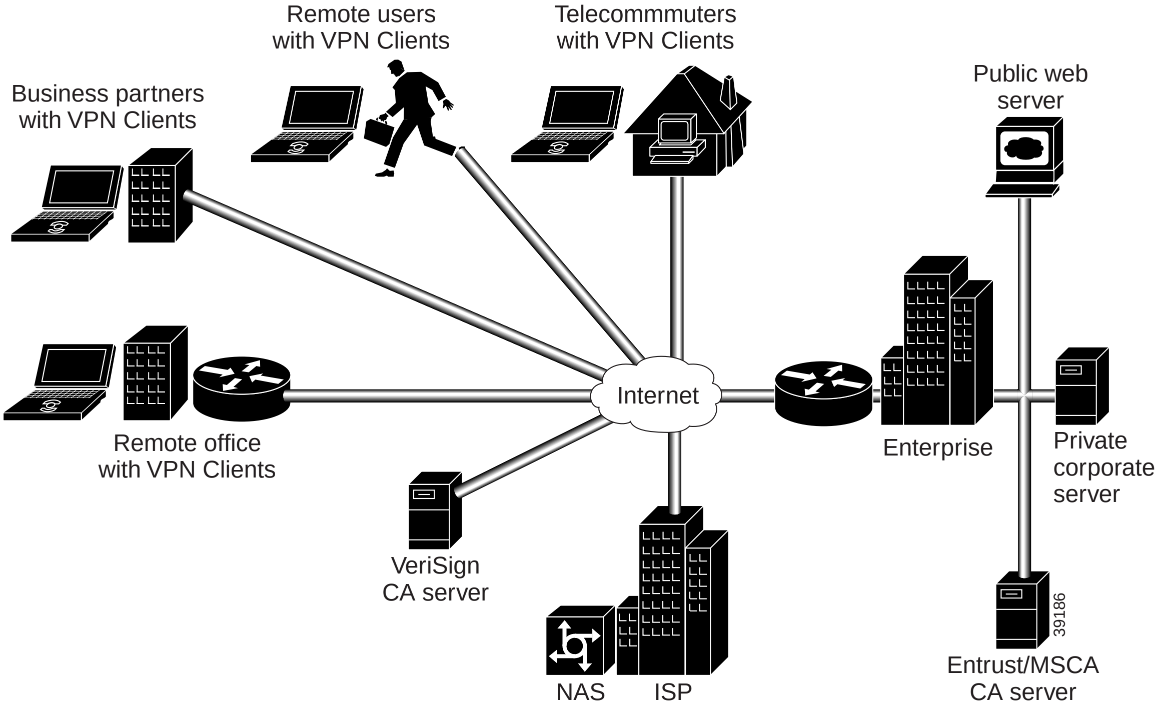
- The VPN Client software, which the network administrator may preconfigure with a one-time-only static IP address or set up to be configured on-the-fly with a dynamic IP address.
- A home gateway (such as a Cisco IOS router or a Cisco Secure PIX Firewall) configured with an IPSec software image from a supported Cisco IOS software release.
- A public web server and a private corporate server.

## Enterprise Access VPN Description

The VPN Clients initiate the IPSec tunnels by requesting authentication with the IPSec peer, the home gateway. Once the home gateway authenticates the connection, the VPN Clients establish an encrypted tunnel to the home gateway. To route authorized traffic to its specified destination, an access-list is set up on the home gateway to permit or deny traffic into different subnets on the corporate network:

- For corporate employees, access to permitted for the private corporate server, where they may access confidential data remotely. Corporate employees may also view information on the public web server.
- For extranet partners, access is limited to a public web server, where they perform various IP-based network tasks, such as placing and managing product orders. Business partner access to all private internal corporate servers is denied.

*Figure 2-2 Access VPN Case Study Network Topology*



## Protocol Negotiation Sequence

Figure 2-3 shows the protocol negotiation sequence between one VPN Client and a gateway. Table 2-1 describes the events displayed in this protocol negotiation sequence.

**Note** Although you may not have all encryption features configured for your VPN, Figure 2-3 shows the period during IKE negotiation during which each feature performs its task.

***Figure 2-3 Protocol Negotiation Sequence—Client-Initiated Access VPN***

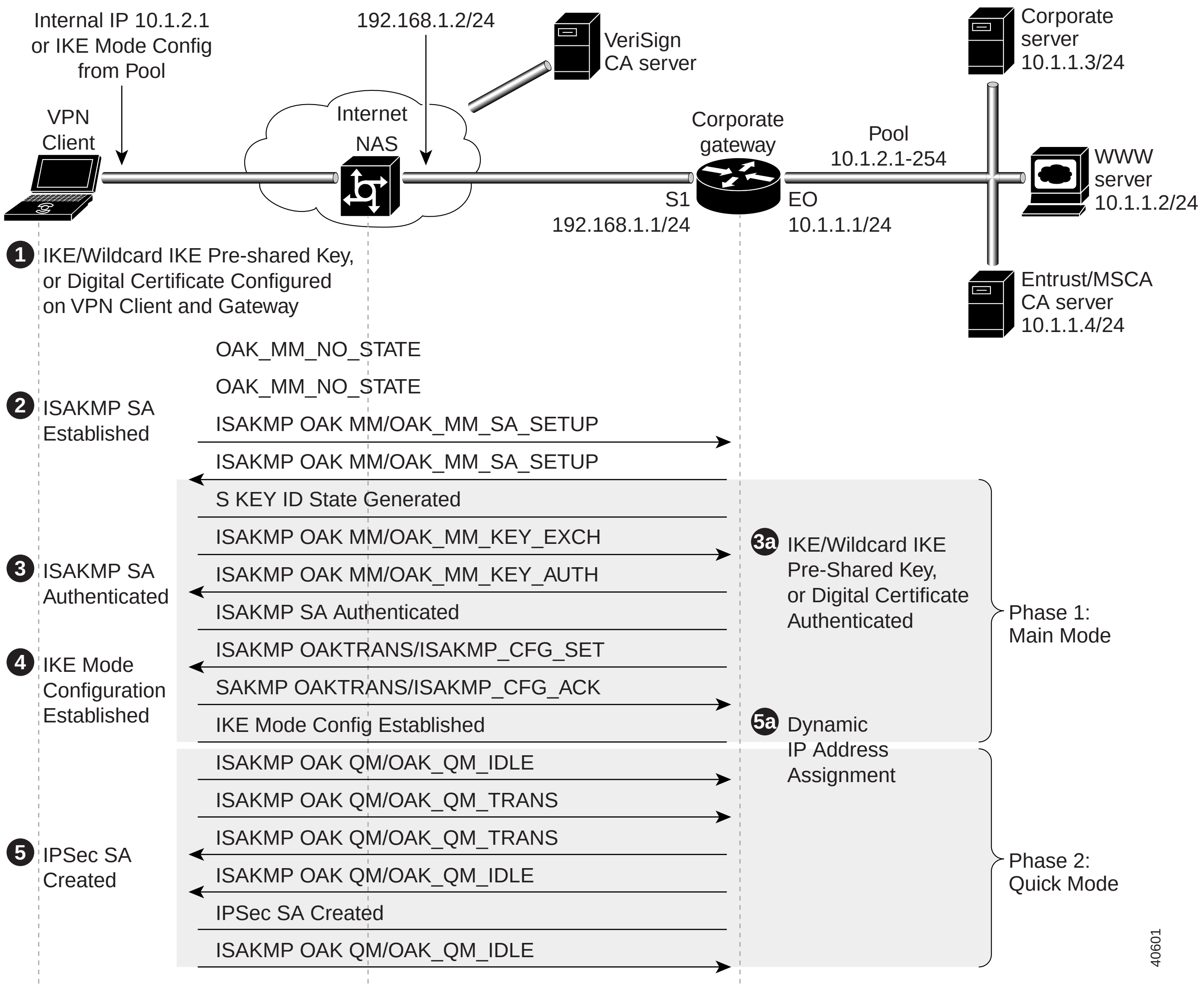


*Table 2-1 Access VPN Events - Client-Initiated*

| Event | Description of Cisco Secure VPN Client | Description of NAS and Gateway |
|---|---|---|
| 1. | To configure VPN access for remote corporate employees, the gateway administrator performs the following tasks:<br>• Either configures a static IP address on the each VPN Client manually, or configures the home gateway to initiate IKE Mode Configuration with the VPN Clients.<br>• Either configures pre-shared keys, wildcard pre-shared key, or digital certification for the VPN Clients' authentication method.<br>Result: A method of assigning internal corporate IP addresses is assigned to each VPN Client. | To configure VPN access for remote corporate employees, the gateway administrator ensures the static IP address configured on the VPN Client is within the IP range of the corporate subnet. The gateway administrator also performs the following tasks:<br>• Either configures a static IP address on the each VPN Client manually, or configures the home gateway to initiate IKE Mode Configuration with the VPN Clients.<br>• Either selects pre-shared keys, wildcard pre-shared key, or digital certification for the VPN Clients' authentication method.<br>Result: A method of assigning internal corporate IP addresses is assigned to each VPN Client. |
| 2. | To start IKE negotiations, the VPN Client sends attributes including KE (Diffie-Hellman keys) and NON (non-repudiation) to the gateway during the first part of ISAKMP OAK MM state.<br>**Note** Diffie-Hellman keys are shared with the gateway during the first part of ISAKMP OAK MM, and are exchanged during the second part of ISAKMP OAK MM state.<br>Result: ISAKMP SA is created. | To start IKE negotiations, the VPN Client establishes ISAKMP SA with the gateway in the OAK_MM_SA_SETUP state. Setting up ISAKMP SA is the first part of Phase 1, Main Mode in IKE negotiation.<br>Result: ISAKMP SA is created. |
| 3. | To authenticate ISAKMP SA, the VPN Client sends attributes including predefined attributes and a CERT_REQ (certificate request) and VID (vendor identification of the certificate authority) to the gateway during the second part of ISAKMP OAK MM state.<br>Result: ISAKMP SA is authenticated. | To authenticate ISAKMP SA, the VPN Client and the gateway participate in a Diffie-Hellman key exchange, OAK_MM_KEY_EXCH, to exchange public keys. Using either digital certificates or pre-shared keys, the gateway authenticates the VPN Client during the OAK_MM_KEY_AUTH state. Authentication of ISAKMP SA is the second part of Phase 1, Main Mode in IKE negotiation.<br>Result: ISAKMP SA is authenticated. |

*Table 2-1 Access VPN Events - Client-Initiated (continued)*

| Event | Description of Cisco Secure VPN Client (continued) | Description of NAS and Gateway (continued) |
|---|---|---|
| 4. | To get a dynamically-assigned IP address from the enterprise, the VPN Client receives the dynamic IP address from the pool of IP addresses on the gateway during the ISAKMP OAK TRANS state, which occurs during the ISAKMP OAK QM state.<br>Result: IKE Mode Configuration occurs. | To get a dynamically-assigned IP address from the enterprise, the gateway transparently assigns the VPN Client a dynamic IP address from a pool of IP addresses during the ISAKMP_CFG_SET state. Then, the gateway receives an acknowledgement of having received the IP address from the VPN Client during the ISAKMP_CFG_ACK state.<br>Result: IKE Mode Configuration occurs. |
| 5. | To finish IKE negotiations, the VPN Client loads the IPSec SA from the gateway during the ISAKMP OAK QM state.<br>Result: IPSec SA is established. | To finish IKE negotiations, the VPN Client establishes the idle Quick Mode state (OAK_QM_IDLE) with the gateway. The VPN Client's internal attributes define the IPSec SA to be transmitted to the gateway during the OAK_QM_TRANS state. The IPSec SA from the VPN Client is authenticated with the gateway and may be used for subsequent Quick Mode exchanges.<br>Result: IPSec SA is established. |

# Site Profile Characteristics

*Table 2-2 Hardware and Software Used in This Case Study*

| | Clients (Remote Access) | Gateway (Enterprise) |
|---|---|---|
| **Chassis Type** | *One* of the following computers, with Pentium processor or equivalent:<br>• Desktop PC<br>• Laptop | For hardware information on interoperable networking devices, see the following:<br>• "Networking Devices with IP Security Protocol" section in Chapter 1, "Access VPNs and IP Security Protocol Tunneling Technology Overview."<br>• "Platform-Specific Documents" section in the "Preface" of this guide.<br>• For supported hardware version or Cisco IOS software release, see the related release notes in the "Cisco Secure VPN Client Documentation" section in the "Preface" of this guide.<br>**Note** This information is available in the "Network Requirements" section of your VPN Client release notes. |
| **Hardware** | For required hardware on the computer, see the "Cisco Secure VPN Client Documentation" section in the "Preface" of this guide.<br>**Note** This information is available in the "System Requirements" section of your VPN Client release notes. | |

***Table 2-2 Hardware and Software Used in This Case Study (continued)***

| | **Clients (Remote Access) (continued)** | **Gateway (Enterprise) (continued)** |
|---|---|---|
| **Software** | *One* of the following clients:<br>• Cisco Secure VPN Client Version 1.0<br>• Cisco Secure VPN Client Version 1.1<br>For supported operating systems, see the “Cisco Secure VPN Client Documentation” section in the “Preface” of this guide.<br>This information is available in the “System Requirements” section of the VPN Client release notes. | An IPSec software image from a supported Cisco IOS release.<br>For supported Cisco IOS releases, see the related release notes in “Cisco Secure VPN Client Documentation” section in the “Preface” of this guide.<br>This information is available in the “Network Requirements” section of the VPN Client release notes. |
| **Memory** | For memory requirements, see the “Cisco Secure VPN Client Documentation” section in the “Preface” of this guide.<br>This information is available in the “System Requirements” section of the VPN Client release notes. | For memory on hardware devices, see “Platform-Specific Documents” section in the “Preface” of this guide.<br>This information is usually available in the “Overview” chapter of the hardware installation guide for your hardware networking device. |
| **Ethernet IP Address**<br>**Note** These sample IP addresses and keys are used throughout this guide. Be sure to use your own IP addresses and key when configuring your network. | Internal IP Address on VPN Client or IKE Mode Config Dynamically-Assigned Address:<br>10.1.2.1<br>255.255.255.0<br>Pre-shared Secret: cisco1234 | Outside S/1 interface:<br>192.168.1.1<br>255.255.255.0<br>Inside E/0 interface:<br>10.1.1.1<br>255.255.255.0<br>Corporate Subnet:<br>10.1.1.0<br>255.255.255.0<br>Pre-shared secret: cisco1234 |
| **Protocol** | Native Microsoft TCP/IP, IPSec Security Protocol | IPSec Security Protocol |