Network Working Group
Request for Comments: 4809
Category: Informational

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February 2007

# Requirements for an IPsec Certificate Management Profile

## Status of This Memo



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## Abstract

This informational document describes and identifies the requirements for transactions to handle Public Key Certificate (PKC) lifecycle transactions between Internet Protocol Security (IPsec) Virtual Private Network (VPN) Systems using Internet Key Exchange (IKE) (versions 1 and 2) and Public Key Infrastructure (PKI) Systems. These requirements are designed to meet the needs of enterprise-scale IPsec VPN deployments. It is intended that a standards track profile of a management protocol will be created to address many of these requirements.

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## 1. Introduction

This document describes and identifies the requirements for transactions to handle PKC lifecycle transactions between [IPsec] VPN Systems using IKE ([IKEv1] and [IKEv2]) and PKI Systems. This document contains requirements for a transaction-based approach. Other models are conceivable, for example, a directory-centric approach, but their requirements are beyond the scope of this document.

This document enumerates requirements for Public Key Certificate (PKC) lifecycle transactions between different VPN System and PKI System products in order to better enable large scale, PKI-enabled IPsec deployments with a common set of transactions. Requirements for both the IPsec and the PKI products are discussed. The requirements are carefully designed to achieve security without compromising ease of management and deployment, even where the deployment involves tens of thousands of IPsec users and devices.

The requirements address transactions for the entire PKC lifecycle for PKI-enabled VPN System: authorization (of PKC issuance), generation (public-private key pair and PKC request), enrollment (PKC request, PKC response, and confirmation), maintenance (rekey, renew, update, revoke, and confirm), and repository lookups. These transactions enable a VPN Operator to:

- Use a VPN Administration function (Admin), which is introduced in this document, to manage PKC authorization and possibly act as the sole interface for the VPN System and the PKI System.

- Authorize individual or batches of PKC issuances based on a pre-agreed template (i.e., both types of authorization requests refer to the pre-agreed template). These authorizations can occur either prior to the enrollment or in the same transaction as the enrollment.

- Provision PKI-based user or machine identity to IPsec Peers, on a large scale.

- Set the corresponding gateway or client authorization policy for remote access and site-to-site connections.

- Establish policies for automatic PKC rekeys, renewals, and updates.

- Ensure timely revocation information is available for PKCs used in IKE exchanges.

These requirements are intended to be used to profile a certificate management protocol that the VPN System will use to communicate with the PKI System. Note that this profile will be in another document. The certificate management profile will also clarify and constrain existing PKIX (PKI for X.509 Certificates) and IPsec standards to limit the complexity of deployment. Some requirements may require either a new protocol, or changes or extensions to an existing protocol.

The desired outcome of the requirements and profile documents is that both IPsec and PKI vendors create interoperable products to enable large-scale IPsec System deployments, and do so as quickly as possible. For example, a VPN Operator should be able to use any conforming IPsec implementation (VPN Administration or IPsec Peer) of the certificate management profile with any conforming PKI vendor's implementation to perform the VPN rollout and management.

## 1.1. Scope

The document addresses requirements on transactions between the VPN Systems and the PKI Systems and between the VPN Administration and IPsec Peers. The requirements strive to meet eighty percent of the market needs for large-scale deployments (i.e., VPNs including hundreds or thousands of managed VPN gateways or VPN remote access clients). Environments will understandably exist in which large-scale deployment tools are desired, but local security policy stringency will not allow for the use of such commercial tools. The solution will possibly miss the needs of the highest ten percent of stringency and the lowest ten percent of convenience requirements. Use cases will be considered or rejected based upon this eighty percent rule. The needs of small deployments are a stated non-goal; however, service providers employing the scoped solution and applying it to many smaller deployments in aggregate may address them.

Gateway-to-gateway access and end-user remote access (to a gateway) are both covered. End-to-end communications are not necessarily excluded, but are intentionally not a focus.

Only VPN-PKI transactions that ease and enable scalable PKI-enabled IPsec deployments are addressed.

## 1.2. Non-Goals

The scenario for PKC cross-certification will not be addressed.

The protocol specification for the VPN-PKI interactions will not be addressed.

The protocol specification for the VPN Administrator to Peer transactions will not be addressed. These interactions are considered vendor proprietary. These interactions may be standardized later to enable interoperability between VPN Administration function stations and IPsec Peers from different vendors, but are far beyond the scope of this current effort, and will be described as opaque transactions in this document.

The protocol specification for Registration Authority - Certificate Authority (RA-CA), CA-Repository, and RA-Repository interactions will not be addressed.

## 1.3. Definitions

VPN System
The VPN System is comprised of the VPN Administration function (defined below), the IPsec Peers, and the communication mechanism between the VPN Administration and the IPsec Peers. VPN System is defined in more detail in Section 2.1.

PKI System
The PKI System, or simply PKI, is the set of functions needed to authorize, issue, and manage PKCs. PKI System is defined in more detail in Section 2.2.

(VPN) Operator
The Operator is the person or group of people that define security policy and configure the VPN System to enforce that policy, with the VPN Administration function.

IPsec Peer (Gateway or Client)
For the purposes of this document, an IPsec Peer, or simply "Peer", is any VPN System component that communicates IKE and IPsec to another Peer in order to create an IPsec Security Association for communications. It can be either a traditional security gateway (with two network interfaces, one for the protected network and one for the unprotected network) or an IPsec client (with a single network interface). In both cases, the Peer can pass traffic with no IPsec protection, and can add IPsec protection to chosen traffic streams. See Section 2.1.1 for more details.

(VPN) Admin
The Admin is the VPN System function that interacts with the PKI System to establish PKC provisioning for the VPN connections. See Section 2.1.2 for more details.

End Entity
An end entity is the entity or subject that is identified in a PKC. The end entity is the one entity that will finally use a private key associated with a PKC to digitally sign data. In this document, an IPsec Peer is certainly an end entity, but the VPN Admin can also constitute an end entity. Note that end entities can have different PKCs for different purposes (e.g., signature vs. key exchange, Admin-functions vs. Peer-functions).

PKC Rekey
The routine procedure for replacement of a PKC with a new PKC with a new public key for the same subject name. A rekey process can rely on the existing key pair to bootstrap authentication for the new enrollment.

PKC Renewal
The acquisition of a new PKC with the same public key due to the expiration of an existing PKC. Renewal occurs prior to the expiration of the existing PKC to avoid any connection outages. A renewal process can rely on the existing key pair to bootstrap authentication for the new enrollment.

PKC Update
A special case of a renewal-like occurrence where a PKC needs to be changed prior to expiration due to some change in its subject's information. Examples might include change in the address, telephone number, or name change due to marriage of the end entity. An update process can rely on the existing key pair to bootstrap authentication for the new enrollment.

Registration Authority (RA)
An optional entity in a PKI System given responsibility for performing some of the administrative tasks necessary in the registration of end entities, such as confirming the subject's identity and verifying that the subject has possession of the private key associated with the public key requested for a PKC.

Certificate Authority (CA)
An authority in a PKI System that is trusted by one or more users to create and sign PKCs. It is important to note that the CA is responsible for the PKCs during their whole lifetime, not just for issuing them.

**Repository**
An Internet-accessible server in a PKI System that stores and makes available for retrieval PKCs and Certificate Revocation Lists (CRLs).

**Root CA/Trust Anchor**
A CA that is directly trusted by an end entity; that is, securely acquiring the value of a Root CA public key requires some out-of-band step(s). This term is not meant to imply that a Root CA is necessarily at the top of any hierarchy, simply that the CA in question is trusted directly.

**Certificate Revocation List (CRL)**
A CRL is a CA-signed, timestamped list identifying revoked PKCs and made freely available in a repository. Peers retrieve the CRL to verify that a PKC being presented to them as the identity in an IKE transaction has not been revoked.

**CRL Distribution Point (CDP)**
The CDP is a PKC extension that identifies the location from which end entities should retrieve CRLs to check status information.

**Authority Info Access (AIA)**
The AIA is a PKC extension that indicates how to access CA information and services for the issuer of the PKC in which the extension appears. Information and services may include on-line validation services and Certificate Policy (CP) data.

## 1.4. Requirements Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [MUSTSHOULD].

## 2. Architecture

This section describes the overall architecture for a PKI-supported IPsec VPN deployment. First, an explanation of the VPN System is presented. Second, key points about the PKI System are stated. Third, the VPN-PKI architecture is presented.

### 2.1. VPN System

The VPN System consists of the IPsec Peers and the VPN Administration function, as depicted in Figure 1.

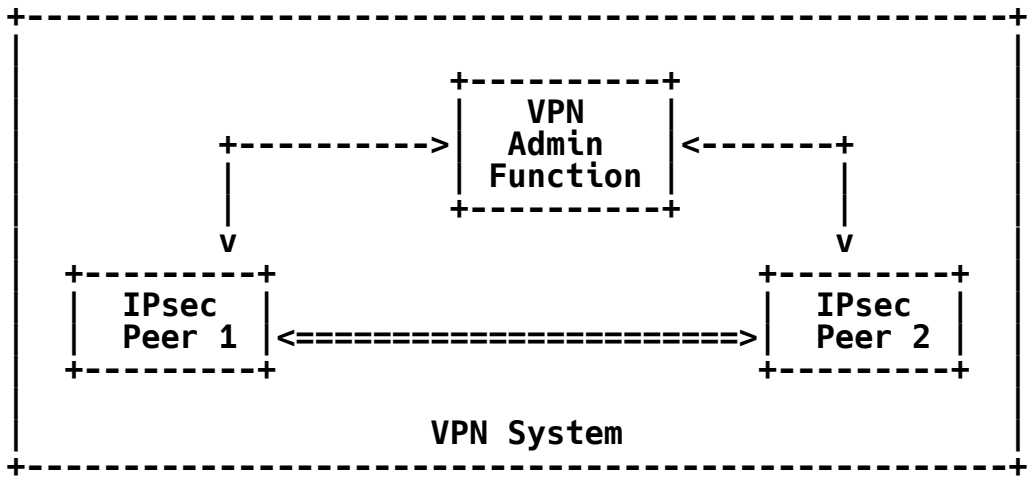



Figure 1: VPN System

#### 2.1.1. IPsec Peer(s)

The Peers are two entities between which establishment of an IPsec Security Association is required. Two Peers are shown in Figure 1, but implementations can support an actual number in the hundreds or thousands. The Peers can be gateway-to-gateway, remote-access-host-to-gateway, or a mix of both. The Peers authenticate themselves in the IKE negotiation using digital signatures generated with PKCs from a PKI System.

#### 2.1.2. VPN Administration Function (Admin)

This document defines the notion of a VPN Administration function, hereafter referred to as Admin, and gives the Admin great responsibility within the VPN System. The Admin is a centralized function used by the Operator to interact with the PKI System to establish PKI policy (e.g., algorithms, key lengths, lifecycle options, and PKC fields) for groups of IPsec Peers. The Admin also

authorizes PKC issuance and can act as the Peer's PKI System interface, which allows the Admin to perform many RA-like functions.

It is important to note that, within this document, the Admin is neither a device nor a person; rather, it is a function. Every large-scale VPN deployment will contain the Admin function. The function can be performed on a stand-alone workstation, on a gateway, or on an administration software component. The Admin function can also be one and the same as the gateway, client device, or software. They are represented in the architectural diagram as different functions, but they need not be different physical entities. As such, the Admin's architecture and the means by which it interacts with the participating IPsec Peers will vary widely from implementation to implementation. However, some basic functions of the Admin are assumed.

- It, and not the PKI, will define the Certificate Policy (CP) [FRAME] for use in a VPN System. The PKC's characteristics and contents are a function of the CP. In VPN Systems, the Operator chooses to strengthen the VPN by using PKI; PKI is a bolt-on to the VPN System. The Operator will configure local security policy in part through the Admin and its authorized PKI-enabled Peers.

- It will interact directly with the PKI System to initiate authorization for end entity PKCs by sending the parameters and contents for individual PKCs or batches of PKCs based on a pre-agreed template (i.e., both types of authorization requests refer to the pre-agreed template). Templates will be agreed in an out-of-band mechanism by the VPN Operator and the PKI Operator. It will receive back from the PKI a unique tuple of authorization identifiers and one-time authorization tokens that will authorize Peers to request a PKC.

- It will deliver instructions to the IPsec Peers, and the Peers will carry out those instructions (e.g., Admin passes Peer information necessary to generate keys and PKC request).

## 2.2. PKI System

The PKI System, as depicted in Figure 2, can be set up and operated by the Operator (in-house), be provided by third party PKI providers to which connectivity is available at the time of provisioning (managed PKI service), or be integrated with the VPN product.

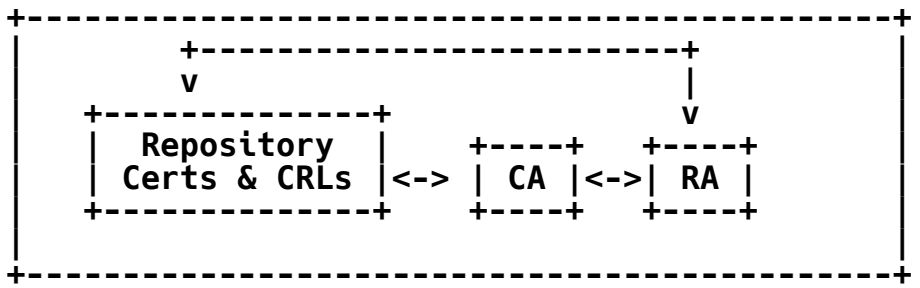


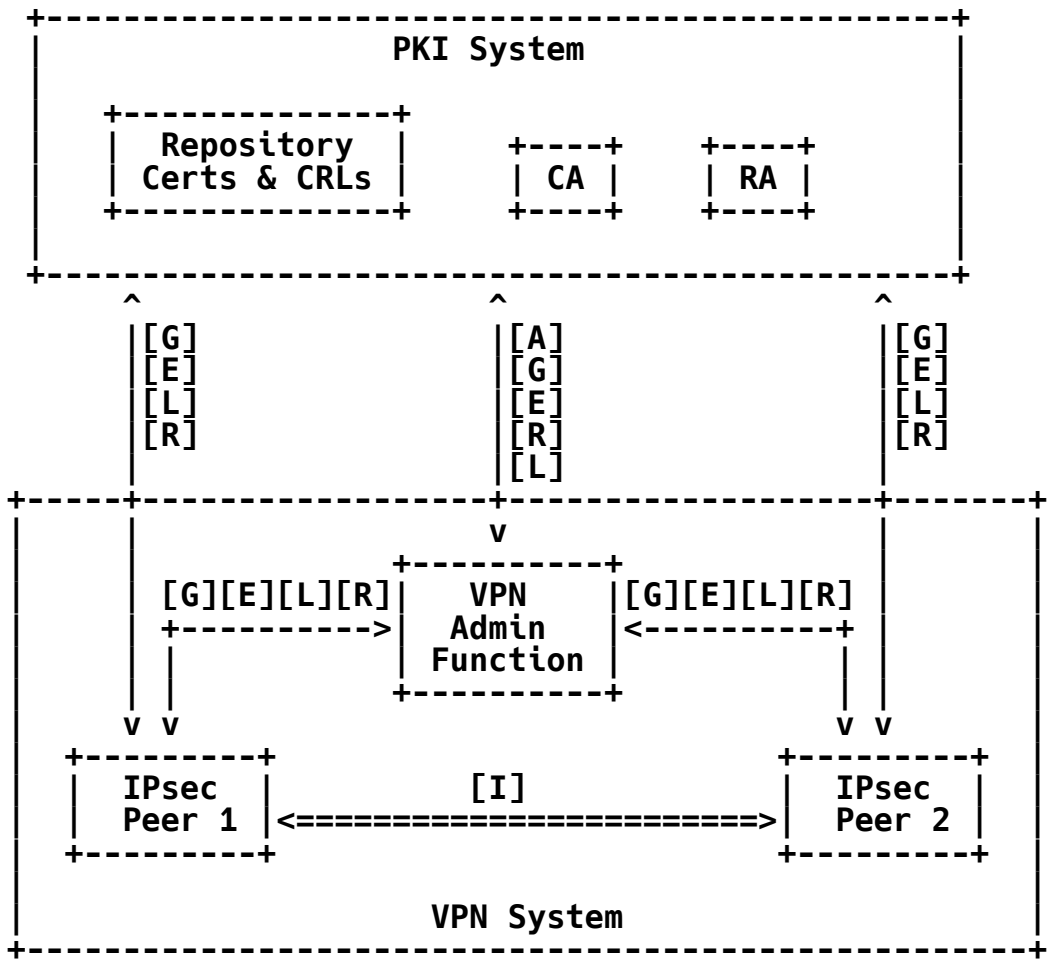

Figure 2: PKI System

This framework assumes that all components of the VPN obtain PKCs from a single PKI community. An IPsec Peer can accept a PKC from a Peer that is from a CA outside of the PKI community, but the auto provision and life cycle management for such a PKC or its trust anchor PKC fall out of scope.

The PKI System contains a mechanism for handling Admin's authorization requests and PKC enrollments. This mechanism is referred to as the Registration Authority (RA). The PKI System contains a Repository for Peers to retrieve each other's PKCs and revocation information. Last, the PKI System contains the core function of a CA that uses a public and private key pair and signs PKCs.

## 2.3. VPN-PKI Interaction

The interaction between the VPN System and the PKI System is the key focus of this requirements document, as shown in Figure 3. Therefore, it is sensible to consider the steps necessary to set up, use, and manage PKCs for one Peer to establish an association with another Peer.




[A] = Authorization: PKC issuance
[G] = Generation: Public key, private key, and PKC request
[E] = Enrollment: Sending PKC request, verifying PKC response, and confirming PKC response
[I] = IKE and IPsec communication
[L] = Lifecycle: Rekey, renewal, update, revocation, and confirmation
[R] = Repository: Posting and lookups

Figure 3. Architectural Framework for VPN-PKI Interaction

Requirements for each of the interactions, [A], [G], [E], [L], and [R], are addressed in Sections 3.2 through 3.6. However, only requirements for [A], [E], [L], and [R] will be addressed by the certificate management profile. Requirements for [I] transactions are beyond the scope of this document. Additionally, the act of certification (i.e., binding the public key to the name) is performed at the CA and is not shown in the figure.

# 3. Requirements

## 3.1. General Requirements

### 3.1.1. One Protocol

The target profile, to be based on this requirements document, MUST call for ONE PROTOCOL or ONE USE PROFILE for each main element of the [A], [E], [L], and [R] interactions. In order to reduce complexity and improve interoperability, having multiple competing protocols or profiles to solve the same requirement should be avoided whenever possible.

Meeting some of the requirements may necessitate the creation of a new protocol or new extension for an existing protocol; however, the latter is much preferred.

### 3.1.2. Secure Transactions

The target certificate management profile MUST specify the [A], [E], [L], and [R] transactions between VPN and PKI Systems. To support these transactions, the Admin and PKI MUST exchange policy details, identities, and keys. As such, the method of communication for [A], [E], and [L] transactions MUST be secured in a manner that ensures privacy, authentication, and message data integrity. The communication method MUST require that mutual trust be established between the PKI and the Admin (see Section 3.7.1). [R] transactions do not require authentication or message data integrity because the responses (i.e., PKCs and CRLs) are already digitally signed. Whether [R] transactions require privacy is determined by the local security policy.

The target certificate management profile will not specify [G] transactions. However, these transactions MUST be secured in a manner that ensures privacy, authentication, and message data integrity because these transactions are the basis for the other transactions.

### 3.1.3. Admin Availability

The Admin MUST be reachable by the Peers. Most implementations will meet this requirement by ensuring Peers can connect to the Admin from anywhere on the network or Internet. However, communication between the Admin and Peers can be "off-line". It can, in some environments, be "moving media" (i.e., the configuration or data is loaded on to a floppy disk or other media and physically moved to the IPsec Peers). Likewise, it can be entered directly on the IPsec Peer via a User Interface (UI). In this case, the Admin function is co-located on

the Peer device itself. Most requirements and scenarios in this document assume on-line availability of the Admin for the life of the VPN System.

### 3.1.4. PKI Availability

Availability is REQUIRED initially for authorization transactions between the PKI and Admin. Further availability is required in most cases, but the extent of this availability is a decision point for the Operator. Most requirements and scenarios in this document assume on-line availability of the PKI for the life of the VPN System.

Off-line interaction between the VPN and PKI Systems (i.e., where physical media is used as the transport method) is beyond the scope of this document.

### 3.1.5. End-User Transparency

PKI interactions are to be transparent to the user. Users SHOULD NOT even be aware that PKI is in use. First time connections SHOULD consist of no more than a prompt for some identification and pass phrase, and a status bar notifying the user that setup is in progress.

### 3.1.6. PKC Profile for PKI Interaction

A PKC used for identity in VPN-PKI transactions MUST include all the [CERTPROFILE] mandatory fields. It MUST also contain contents necessary to support path validation and certificate status checking.

It is preferable that the PKC profiles for IPsec transactions [IKECERTPROFILE] and VPN-PKI transactions (in the certificate management profile) are the same so that one PKC could be used for both transaction sets. If the profiles are inconsistent, then different PKCs (and perhaps different processing requirements) might be required. However, the authors urge that progress continue on other aspects of this standardization effort regardless of the status of efforts to achieve PKC profile consensus.

#### 3.1.6.1. Identity

PKCs MUST support identifying (i.e., naming) Peers and Admins. The following name forms MUST be supported:

- Fully-Qualified Domain Name (FQDN)
- RFC 822 (also called USER FQDN)
- IPv4 Address
- IPv6 Address

#### 3.1.6.2. Key Usage

PKCs MUST support indicating the purposes for which the key (i.e., digital signature) can be used. Further, PKCs MUST always indicate that relying parties (i.e., Peers) need to understand the indication.

#### 3.1.6.3. Extended Key Usage

Extended Key Usage (EKU) indications are not required. The presence or lack of an EKU MUST NOT cause an implementation to fail an IKE connection.

#### 3.1.6.4. Revocation Information Location

PKCs MUST indicate the location of CRL such that any Peer who holds the PKC locally will know exactly where to go and how to request the CRL.

### 3.1.7. Error Handling

The protocol for the VPN-PKI transactions MUST specify error handling for each transaction. Thorough error condition descriptions and handling instructions will greatly aid interoperability efforts between the PKI and VPN System products.

## 3.2. Authorization

This section refers to the [A] elements labeled in Figure 3.

### 3.2.1. One Protocol

One protocol MUST be specified for the Admin to PKI (RA/CA) interactions. This protocol MUST support privacy, authorization, authentication, and integrity. PKCs for authorization of the Admin can be initialized through an out-of-band mechanism.

The transport used to carry the authorization SHOULD be reliable (TCP).

The protocol SHOULD be as lightweight as possible.

### 3.2.2. Bulk Authorization

Bulk authorization MUST be supported by the certificate management profile. Bulk authorization occurs when the Admin requests of the PKI that authorization be established for several different subjects with almost the same contents. A minimum of one value (more is also acceptable) differs per subject. Because the authorizations may occur before any keys have been generated, the only way to ensure unique authorization identifiers are issued is to have at least one value differ per subject.

Authorization can occur prior to a PKC enrollment request, or the authorization and the PKC enrollment request can be presented to the PKI at the same time. Both of these authorization scenarios MUST be supported.

A bulk authorization SHOULD occur in one single connection to the PKI (RA/CA), with the number of subjects being one or greater. Implementations SHOULD be able to handle one thousand subjects in a batch authorization.

### 3.2.3 Authorization Scenario

The authorization scenario for VPN-PKI transactions involves a two-step process: an authorization request and an authorization response. Figure 4 shows the salient interactions to perform authorization transactions.

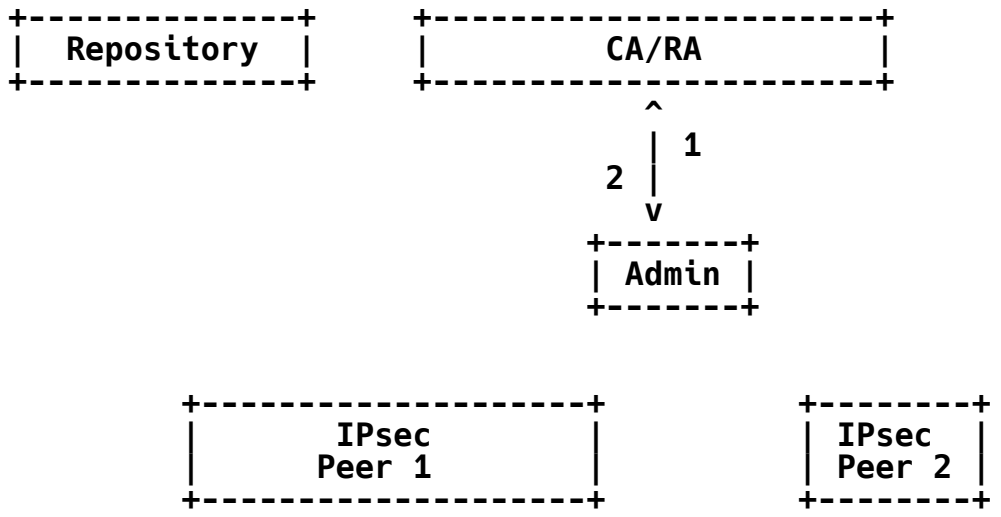



Figure 4. Authorization Transactions

1) Authorization Request [A]. Admin sends a list of identities and PKC contents for the PKI System to authorize enrollment. See Section 3.2.4.

2) Authorization Response [A]. The PKI returns a list of unique authorization identifiers and one-time authorization tokens to be used for the enrollment of each PKC (1). Response may indicate success, failure, or errors for any particular authorization. See Section 3.2.5.

### 3.2.4. Authorization Request

#### 3.2.4.1. Specifying Fields within the PKC

The Admin authorizes individual PKCs or batches of PKC issuances based on a pre-agreed template. This template is agreed by the VPN Operator and PKI Operator and is referred to in each authorization request. This allows the authorization requests to include the minimal amount of information necessary to support a VPN System.

The Admin can send the PKI System the set of PKC contents that it wants the PKI to issue to a group of IPsec Peers. In other words, it tells the PKI System, "if you see a PKC request that looks like this, from this person, process it and issue the PKC."

Requirements for PKC fields used in IPsec transactions are specified in [IKECERTPROFILE].

Requirements for PKC fields used in VPN-PKI transactions are specified in Section 3.1.6.

#### 3.2.4.2. Authorizations for Rekey, Renewal, and Update

When the VPN Operator and PKI Operator pre-agree on a template, they MUST also agree on the local policy regarding PKC renewal and PKC update. These are:

- Admin MUST specify if automatic renewals are allowed, that is, the Admin authorizes the PKI to process a future renewal for the specified Peer PKC.

- Admin MUST specify if PKC update is allowed, that is, the Admin authorizes the PKI to accept a future request for a new PKC with changes to non-key-related fields.

  If a PKC renewal is authorized, the Admin MUST further specify:

- Who can renew, that is, can only the Admin send a renewal request or can the Peer send a request directly to the PKI, or either.

- How long before the PKC expiration date the PKI will accept and process a renewal (i.e., N% of validity period, or the UTC time after which renewal is permitted).

If a PKC update is authorized, the Admin MUST further specify:

- The aspects of non-key-related fields that are changeable.

- The entity that can send the PKC Update request, that is, only the Admin, only the Peer, or either.

- How long before the PKC expiration date the PKI will accept and process an update (i.e., N% of validity period, or the UTC time after which update is permitted).

A new authorization by the Admin is REQUIRED for PKC rekey. No parameters of prior authorizations need be considered.

#### 3.2.4.3. Other Authorization Elements

The Admin MUST have the ability to specify the format for the authorization ID and one-time authorization token. The one-time authorization token SHOULD be unique per authorization ID. The more randomness that can be achieved in the relationship between an authorization ID and its one-time authorization token, the better. The one-time authorization token MUST be in UTF-8 format to avoid

incompatibilities that may occur due to international characters. It MUST support normalization as in [CERTPROFILE]. The Admin MUST have the ability to constrain the UTF-8 character set.

There MUST be an option to specify a validation period for the authorization ID and its one-time authorization token. If such a validation period is set, any PKC requests using the authorization ID and one-time authorization token that arrive at the PKI outside of the validation period MUST be dropped, and the event logged.

The Protocol SHOULD consider what happens when Admin-requested information conflicts with PKI settings such that the Admin request cannot be issued as requested (e.g., Admin requests validation period = 3 weeks and CA is configured to only allow validation periods = 1 week). Proper conflict handling MUST be specified.

#### 3.2.4.4. Cancel Capability

Either the Admin or the Peer can send a cancel authorization message to PKI. The canceling entity MUST provide the authorization ID and one-time authorization token in order to cancel the authorization. At that point, the authorization will be erased from the PKI, and a log entry of the event written.

After the cancellation has been verified (a Cancel, Cancel ACK, ACK type of a process is REQUIRED to cover a lost connections scenario), the PKI will accept a new authorization request with the exact same contents as the canceled one, except that the identifier MUST be new. The PKI MUST NOT process duplicate authorization requests.

Note that if the PKI has already issued a PKC associated with an authorization, then cancellation of the authorization is not possible and the authorization request SHOULD be refused by the PKI. Once a PKC has been issued it MUST be revoked in accordance with Section 3.6.

### 3.2.5. Authorization Response

If the authorization request is acceptable, the PKI will respond to the Admin with a unique authorization identifier per subject authorization requested and a one-time authorization token per authorization ID. See Section 3.2.4.3 for additional authorization ID and one-time authorization token requirements.

The PKI can alter parameters of the authorization request submitted by the Admin. In that event, the PKI MUST return all the contents of the authorization request (as modified) to the Admin with the confirmation of authorization success. This will allow the Admin to

perform an "operational test" to verify that the issued PKCs will meet its requirements. If the Admin determines that the modified parameters are unacceptable, then the authorization should be cancelled in accordance with Section 3.2.4.4.

After receiving a bulk authorization request from the Admin, the PKI MUST be able to reply YES to those individual PKC authorizations that it has satisfied and NO or FAILED for those requests that cannot be satisfied, along with sufficient reason or error codes.

A method is REQUIRED to identify if there is a change in PKI settings between the time the authorization is granted and the PKC request occurs, and what to do about the discrepancy.

#### 3.2.5.1. Error Handling for Authorization

Thorough error condition descriptions and handling instructions MUST be provided to the Admin for each transaction in the authorization process. Providing such error codes will greatly aid interoperability efforts between the PKI and IPsec products.

### 3.3. Generation

This section refers to the [G] elements labeled in Figure 3.

Once the PKI System has responded with authorization identifiers and authorization tokens (see Section 3.2), and this information is received at the Admin, the next step is to generate public and private key pairs and to construct PKC requests using those key pairs. The key generations can occur at one of three places, depending on local requirements: at the IPsec Peer, at the Admin, or at the PKI. The PKC request can come from either the IPsec Peer, a combination of the Peer and the Admin, or not at all.

### 3.3.1. Generation Method 1: IPsec Peer Generates Key Pair, Constructs PKC Request, and Signs PKC Request

This option will be used most often in the field. This is the most secure method for keying, as the keys are generated on the end entity and the private key never leaves the end entity. However, it is the most computationally intensive for the Peer, as it must be "ASN.1 aware" to support generating and digitally signing the PKC request.

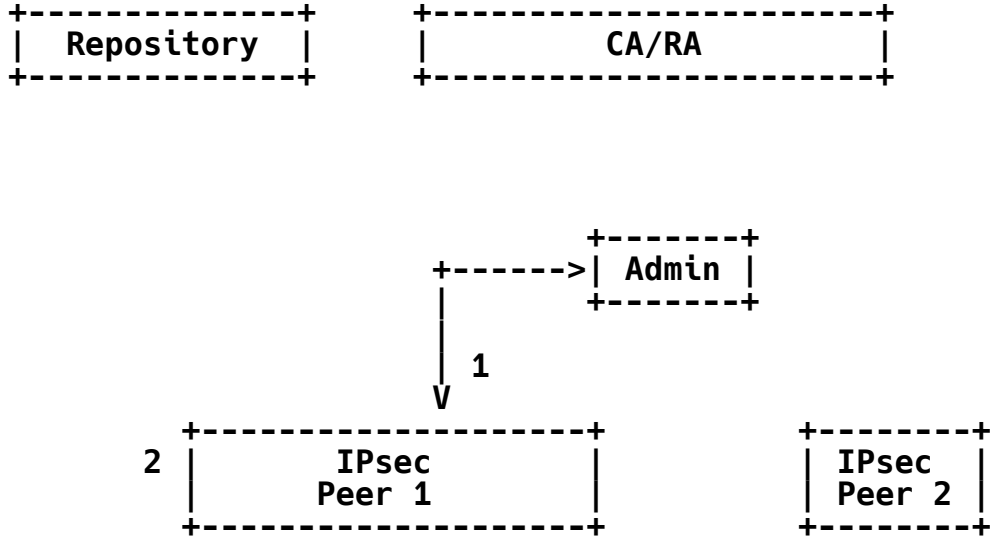



Figure 5. Generation Interactions: IPsec Peer Generates Key Pair and Constructs PKC Request

1) Opaque transaction [G]. Admin sends authorization identifier, one-time authorization token, and any other parameters needed by the Peer to generate the PKC request, including key type and size.

2) Generation [G]. Peer receives authorization identifier, one-time authorization token, and any parameters. Peer generates key pair and constructs PKC request.

Steps prior to these can be found in Section 3.2. The next step, enrollment, can occur either directly between the Peer and PKI (see Section 3.4.5) or through the Admin (see Section 3.4.6).

### 3.3.2. Generation Method 2: IPsec Peer Generates Key Pair, Admin Constructs PKC Request, Admin Signs PKC Request

This option also supports IPsec Peer generation of a key pair, but removes the requirement for the Peer to be ASN.1 aware because it does not have to construct or digitally sign the PKC request. The drawback is that the key pair does need to be provided to the Admin. In the most probable cases where the Admin function is remotely located from the peer, this means that the private key will leave the cryptographic boundary of the peer, which is a significant security trade-off consideration. Whenever possible, it is always better to have private keys generated and never leave the cryptographic boundary of the generating system.

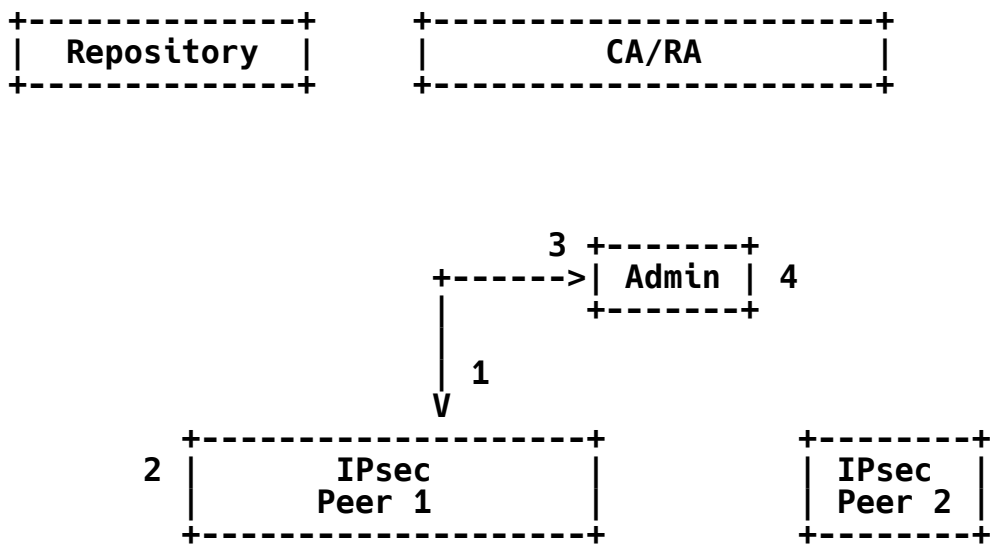



Figure 6. Generation Interactions: IPsec Peer Generates Key Pair, Admin Constructs PKC Request

1) Opaque transaction [G]. Admin sends command to Peer to generate key pair, based on parameters provided in the command.

2) Generation [G]. Peer generates key pair.

3) Opaque transaction [G]. Peer returns key pair to Admin.

4) Generation [G]. Admin constructs and digitally signs PKC request.

Steps prior to these can be found in Section 3.2. The next step, enrollment, occurs through the Admin (see Section 3.4.7).

### 3.3.3. Generation Method 3: Admin Generates Key Pair, Constructs PKC Request, and Signs PKC Request

This option exists for deployments where Peers cannot generate their own key pairs. Some examples are for PDAs and handsets where to generate an RSA key would be operationally impossible due to processing and battery constraints. Another case covers key recovery requirements, where the same PKCs are used for other functions in addition to IPsec, and key recovery is required (e.g., local data encryption), therefore key escrow is needed from the Peer. If key escrow is performed then the exact requirements and procedures for it are beyond the scope of this document.

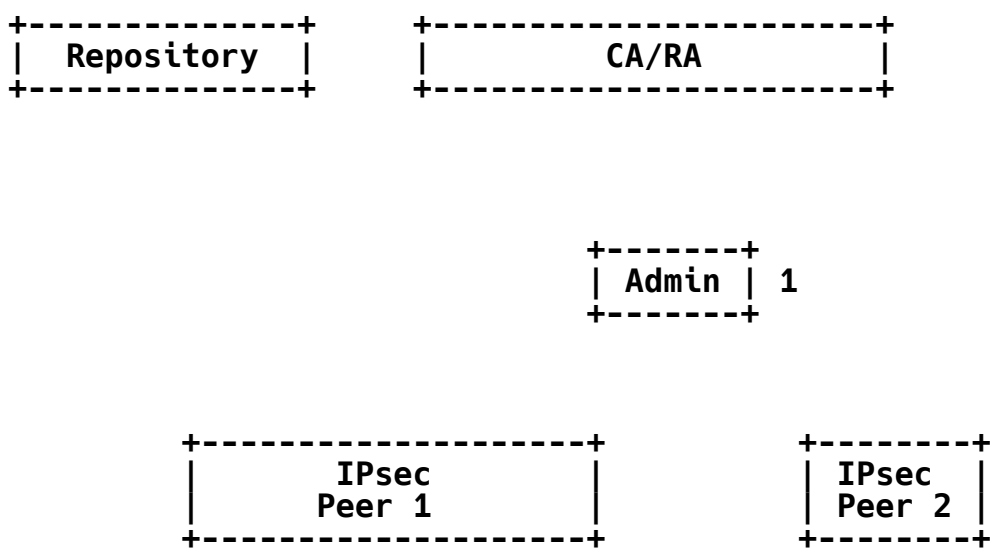



Figure 7. Generation Interactions: Admin Generates Key Pair and Constructs PKC Request

1) Generation [G]. Admin generates key pair, constructs PKC request, and digitally signs PKC request.

Steps prior to these can be found in Section 3.2. The next step, enrollment, occurs through the Admin (see Section 3.4.8).

Note that separate authorizations steps are still of value even though the Admin is also performing the key generation. The PKC template, Subject fields, SubjectAltName fields, and more are part of the request, and must be communicated in some way from the Admin to the PKI. Instead of creating a new mechanism, the authorization schema can be reused. This also allows for the feature of role-based

administration, where Operator 1 is the only one allowed to have the Admin function pre-authorize PKCs, but Operator 2 is the one doing batch enrollments and VPN device configurations.

### 3.3.4. Method 4: PKI Generates Key Pair

This option exists for deployments where end entities cannot generate their own key pairs and the Admin function is a minimal implementation. The PKI and Admin pre-agree to have the PKI generate key pairs and PKCs. This is, in all likelihood, the easiest way to deploy PKCs, though it sacrifices some security since both the CA and the Admin have access to the private key. However, in cases where key escrow is required, this may be acceptable. The Admin effectively acts as a proxy for the Peer in the PKC enrollment process.

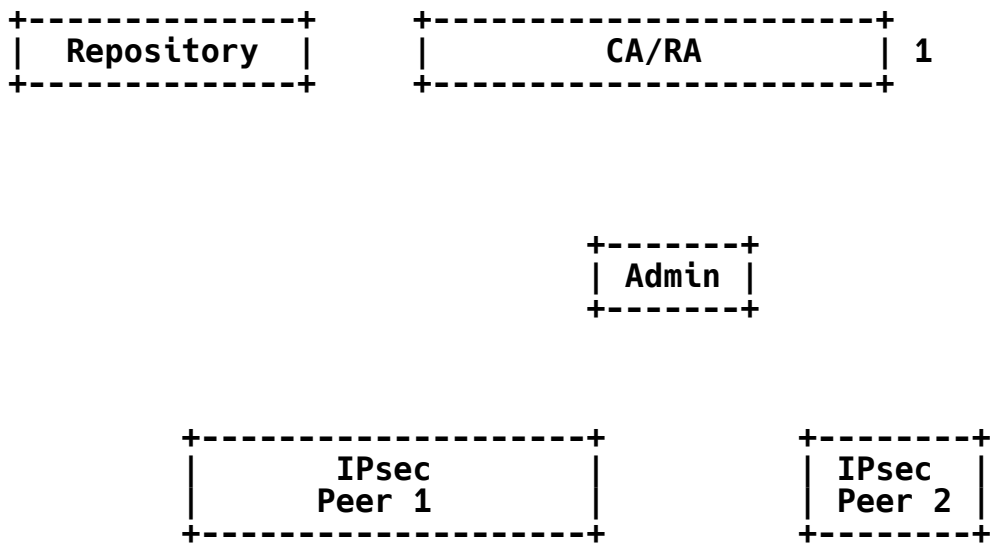



Figure 8. Generation Interactions:
IPsec Peer Generates Key Pair, Admin Constructs PKC Request

1) Generation [G] The PKI generates the key pair.

Steps prior to these can be found in Section 3.2. The next step, enrollment, occurs through the Admin (see Section 3.4.9).

### 3.3.5. Error Handling for Generation

Thorough error condition descriptions and handling instructions MUST be provided for each transaction in the key generation and PKC request construction process. Providing such error codes will greatly aid interoperability efforts between the PKI and IPsec products.

Error conditions MUST be communicated to the Admin regardless of who generated the key or PKC request.

## 3.4. Enrollment

This section refers to the [E] elements labeled in Figure 3.

Regardless of where the keys were generated and the PKC request constructed, an enrollment process will need to occur to request that the PKI issue a PKC and the corresponding PKC be returned.

The protocol MUST be exactly the same regardless of whether the enrollment occurs from the Peer to the PKI or from the Admin to the PKI.

### 3.4.1. One Protocol

One protocol MUST be specified for enrollment requests, responses, and confirmations.

### 3.4.2. On-line Protocol

The protocol MUST support enrollment that occurs over the Internet and without the need for manual intervention.

### 3.4.3. Single Connection with Immediate Response

Enrollment requests and responses MUST be able to occur in one on-line connection between the Admin on behalf of the Peer or the Peer itself and the PKI (RA/CA).

### 3.4.4. Manual Approval Option

Manual approval of PKC enrollments is too time consuming for large scale implementations, and is therefore not required.

### 3.4.5. Enrollment Method 1: Peer Enrolls to PKI Directly

In this case, the IPsec Peer only communicates with the PKI after being commanded to do so by the Admin. This enrollment mode is depicted in Figure 9 and the letters in the following description refer to Figure 3. Prior authorization (Section 3.2) and generation (Section 3.3.1) steps are not shown.

Most IPsec Systems have enough CPU power to generate a public and private key pair of sufficient strength for secure IPsec. In this case, the end entity needs to prove to the PKI that it has such a key pair; this is normally done by the PKI sending the end entity a nonce, which the end entity signs and returns to the Admin along with the end entity's public key.

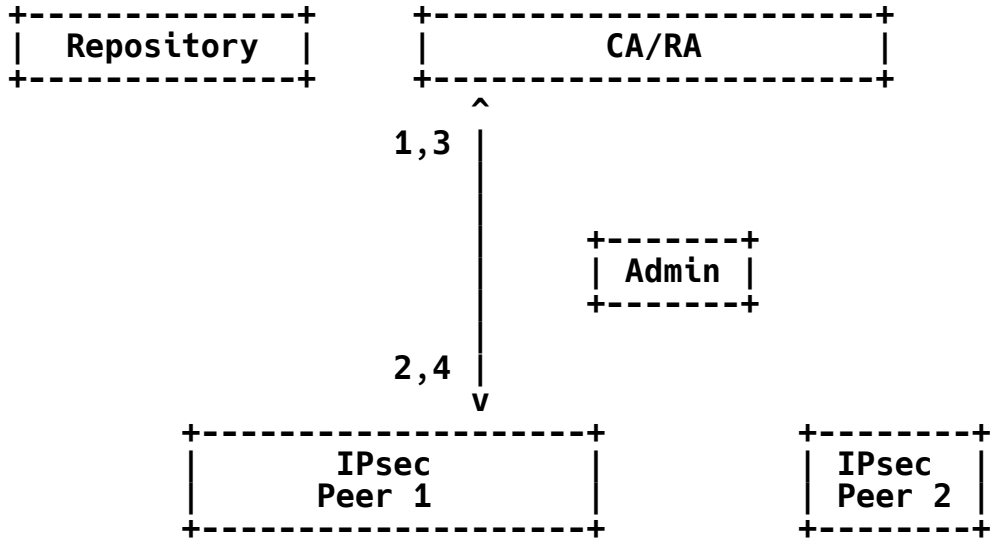



Figure 9. VPN-PKI Interaction Steps: IPsec Peer Generates Keys and PKC Request, Enrolls Directly with PKI

1) Enrollment Request [E]. The IPsec Peer sends PKC requests to the PKI, providing the generated public key.

2) Enrollment Response [E]. The PKI responds to the enrollment request, providing either the new PKC that was generated or a suitable error indication.

3) Enrollment Confirmation [E]. Peer positively acknowledges receipt of new PKC back to the Admin.

4) Enrollment Confirmation Receipt [E]. PKI sends enrollment confirmation receipt back to the Peer.

### 3.4.6 Enrollment Method 2a: Peer Enrolls through Admin

In this case, the IPsec Peer has generated the key pair and the PKC request, but does not enroll directly to the PKI System. Instead, it automatically sends its request to the Admin, and the Admin redirects the enrollment to the PKI System. The PKI System does not care where the enrollment comes from, as long as it is a valid enrollment. Once the Admin receives the PKC response, it automatically forwards it to the IPsec Peer.

Most IPsec Systems have enough CPU power to generate a public and private key pair of sufficient strength for secure IPsec. In this case, the end entity needs to prove to the Admin that it has such a key pair; this is normally done by the Admin sending the end entity a nonce, which the end entity signs and returns to the Admin along with the end entity's public key.

This enrollment mode is depicted in Figure 10 and the letters in the following description refer to Figure 3. Prior authorization (Section 3.2) and generation (Section 3.3.1) steps are not shown.

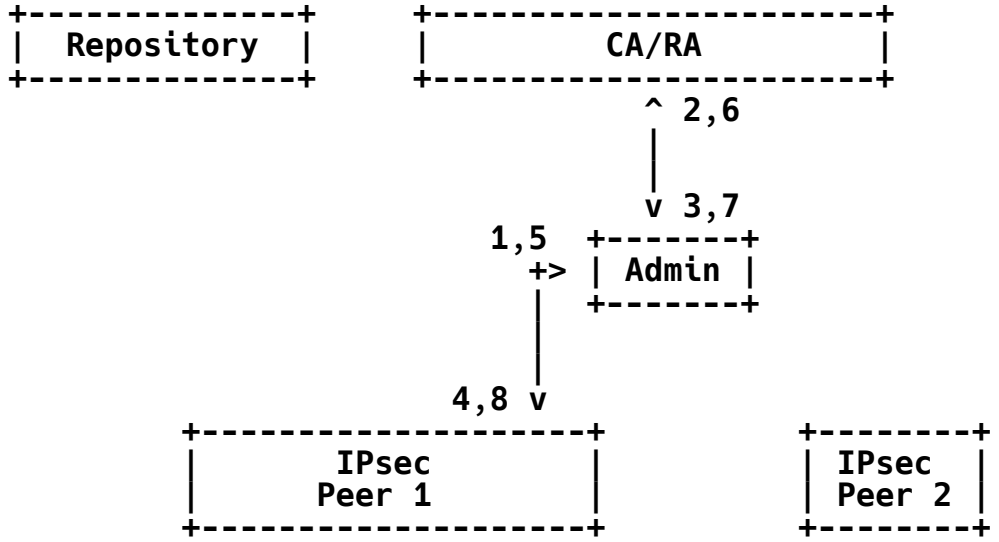



Figure 10. VPN-PKI Interaction Steps: IPsec Peer Generates Keys and PKC Request, Enrolls Through Admin

1) Opaque Transaction [E]. The IPsec Peer requests a PKC from the Admin, providing the generated public key.

2) Enrollment Request [E]. The Admin forwards the enrollment request to the PKI.

3) Enrollment Response [E]. The PKI responds to the enrollment request, providing either the new PKC that was generated or a suitable error indication.

4) Opaque Transaction [E]. The Admin forwards the enrollment response back to the IPsec Peer.

5) Opaque Transaction [E]. Peer positively acknowledges receipt of new PKC back to the Admin.

6) Enrollment Confirmation [E]. Admin forwards enrollment confirmation back to the PKI.

7) Enrollment Confirmation Receipt [E]. PKI sends enrollment confirmation receipt back to the Admin.

8) Opaque Transaction [E]. Admin forwards PKI's enrollment confirmation receipt back to the Peer.

### 3.4.7. Enrollment Method 2b: Peer Enrolls through Admin

In this case, the IPsec Peer has generated the key pair, but the PKC request is constructed and signed by the Admin. The PKI System does not care where the enrollment comes from, as long as it is a valid enrollment. Once the Admin retrieves the PKC, it then automatically forwards it to the IPsec Peer along with the key pair.

Some IPsec Systems do not have enough CPU power to generate a public and private key pair of sufficient strength for secure IPsec. In this case, the Admin needs to prove to the PKI that it has such a key pair; this is normally done by the PKI sending the Admin a nonce, which the Admin signs and returns to the PKI along with the end entity's public key. A drawback to this case is that the private key will eventually be sent over the wire (though hopefully securely so) from Admin to the IPsec Peer; whenever possible, it is preferred to keep a key within its cryptographic boundary of origin. Failing to do so opens the system to risk of the private keys being sniffed and discerned.

This enrollment mode is depicted in Figure 11 and the letters in the following description refer to Figure 3. Prior authorization (Section 3.2) and generation (Section 3.3.2) steps are not shown.

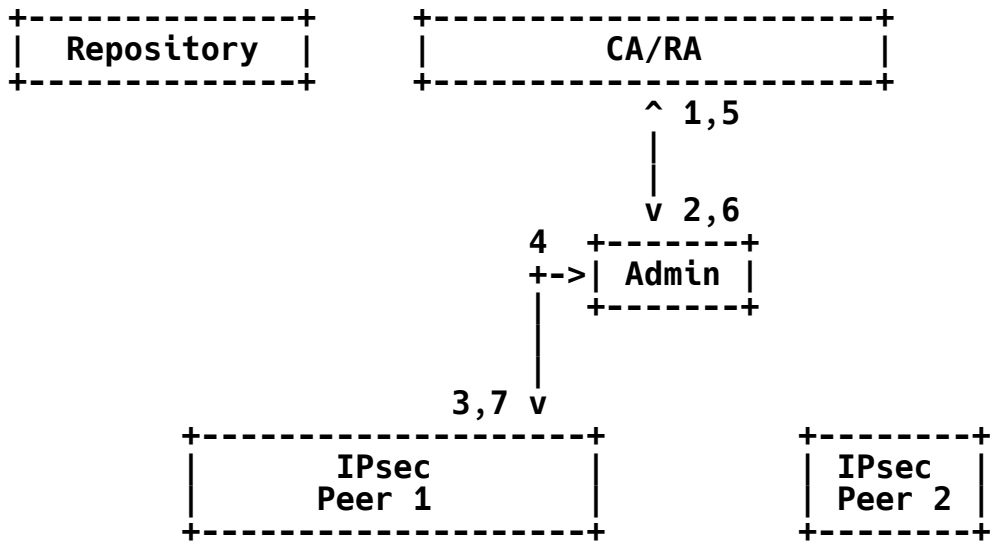



Figure 11. VPN-PKI Interaction Steps: IPsec Peer Generates Keys, Admin Constructs and Signs PKC Request, Enrolls through Admin

1) Enrollment Request [E]. The Admin requests a PKC from the PKI, providing the generated public key.

2) Enrollment Response [E]. The PKI responds to the enrollment request, providing either the new PKC that was generated or a suitable error indication.

3) Opaque Transaction [E]. The Admin forwards the enrollment response back to the IPsec Peer.

4) Opaque Transaction [E]. Peer positively acknowledges receipt of new PKC back to the Admin.

5) Enrollment Confirmation [E]. Admin forwards enrollment confirmation back to the PKI.

6) Enrollment Confirmation Receipt [E]. PKI sends enrollment confirmation receipt back to the Admin.

7) Opaque Transaction [E]. Admin forwards PKI's enrollment confirmation receipt back to the Peer.

### 3.4.8. Enrollment Method 3a: Admin Authorizes and Enrolls Directly to PKI

In this case, the Admin generates the key pair, PKC request, and digitally signs the PKC request. The PKI System does not care where the enrollment comes from, as long as it is a valid enrollment. Once the Admin retrieves the PKC, it then automatically forwards it to the IPsec Peer along with the key pair.

Some IPsec Systems do not have enough CPU power to generate a public and private key pair of sufficient strength for secure IPsec. In this case, the Admin needs to prove to the PKI that it has such a key pair; this is normally done by the PKI sending the Admin a nonce, which the Admin signs and returns to the PKI along with the end entity's public key. A drawback to this case is that the private key will eventually be sent over the wire (though hopefully securely so) from Admin to the IPsec Peer; whenever possible, it is preferred to keep a key within its cryptographic boundary of origin. Failing to do so opens the system to risk of the private keys being sniffed and discerned.

This enrollment mode is depicted in Figure 12 and the letters in the following description refer to Figure 3. Prior authorization (Section 3.2) and generation (Section 3.3.3) steps are not shown.

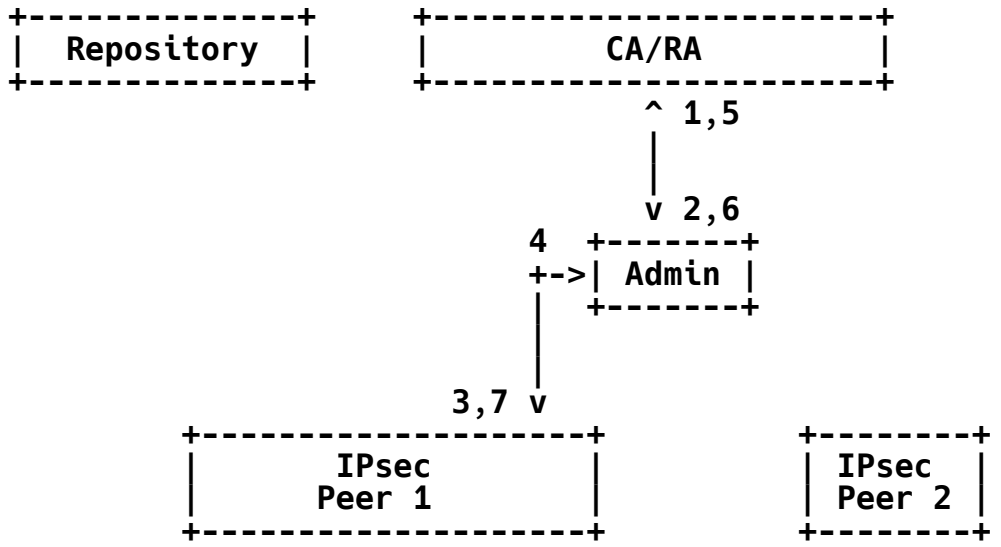



Figure 12. VPN-PKI Interaction Steps: Admin Generates Keys and PKC Request, and Enrolls Directly with PKI

1) Enrollment Request [E]. The Admin requests a PKC from the PKI, providing the generated public key.

2) Enrollment Response [E]. The PKI responds to the enrollment request, providing either the new PKC that was generated or a suitable error indication.

3) Opaque Transaction [E]. The Admin forwards the enrollment response back to the IPsec Peer, along with the keys.

4) Opaque Transaction [E]. Peer positively acknowledges receipt of new PKC back to the Admin.

5) Enrollment Confirmation [E]. Admin forwards enrollment confirmation back to the PKI.

6) Enrollment Confirmation Receipt [E]. PKI sends enrollment confirmation receipt back to the Admin.

7) Opaque Transaction [E]. Admin forwards PKI's enrollment confirmation receipt back to the Peer.

### 3.4.9. Enrollment Method 3b: Admin Requests and PKI Generates and Sends PKC

In this instance, the PKI and Admin have previously agreed to have the PKI generate keys and certificates when the PKI receives an authorization request. The PKI returns to the IPsec Peer through the Admin, the final product of a key pair and PKC. Again, the mechanism for the Peer to Admin communication is opaque.

A drawback to this case is that the private key will eventually be sent over the wire (though hopefully securely so) from Admin to the IPsec Peer; whenever possible, it is preferred to keep a key within its cryptographic boundary of origin. Failing to do so opens the system to risk of the private keys being sniffed and discerned.

This enrollment mode is depicted in Figure 13 and the letters in the following description refer to Figure 3. Prior authorization (Section 3.2) and generation (Section 3.3.4) steps are not shown.

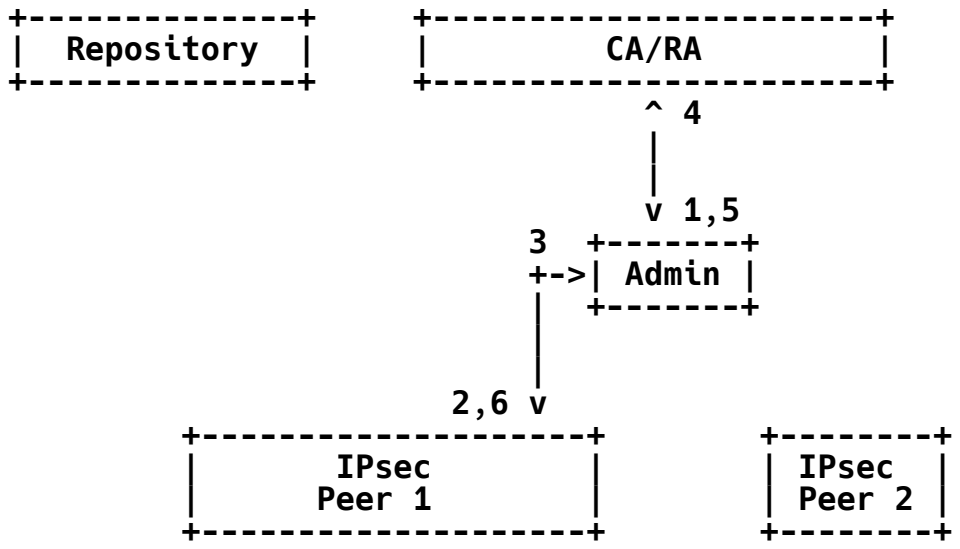



Figure 13. VPN-PKI Interaction Steps: PKI Generates Keys, PKC Request, and Enrolls Directly with PKI

1) Enrollment Response [E]. The PKI responds to the authorization request sent, providing either the new PKC and public-private key pair that were generated or a suitable error indication.

2) Opaque Transaction [E]. The Admin forwards the enrollment response back to the IPsec Peer, along with the keys.

3) Opaque Transaction [E]. Peer positively acknowledge receipt of new PKC back to the Admin.

4) Enrollment Confirmation [E]. Admin forwards enrollment confirmation back to the PKI.

5) Enrollment Confirmation Receipt [E]. PKI sends enrollment confirmation receipt back to the Admin.

6) Opaque Transaction [E]. Admin forwards PKI's enrollment confirmation receipt back to the Peer.

### 3.4.10. Confirmation Handshake

Any time a new PKC is issued by the PKI, a confirmation of PKC receipt MUST be sent back to the PKI by the Peer or the Admin (forwarding the Peer's confirmation).

Operationally, the Peer MUST send a confirmation to the PKI verifying that it has received the PKC, loaded it, and can use it effectively in an IKE exchange. This requirement exists so that:

- The PKI does not publish the new PKC in the repository for others until that PKC is able to be used effectively by the Peer, and

- A revocation may be invoked if the PKC is not received and operational within an allowable window of time.

To assert such proof, the Peer MUST sign a portion of data with the new key. The result MUST be sent to the PKI. The entity that actually sends the result to the PKI MAY be either the Peer (sending it directly to the PKI) or Admin (the Peer would send it to Admin, and Admin can, in turn, send it to the PKI).

The Admin MUST acknowledge the successful receipt of the confirmation, thus signaling to the Peer that it may proceed using this PKC in IKE connections. The PKI MUST complete all the processing necessary to enable the Peer's operational use of the new PKC (for example, writing the PKC to the repository) before sending the confirmation acknowledgement. The Peer MUST NOT begin using the PKC until the PKI's confirmation acknowledgement has been received.

### 3.4.11. Error Handling for Enrollment

Thorough error condition descriptions and handling instructions are REQUIRED for each transaction in the enrollment process. Providing such error codes will greatly aid interoperability efforts between the PKI and IPsec products.

The profile will clarify what happens if the request and retrieval fails for some reason. The following cases MUST be covered:

- Admin or Peer cannot send the request.

- Admin or Peer sent the request, but the PKI did not receive the request.

- PKI received the request, but could not read it effectively.

- PKI received and read the request, but some contents of the request violated the PKI's configured policy such that the PKI was unable to generate the PKC.

- The PKI System generated the PKC, but could not send it.

- The PKI sent the PKC, but the requestor (Admin or Peer) did not receive it.

- The Requestor (Admin or Peer) received the PKC, but could not process it due to incorrect contents, or other PKC-construction-related problem.

- The Requestor failed trying to generate the confirmation.

- The Requestor failed trying to send the confirmation.

- The Requestor sent the confirmation, but the PKI did not receive it.

- The PKI received the confirmation but could not process it.

In each case the following questions MUST be addressed:

- What does Peer do?
- What does Admin do?
- What does PKI do?
- Is Authorization used?

If a failure occurs after the PKI sends the PKC and before the Peer receives it, then the Peer MUST re-request with the same authorization ID and one-time authorization token. The PKI, seeing the authorization ID and authorization token, MUST send the PKC again.

Enrollment errors MUST be sent to the Admin regardless of the entity that generated the enrollment request.

### 3.5. Lifecycle

This section refers to the [L] elements labeled in Figure 3.

Once the PKI has issued a PKC for the end entity Peer, the Peer MUST be able to either contact the PKI directly or through the Admin for any subsequent rekeys, renewals, updates, or revocations. The PKI MUST support either case for renewals, updates, and revocations. Rekeys are Admin initiated; therefore, Peer initiated rekeys MUST be transferred via the Admin.

#### 3.5.1. One Protocol

One protocol MUST be specified for rekey, renew, and update requests, responses, and confirmations. It MUST be the same protocol as is specified in Section 3.4.

Revocation requests MAY use the same protocol as rekey, renew, and update operations. Revocation requests MAY also occur via email, telephone, Instant Messaging, etc.

### 3.5.2. PKC Rekeys, Renewals, and Updates

Rekeys, renewals, and updates are variants of a PKC enrollment request scenario with unique operational and management requirements.

- A PKC rekey replaces an end entity's PKC with a new PKC that has a new public key for the same SubjectName and SubjectAltName contents before the end entity's currently held PKC expires.

- A PKC renewal replaces an end entity's PKC with the same public key for the same SubjectName and SubjectAlternativeName contents as an existing PKC before that PKC expires.

- A PKC update is defined as a new PKC issuance with the same public key for an altered SubjectName or SubjectAlternativeName before expiration of the end entity's current PKC.

When sending rekey, renew, or update requests, the entire contents of the PKC request needs to be sent to the PKI, not just the changed elements.

The rekey, renew, and update requests MUST be signed by the private key of the old PKC. This will allow the PKI to verify the identity of the requestor, and ensure that an attacker does not submit a request and receive a PKC with another end entity's identity.

Whether or not a new key is used for the new PKC in a renew or update scenario is a matter of local security policy, and MUST be specified by the Admin to the PKI in the original authorization request. Reusing the same key is permitted, but not encouraged. If a new key is used, the update or renew request must be signed by both the old key -- to prove the right to make the request -- and the new key -- to use for the new PKC.

The new PKC resulting from a rekey, renew, or update will be retrieved in-band, using the same mechanism as a new PKC request.

For the duration of time after a rekey, renew, or update has been processed and before PKI has received confirmation of the Peer's successful receipt of the new PKC, both PKCs (the old and the new) for the end entity will be valid. This will allow the Peer to continue with uninterrupted IKE connections with the previous PKC while the rekey, renewal, or update process occurs.

After the rekey, renewal, or update occurs, the question now exists for the PKI of what to do about the old PKC. If the old PKC is to be made unusable, the PKI will need to add it to the revocation list, removed from the repository; however this should only occur once all connections that used the old PKC have expired. The decision about if the old PKC should be made unusable is determined by local policy. Either the PKI or the Admin MUST specify this parameter during the authorization phase. In this case, the PKI or the Admin MUST also specify the length of time from when the PKI receives the end entity Peer's confirmation (of receipt of the PKC) until when the old PKC is made unusable.

In the case where the new keys were generated for a renew or update request and for rekey requests, once the Peer receives the confirmation acknowledgement from the PKI, it is good practice for the old key pair to be destroyed as soon as possible. Deletion can occur once all connections that used the old PKC have expired.

If a PKC has been revoked, it MUST NOT be allowed a rekey, renewal, or update.

Should the PKC expire without rekey, renewal, or update, an entirely new request MUST be made.

#### 3.5.2.1. Rekey Request

Admins manage rekeys to ensure uninterrupted use of the VPN by Peers with new keys. Rekeys can occur automatically if the Admin is configured to initiate a new authorization for the rekey.

Scenarios for rekey are omitted as they use the same scenarios used in the original PKC enrollment from Sections 3.2, 3.3, and 3.4.

#### 3.5.2.2. Renew Request

Admins manage renewals to ensure uninterrupted use of the VPN by Peers with the same key pair.

At the time of authorization, certain details about renewal acceptance will be conveyed by the Admin to the PKI, as stated in Section 3.2.4.2. The renewal request MUST match the conditions that were specified in the original authorization for:

- Keys: New, existing, or either.
- Requestor: End entity Peer, Admin, or either.
- Period: How soon before PKC expiry.
- Time: Length of time before making the old PKC unusable.

If any of these conditions are not met, the PKI must reject the renewal and log the event.

Scenarios for renewal are omitted as they use the same scenarios used in the original PKC enrollment from Sections 3.2, 3.3, and 3.4.

#### 3.5.2.3. Update Request

An update to the contents of a PKC will be necessary when details about an end entity Peer's identity change, but the Operator does not want to generate a new PKC from scratch, requiring a whole new authorization. For example, a gateway device may be moved from one site to another. Its IPv4 Address will change in the SubjectAltName extension, but all other information could stay the same. Another example is an end user who gets married and changes the last name or moves from one department to another. In either case, only one field (the Surname or Organizational Unit (OU) in the DN) need change.

An update differs from a rekey or a renewal in a few ways:

- A new key is not necessary
- The timing of the update event is not predictable, as is the case with a scheduled rekey or renewal.
- The update request may occur at any time during a PKC's period of validity.
- Once the update is completed, and the new PKC is confirmed, the old PKC should cease to be usable, as its contents no longer accurately describe the subject.

At the time of authorization, certain details about update acceptance can be conveyed by the Admin to the PKI, as stated in Section 3.2.4.2. The update request MUST match the conditions that were specified in the original authorization for:

- Keys: new, existing, or either.
- Requestor: End entity Peer, Admin, or either.
- The fields in the Subject and SubjectAltName that are changeable.
- Time: Length of time before making the old PKC unusable.

If any of these conditions are not met, the PKI MUST reject the update and log the event.

If an update authorization was not made at the time of original authorization, one can be made from Admin to the PKI at any time during the PKC's valid life. When such an update is desired, Admin

must notify the PKI System that an update is authorized for the end entity and must specify the new contents. Admin then initiates the update request with the given contents in whichever mechanism the VPN System employs (direct from end entity to PKI, from end entity through Admin, or directly from Admin).

Scenarios for update are omitted as they use the same scenarios used in the original PKC enrollment from Sections 3.2, 3.3, and 3.4.

#### 3.5.2.4. Error Handling for Rekey, Renewal, and Update

Thorough error condition descriptions and handling instructions are required for each transaction in the rekey, renewal, or update process. Providing such error codes will greatly aid interoperability efforts between the PKI and IPsec products.

#### 3.5.2.5. Confirmation Handshakes

The confirmation handshake requirements are the same as in Sections 3.2, 3.3, and 3.4 except that depending on the Administrative policy the PKI MUST also issue a revocation on the original PKC before sending the confirmation response.

### 3.5.3. Revocation

The Peer MUST be able to initiate revocation for its own PKC. In this case the revocation request MUST be signed by the Peer's current key pair for the PKC it wishes to revoke. Whether the actual revocation request transaction occurs directly with the PKI or is first sent to Admin (who proxies or forwards the request to the PKI) is a matter of implementation.

The Admin MUST be able to initiate revocation for any PKC issued under a template it controls. The Admin will identify itself to the PKI by use of its own PKC; it MUST sign any revocation request to the PKI with the private key from its own PKC. The PKI MUST have the ability to configure Admin(s) with revocation authority, as identified by its PKC. Any PKC authorizations must specify if said PKC may be revoked by the Admin (see Section 3.2.3.2 for more details).

The profile MUST identify the one protocol or transaction within a protocol to be used for both Peer and Admin initiated revocations.

The profile MUST identify the size of CRL the client will be prepared to support.

Below are guidelines for revocation in specific transactions:

- AFTER RENEW, BEFORE EXPIRATION: The PKI MUST be responsible for the PKC revocation during a renew transaction. PKI MUST revoke the PKC after receiving the confirm notification from the Peer, and before sending the confirm-ack to the Peer. The Peer MUST NOT revoke its own PKC in this case.

- AFTER UPDATE, BEFORE EXPIRATION: The PKI MUST be responsible for the PKC revocation during an update transaction. PKI MUST revoke the PKC after receiving the confirm notification from the Peer, and before sending the confirm-ack to the Peer. The Peer MUST NOT revoke its own PKC in this case.

### 3.6. Repositories

This section refers to the [R] elements labeled in Figure 3.

#### 3.6.1. Lookups

The PKI System SHOULD be built so that lookups resolve directly and completely at the URL indicated in a CDP or AIA. The PKI SHOULD be built such that URL contents do not contain referrals to other hosts or URLs, as such referral lookups will increase the time to complete the IKE negotiation, and can cause implementations to timeout.

CDP MUST be flagged as required in the authorization request. The method MUST also be specified: the HTTP method MUST be method; the Lightweight Directory Access Protocol (LDAP) method MAY be supported.

The complete hierarchical PKC chain (except the trust anchor) MUST be able to be searched in their respective repositories. The information to accomplish these searches MUST be adequately communicated in the PKCs sent during the IKE transaction.

All PKCs must be retrievable through a single protocol. The final specification will identify one protocol as a "MUST", others MAY be listed as "OPTIONAL".

The general requirements for the retrieval protocol include:

- The protocol can be easily firewalled (including Network Address Translation (NAT) or Port Address Translation (PAT)).

- The protocol can easily perform some query against a remote repository on a specific ID element that was given to it in a standard PKC field.

Other considerations include:

- Relative speed
- Relative ease of administration
- Scalability

Intermediate PKCs will be needed for the case of re-keying of the CA, or a PKI System where multiple CAs exist.

PKCs MAY have extendedKeyusage to help identify the proper PKC for IPsec, though the default behavior is to not use them (see 3.1.5.3).

IPsec Peers MUST be able to resolve Internet domain names and support the mandatory repository access protocol at the time of starting up so they can perform the PKC lookups.

IPsec Peers should cache PKCs to reduce latency in setting up Phase 1. Note that this is an operational issue, not an interoperability issue.

The use case for accomplishing lookups when PKCs are not sent in IKE is a stated non-goal of the profile at this time.

### 3.6.2. Error Handling for Repository Lookups

Thorough error condition descriptions and handling instructions are required for each transaction in the repository lookup process. Providing such error codes will greatly aid interoperability efforts between the PKI and IPsec products.

## 3.7. Trust

### 3.7.1. Trust Anchor PKC Acquisition

The root PKC MUST arrive on the Peer via one of two methods:

(a) Peer can get the root PKC via its secure communication with Admin. This requires the Peer to know less about interaction with the PKI.

(b) Admin can command Peer to retrieve the root cert directly from the PKI. How retrieval of the root cert takes place is beyond the scope of this document, but is assumed to occur via an unauthenticated but confidential enrollment protocol.

### 3.7.2. Certification Path Validation

The IPsec Peer MUST perform identity verification based on the fields of the PKC and parameters applicable to the VPN Security Association. The fields of the PKC used for verification MAY include either the X.500 Distinguished Name (DN) within the Subject Name, or a specific field within the Extension SubjectAltName (per [DOI] 4.6.2.1 Identification Type Values). Usage descriptions for each follow.

The Peers or a Simple Certificate Validation Protocol (SCVP) server MUST validate the certification path, as per RFC 3280. The contents necessary in the PKC to allow this will be enumerated in the profile document.

The Peer MAY have the ability to construct the certification path itself; however, Admin MUST be able to supply Peers with the trust anchor and any chaining PKCs necessary. The Admin MAY ensure the template uses the AIA extension in PKCs as a means of facilitating path validation.

DNS MUST be supported by the Peers in order to support resolving URLs present in CDPs and AIA extensions.

### 3.7.3. Revocation Checking and Status Information

The PKI System MUST provide a mechanism whereby Peers can check the revocation status of PKCs that are presented to it for IKE identity. The mechanism should allow for access to extremely fresh revocation information. CRLs have been chosen as the mechanism for communicating this information. Operators are RECOMMENDED to refresh CRLs as often as logistically possible.

A single mandatory protocol mechanism for performing CRL lookups MUST be specified by the final specification.

All PKCs used in IKE MUST have cRLDistributionPoint and authorityInfoAccess fields populated with valid URLs. This will allow all recipients of the PKC to know immediately how revocation is to be accomplished, and where to find the revocation information. The AIA is needed in an environment where multiple layers of CAs exist and for the case of a CA key roll-over.

IPsec Systems have an OPTION to turn off revocation checking. Such may be desired when the two Peers are communicating over a network without access to the CRL service, such as at a trade show, in a lab, or in a demo environment. If revocation checking is OFF, the implementation MUST proceed to use the PKC as valid identity in the exchange and need not perform any check.

If the revocation of a PKC is used as the only means of deactivation of access authorization for the Peer (or user), then the speed of deactivation will be as rapid as the refresh rate of the CRL issued and published by the PKI. If more immediate deactivation of access is required than the CRL refreshing can provide, then another mechanism for authorization that provides more immediate access deactivation should be layered into the VPN deployment. Such a second mechanism is out of the scope of this profile. (Examples are Xauth, L2TP's authentication, etc.)

#### 3.7.4. Error Handling in Revocation Checking and Certificate Path Validation

Thorough error condition descriptions and handling instructions are required for each transaction in the revocation checking and path validation process. Providing such error codes will greatly aid interoperability efforts between the PKI and IPsec products.

## 4. Security Considerations

This requirements document does not specify a concrete solution, and as such has no system-related security considerations per se. However, the intent of the PKI4IPSEC WG was to profile and use concrete protocols for certificate management (e.g., Cryptographic Message Syntax (CMS), Certificate Management over CMS (CMC), Certificate Request Message Format (CRMF)). The individual security considerations of these protocols should be carefully considered in the profiling effort.

In addition, this document allows significant flexibility in the allocation of functions between the roles of Peer and Admin. This functional allocation is crucial both to achieving successful deployment, and to maintaining the integrity of the PKI enrollment and management processes. However, much of the responsibility for this allocation necessarily falls to product implementers and system operators through the selection of applicable use cases and development of security policy constraints. These factors must be carefully considered to ensure the security of PKI4IPSEC certificate management.

## 5. References

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## 6. Acknowledgements

This RFC is substantially based on a prior document developed by Project Dploy. The principle editor of that document was Gregory M. Lebovitz (NetScreen/Juniper). Contributing authors included Lebovitz, Paul Hoffman (VPN Consortium), Hank Mauldin (Cisco Systems), and Jussi Kukkonen (SSH Communications Security). Substantial editorial contributions were made by Leo Pluswick (ICSA), Tim Polk (NIST), Chris Wells (SafeNet), Thomas Hardjono (VeriSign), Carlisle Adams (Entrust), and Michael Shieh (NetScreen/Juniper).

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## Acknowledgement

Funding for the RFC Editor function is currently provided by the Internet Society.