Internet X.509 Public Key Infrastructure
Data Validation and Certification Server Protocols

Status of this Memo

This memo defines an Experimental Protocol for the Internet community. It does not specify an Internet standard of any kind. Discussion and suggestions for improvement are requested.

Distribution of this memo is unlimited.

Copyright Notice

Copyright (C) The Internet Society (2001). All Rights Reserved.

Abstract

This document describes a general Data Validation and Certification Server (DVCS) and the protocols to be used when communicating with it. The Data Validation and Certification Server is a Trusted Third Party (TTP) that can be used as one component in building reliable non-repudiation services.

Useful Data Validation and Certification Server responsibilities in a PKI are to assert the validity of signed documents, public key certificates, and the possession or existence of data.

Assertions created by this protocol are called Data Validation Certificates (DVC).

We give examples of how to use the Data Validation and Certification Server to extend the lifetime of a signature beyond key expiry or revocation and to query the Data Validation and Certification Server regarding the status of a public key certificate. The document includes a complete example of a time stamping transaction.
1. Introduction

This document is the result of work that has been proposed and discussed within the IETF PKIX working group. The authors and some members of the group felt that promoting the rather new concepts into the standards process seemed premature. The concepts presented have been stable for some time and partially implemented. It was agreed that a publication as experimental RFC was an appropriate means to
get a stable reference document to permit other implementations to occur.

The key words "MUST", "MUST NOT", "REQUIRED", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document (in uppercase, as shown) are to be interpreted as described in [RFC2119].

A Data Validation and Certification Server (DVCS) is a Trusted Third Party (TTP) providing data validation services, asserting correctness of digitally signed documents, validity of public key certificates, and possession or existence of data.

As a result of the validation, a DVCS generates a Data Validation Certificate (DVC). The data validation certificate can be used for constructing evidence of non-repudiation relating to the validity and correctness of an entity’s claim to possess data, the validity and revocation status of an entity’s public key certificate and the validity and correctness of a digitally signed document.

Services provided by a DVCS do not replace the usage of CRLs and OCSP for public key certificate revocation checking in large open environments, due to concerns about the scalability of the protocol.

It should be rather used to support non-repudiation or to supplement more traditional services concerning paperless document environments. The presence of a data validation certificate supports non-repudiation by providing evidence that a digitally signed document or public key certificate was valid at the time indicated in the DVC.

A DVC validating a public key certificate can for example be used even after the public key certificate expires and its revocation information is no longer or not easily available. Determining the validity of a DVC is assumed to be a simpler task, for example, if the population of DVCS is significantly smaller than the population of public key certificate owners.

An important feature of the protocol is that DVCs can be validated by using the same protocol (not necessarily using the same service), and the validity of a signed document, in particular a DVC, can also be determined by means other than by verifying its signature(s), e.g., by comparing against an archive.

The production of a data validation certificate in response to a signed request for validation of a signed document or public key certificate also provides evidence that due diligence was performed by the requester in validating a digital signature or public key certificate.
This document defines the use of digital signatures to insure the authenticity of documents and DVCs, and uses a corresponding terminology; the use of other methods to provide evidence for authenticity is not excluded, in particular it is possible to replace a SignedData security envelope by another one.

2. Services provided by DVCS

The current specification defines 4 types of validation and certification services:

- Certification of Possession of Data (cpd),
- Certification of Claim of Possession of Data (ccpd),
- Validation of Digitally Signed Document (vsd), and
- Validation of Public Key Certificates (vpkc).

A DVCS MUST support at least a subset of these services. A DVCS may support a restricted vsd service allowing to validate data validation certificates.

On completion of each service, the DVCS produces a data validation certificate - a signed document containing the validation results and trustworthy time information.

2.1 Certification of Possession of Data

The Certification of Possession of Data service provides evidence that the requester possessed data at the time indicated and that the actual data were presented to the Data Validation Server.

2.2 Certification of Claim of Possession of Data

The Certification of Claim of Possession of Data service is similar to the previous one, except that the requester does not present the data itself but a message digest.

2.3 Validation of Digitally Signed Documents

The Validation of Digitally Signed Document service is used when validity of a signed document is to be asserted.

The DVCS verifies all signatures attached to the signed document using all appropriate status information and public key certificates. The DVCS verifies the mathematical correctness of all signatures attached to the document and also checks whether the signing entities can be trusted, for example by validating the full certification path from the signing entities to a trusted point (e.g., the DVCS’s CA, or the root CA in a hierarchy).
The DVCS may be able to rely on relevant CRLs or may need to supplement this with access to more current status information from the CAs for example by accessing an OCSP service, a trusted directory service, or other DVCS services.

The DVCS will perform verification of all signatures attached to the signed document. A failure of the verification of one of the signatures does not necessarily result in the failure of the entire validation, and vice versa, a global failure may occur if the document has an insufficient number of signatures.

2.4 Validation of Public Key Certificates

The Validation of Public Key Certificates service is used to verify and assert the validity (according to [RFC2459]) of one or more public key certificates at the specified time.

When verifying a public key certificate, the DVCS verifies that the certificate included in the request is a valid certificate and determines its revocation status at a specified time. DVS checks the full certification path from the certificate’s issuer to a trusted point. Again, the DVCS MAY be able to rely on external information (CRL, OCSP, DVCS).

3. Data Certification Server Usage and Scenarios.

It is outside the scope of this document to completely describe different operational scenarios or usages for DVCS.

See Appendix B and C for a set of some basic examples and use cases.

The Validate Signed Document service can be used to support non-repudiation services, to allow use of the signed document beyond public key certificate revocation or expiry, or simply to delegate signature validation to a trusted central (company wide) service.

The Validate Public Key Certificate service can be used when timely information regarding a certificate’s revocation status is required (e.g., high value funds transfer or the compromise of a highly sensitive key) or when evidence supporting non-repudiation is required.

A data validation certificate may be used to simplify the validation of a signature beyond the expiry or subsequent revocation of the signing certificate: a Data validation certificate used as an authenticated attribute in a signature includes an additional
assertion about the usability of a certificate that was used for signing. In order to validate such a signature it may be sufficient to only validate the data validation certificate.

A DVCS may include additional key exchange certificates in a data validation certificate to validate a key exchange certificate in order to provide to an application a set of additional authorised recipients for which a session key should also be encrypted. This can be used for example to provide central management of a company wide recovery scheme. Note, that the additional certificates may not only depend on the requested certificate, but also on the requester’s identity.

The Certification of Claim of Possession of Data service is also known as time stamping.

The Certification of Possession of Data service can be used to assert legal deposit of documents, or to implement archival services as a trusted third party service.

The Data Validation and Certification Server Protocols can be used in different service contexts. Examples include company-wide centralised services (verification of signatures, certification of company certificates), services to cooperate in a multi-organization community, or general third party services for time stamping or data archival.

An important application of DVCS is an enterprise environment where all security decisions are based on company wide rules. A company wide DVCS service can be used to delegate all technical decisions (e.g., path validation, trust configuration) to a centrally managed service.

In all cases, the trust that PKI entities have in the Data Validation and Certification Server is transferred to the contents of the Data Validation Certificate (just as trust in a CA is transferred to the public key certificates that it issues).

A DVCS service may be combined with or use archiving and logging systems, in order to serve as a strong building block in non-repudiation services. In this sense it can be regarded as an Evidence Recording Authority [ISO-NR].
4. Functional Requirements for DVCS

The DVCS MUST

1. provide a signed response in the form of a data validation certificate to the requester, as defined by policy, or an error response. The DVCS service definition and the policy define how much information that has been used by the DVCS to generate the response will be included in a data validation certificate, e.g., public key certificates, CRLs, and responses from other OCSP servers, DVCS, or others.

2. indicate in the data validation certificate whether or not the signed document, the public key certificate(s), or the data were validated, and, if not, the reason why the verification failed.

3. include a strictly monotonically increasing serial number in each data validation certificate.

4. include a time of day value or a time stamp token into each data validation certificate.

5. sign each data certification token using a key that has been certified with a dvcs signing extended key purpose, and include a reference to this certificate as a signed attribute in the signature.

6. check the validity of its own signing key and certificate before delivering data validation certificates and MUST not deliver data validation certificate in case of failure.

A DVCS SHOULD include within each data validation certificate a policy identifier to determine the trust and validation policy used for DVC’s signature.

5. Data Certification Server Transactions

A DVCS transaction begins with a client preparing a Data Validation and Certification Request. The request always contains data for which validity, correctness or possession is to be certified.

The request MAY be encapsulated using a security envelope to provide for authentication of both requester and server. Requester authentication can be achieved by several of the formats described in CMS, in particular, signedData.
The DVCS client chooses an appropriate transport mechanism to convey the requests to a DVCS. It may also be necessary to choose a transport mechanism providing confidentiality and, in particular, allowing authentication of the DVCS by the requestor, e.g., TLS or CMS or S/MIME encryption.

If the request is valid, the DVCS performs all necessary verifications steps, and generates a Data Validation Certificate (DVC), and sends a response message containing the DVC back to the requestor.

The Data Validation Certificate is formed as a signed document (CMS SignedData).

As with the request, it may be necessary to choose a transport mechanism that provides for confidentiality to carry the DVC. DVCs are not necessarily transported the same way as requests, e.g., they can be returned using e-mail after an online request received via HTTPS.

If the request was invalid, the DVCS generates a response message containing an appropriate error notification.

Upon receiving the response, the requesting entity SHOULD verify its validity, i.e., whether it contains an acceptable time, the correct name for the DVCS, the correct request information and message imprint, a valid signature, and satisfactory status, service and policy fields.

When verifying the validity of a DVC, it is up to the requestor’s application to check whether a DVCS’s signing certificate is valid. Depending on the usage environment, different methods, online or out of band, e.g., CRLs, DVCS, or OCSP, may have to be used.

After all checks have passed, the data validation certificate can be used to authenticate the correctness or possession of the corresponding data.

A DVCS may return more than one DVC corresponding to one request. In this case, all but one request have a global status of ‘WAITING’.

6. Identification of the DVCS

In order to be able to import elements from dvcs the following object identifier is used as a ASN.1 module identifier.

\[
\text{id-mod-dvcs OBJECT IDENTIFIER ::= \{iso(1) identified-organization(3) dod(6) internet(1) security(5) mechanisms(5) pkix(7) id-mod(0) 15\}}
\]
The DVCS that use SignedData to provide authentication for DVCs MUST sign all data certification messages with a key whose corresponding certificate MUST contain the extended key usage field extension as defined in [RFC2459] Section 4.2.1.14 with KeyPurposeID having value id-kp-dvcs. This extension MUST be marked as critical.

The Data Validation Certificate MUST contain an ESSCertID authenticated attribute for the certificate used by the DVCS for signing.

id-kp-dvcs OBJECT IDENTIFIER ::= {iso(1) identified-organization(3) dod(6) internet(1) security(5) mechanisms(5) pkix(7) kp(3) 10}

Consistent KeyUsage bits:
digitalSignature, nonRepudiation, keyCertSign, cRLSign

A DVCS’s certificate MAY contain an Authority Information Access extension [RFC2459] in order to convey the method of contacting the DVCS. The accessMethod field in this extension MUST contain the OID id-ad-dvcs:

id-ad-dvcs OBJECT IDENTIFIER ::= {iso(1) identified-organization(3) dod(6) internet(1) security(5) mechanisms(5) pkix(7) ad(48) 4}

The value of the ‘accessLocation’ field defines the transport (e.g., an URI) used to access the DVCS.

7. Common Data Types

There are several common data types that occur in the request and the response data structures. These data types are either defined by this document or imported from other sources. This chapter defines and describes these types and lists their usages.

7.1 Version:

The request and the response include an optional integer field specifying the version of the data structure. For both fields the value is 1, or the field is not present at all in this version of the protocol.
7.2 DigestInfo:

This element is defined in [RFC2315]. Since the status of that document is informational, the definition is repeated here:

DigestInfo ::= SEQUENCE {
    digestAlgorithm   DigestAlgorithmIdentifier,
    digest            Digest }

Digest ::= OCTET STRING

The fields of type DigestInfo have the following meanings:

- The field 'digestAlgorithm' identifies the message-digest algorithm (and any associated parameters) under which data are digested.
- The field 'digest' is the result of the message-digesting process.

A DigestInfo is used in two places:

- as a data portion for the ccpd service, and
- in all a data validation certificates to hold a digest of the data portion of the corresponding request or a copy of the data field for a ccpd service.

7.3. Time Values

Indicators of time can be present in requests and responses. In the most simple form, the time is represented as GeneralizedTime where fractions of seconds are allowed.

An alternate form is a timeStampToken from a TSA, or as a DVC (or some other token) from another third party service.

It is a matter of policy whether a DVCS tries to interpret or validate a Time Value in a request.

DVCSTime ::= CHOICE {
    genTime                      GeneralizedTime,
    timeStampToken               ContentInfo }

Future versions of the protocol MAY include additional time formats.

Time values generated by the DVCS are increasing but not necessarily unique, an order among DVCs is defined by serial numbers.
7.4. PKIStatusInfo

This structure is defined in [RFC2510]. It is used as component of the ‘chain’ field of a TargetEtcChain structure, and as a global status indicator in the DVCSResponse structure. Every occurrence of PKIStatusInfo is generated by the responding DVCS to reflect the result of some local verification.

7.5. TargetEtcChain

A TargetEtcChain structure contains certificates and other indicators to describe either (in a request for a cpkc service) information to be validated, or the result of the verifications. The structure may also contain information about policies and policy mappings.

The details about how to fill in and to interpret the structure are defined later for each service.

The ‘pathProcInput’ field contains information about policies and policy mapping to be used or used during a validation.

In a response, the ‘pkistatus’ and ‘certstatus’ choices can only occur in the ‘chain’ sequence. If present, they contain the result of a local verification of the immediately preceding element, or of the target value, if it is the first element in the ‘chain’ sequence. If no ‘pkistatus’ or ‘certstatus’ is present, the DVCS considers all elements in the ‘chain’ as trustworthy. Note, that there may be a valid OCSP response or DVC indicating an invalid certificate.

TargetEtcChain ::= SEQUENCE {
  target                       CertEtcToken,
  chain                        SEQUENCE SIZE (1..MAX) OF CertEtcToken OPTIONAL,
  pathProcInput                [0] PathProcInput OPTIONAL }

PathProcInput ::= SEQUENCE {
  acceptablePolicySet          SEQUENCE SIZE (1..MAX) OF PolicyInformation,
  inhibitPolicyMapping         BOOLEAN DEFAULT FALSE,
  explicitPolicyReqd           BOOLEAN DEFAULT FALSE }

CertEtcToken ::= CHOICE {
  certificate                  [0] IMPLICIT Certificate ,
  esscertid                    [1] ESSCertId ,
  pkistatus                    [2] IMPLICIT PKIStatusInfo ,
  assertion                    [3] ContentInfo ,
  crl                          [4] IMPLICIT CertificateList,
The choice 'assertion' can contain a data validation certificate, or a timeStamp, or other assertions.

The choices 'assertion', 'ocspresponse' and 'crl' are provided by services external to the responding DVCS. The choices 'certStatus' and 'pkistatus' reflect decisions made directly by the responding DVCS.

As a replacement for certificates, certification identifiers (ESSCertId, CertId) MAY be used in requests and responses, if this is sufficient to perform the service, e.g., when the corresponding certificates are provided elsewhere in a request or response (as part of the SignedData type).

Certificate or certification identifiers of certification authorities MAY occur in any order and MAY represent several certification chains.

The choice 'capabilities' can be used to indicate SMIMECapabilities. It applies to the certificate identified by the preceding element in the sequence.

7.6. DVCSRequestInformation

A DVCSRequestInformation data structure contains general information about the Data Validation and Certification Request. This structure occurs in a request, and is also included in a corresponding Data Validation Certificate.

DVCSRequestInformation ::= SEQUENCE { version INTEGER DEFAULT 1 ,
service ServiceType ,
nonce INTEGER OPTIONAL ,
requestTime DVCSTime OPTIONAL ,
requester [0] GeneralNames OPTIONAL ,
requestPolicy [1] PolicyInformation OPTIONAL ,
The ServiceType type enumerates the DVCS service type of a request. See chapter 2 for the description of the services.

ServiceType ::= ENUMERATED { cpd(1), vsd(2), cpkc(3), ccpd(4) }

7.7. GeneralName and GeneralNames

There are several occurrences of SEQUENCES of GeneralName and GeneralNames. These structures are imported from [RFC2459].

8. Data Validation and Certification Requests

A Data Validation and Certification request is a ContentInfo defined in [RFC2630].

It may consist of a [RFC2630] content with a contenttype id-ct-DVCSRequestData signalling a DVCSRequestData,

id-ct-DVCSRequestData OBJECT IDENTIFIER ::= {iso(1) member-body(2) us(840) rsadsi(113549) pkcs(1) pkcs-9(9) smime(16) ct(1) 7}

These data are optionally encapsulated by contenttypes that provide for authentication and/or confidentiality.

This document describes the usage of a SignedData construct of [RFC2630] where the contenttype indicated in the eContentType of the encapsContentInfo is id-ct-DVCSRequestData and the eContent of the encapsContentInfo, carried as an octet string, contains a DVCSRequestData structure.

When using a SignedData structure, a Data Validation and Certification Request MAY contain several SignerInfo structures, and countersignature attributes depending on operational environments. When an end user client creates the request, there is one or zero SignerInfo. A relaying DVCS MAY add an additional signature or a countersignature attribute, or MAY use another encapsulation from [RFC2630] that provides for authentication and/or confidentiality.

The content of a request consists of a description of the desired service and additional parameters, the data to be validated, and an optional identifier of the request.
DVCSRequest ::= SEQUENCE  
   {  
      requestInformation     DVCSRequestInformation,  
      data                   Data,  
      transactionIdentifier  GeneralName OPTIONAL  
   }  

The ‘DVCSRequest.requestInformation’ element contains general information about the request. It is filled in by the requester as follows:

- The ‘version’ field is set to 1 or the field is absent in this version of the protocol.

The field ‘service’ contains the requested service.

- The ‘nonce’ field MAY be used to provide additional protection against replay or content guessing attacks.

- The ‘requestTime’ field MAY be used to indicate the time for which the requested service should be performed. For a vsd and cpkc service, it specifies the time for which the validity of a signed document or certificates is to be asserted. For the other service, the field is ignored by the DVCS. If the field is absent, the current time is assumed.

- The value of the ‘requester’ field indicates the requesting entity.

The interpretation and usage of this field MUST be defined by the DVCS policy.

Some usage examples are:

If the field is present, and the request is signed, a DVCS MAY require that the field MUST match the identity (subjectName or subjectAltName extension) of the corresponding signature certificate.

A request MAY be signed by a DVCS when relaying it to another DVCS.

When acting as a relay, a DVCS MAY add its own identity in the request relayed to another service provider, and it MAY remove the initial value.

- The ‘requestPolicy’ field SHOULD indicate the policy under which the validation is requested. This field MUST be checked by the DVCS to verify agreement with its own policy. The absence of this field indicates that any policy is acceptable.
- The 'dvcs' field MAY be used to indicate a list of DVCS which can be contacted to provide (additional) information or to perform additional operations necessary to produce the response.

It is up to the DVCS policy whether to honor this field or not, and to define which choice of a general name is acceptable (e.g., an URL or a DN).

- The 'dataLocations' field MAY be used to indicate where a copy of the 'data' field of the request or supplementary information can be obtained. The DVCS does not use this field for its own operation, the exact interpretation of this field is defined by applications.

- The 'requestTime' field MAY be used to indicate the time for which the requested service should be performed. For a vsd and cpkc service, it specifies the time for which the validity of a signed document or certicates is to be asserted. For the other service, the field is ignored by the DVCS. If the field is absent, the current time is assumed. The DVCS service may have a time limit or a delta time limit regarding current time which are specified in the local policy of the DVCS service.

- The 'extensions' field MAY be used to include additional information. Extensions may be marked critical or not in order to indicate whether the DVCS is supposed to understand them. This document does not define extensions.

The DVCSRequest.data contains service-specific content, defined by each particular service provided by the DVCS.

Depending on the requested service type, the field may contain a signed document, a list of certicates, a message digest or arbitrary data.

The following type is used:

Data ::= CHOICE {
    message           OCTET STRING ,
    messageImprint    DigestInfo,
    certs             SEQUENCE SIZE (1..MAX) OF TargetEtcChain
}

The requester fills the 'data' element as follows:

- For a vsd service request, the requestor encapsulates a CMS SignedData object in the value octets of the 'message' choice.
It is up to the requester to decide whether and how to provide any certificate that may be needed to verify the signature(s) in the signedData object. A requester MAY add certificates to the encapsulated signedData object or in the certificate list of the request.

- For a cpkc service request the ‘certs’ choice is used.

Each certificate to be verified MUST be included in a separate instance of TargetEtcChain. The ‘TargetEtcChain.chain’ field, if present, indicates one or more chains of trust that can be used to validate the certificate. The DVCS MAY choose to select a subset of certificates as certification path, or to ignore this field. The ‘TargetEtcChain.pathProcInput’ field, if present, indicates the acceptable policy set and initial settings for explicit-policy-indicator and inhibit-policy-mapping indicators to be used in X.509 public key certificate path validation (see [RFC2459]).

Only the Certificate, ESSCertId, CertId or Extension choices of the TargetEtcChain can be used in the request.

The requester is responsible for providing sufficient information to the DVCS to identify the corresponding certificates.

- For a ccpd service the ‘messageImprint’ choice is used.

The hash algorithm indicated in the hashAlgorithm field SHOULD be a "strong" hash algorithm (that is, it SHOULD be one-way and collision resistant). It is up to the Data Certification Server to decide whether or not the given hash algorithm is sufficiently "strong" (based on the current state of knowledge in cryptanalysis and the current state of the art in computational resources, for example).

- For a cpd service the ‘message’ choice is used.

The field contains requester-specific data with any type of content. The DVCS does not inspect, modify, or take any particular action based on the particular content of the ‘message’ field.

The field ‘DVCSRequest.transactionIdentifier’ MAY be used in order to associate DVCS responses containing error messages, to requests. For example, in a mail based environment, the parameter could be a copy of a messageid. Note, that the transactionIdentifier is not necessary for associating a request with a valid data validation certificate.
9. DVCS Responses

This chapter describes the data structures that are created by a DVCS to indicate the results of validation and certification requests.

A DVCS Response structure is generated by the DVCS as a result of processing of the data validation and certification request.

A Data Validation response contains an [RFC2630] ContentInfo with a type of id-ct-DVCSResponseData signalling a DVCSResponse structure.

id-ct-DVCSResponseData OBJECT IDENTIFIER ::= { iso(1) member-body(2) us(840) rsadsi(113549) pkcs(1) pkcs-9(9) smime(16) ct(1) 8 }

The data MAY be encapsulated by constructs of [RFC2630] in order to provide authentication of the DVCS, and or integrity and confidentiality of the request. This document specifies the usage of a SignedData construct of [RFC2630].

The contentType indicated in the eContentType of the encapContentInfo is of type id-ct-DVCSResponseData, signalling a DVCSResponse as eContent of the encapContentInfo (carried as an octet string). The DVCS SHOULD use a key for which a corresponding certificate indicates in an extendedKeyUsage the purpose of DVCS signing.

In a critical situation when a DVCS cannot produce a valid signature (if the DVCS’s signing key is known to be compromised, for example), the DVCSResponse, containing the error notification, MUST be generated as a signedData with no signerInfo attached. Receiving unsigned DVCSResponse MUST be treated by the clients as a critical and fatal error, and the content of the message should not be implicitly trusted.

A valid response can contain one of the following:

1. A Data Validation Certificate (DVC), delivering the results of data validation operations, performed by the DVCS.

2. An error notification. This may happen when a request fails due to a parsing error, requester authentication failure, or anything else that prevents the DVCS from executing the request.
The following type is used:

DVCSResponse ::= CHOICE {
    dvCertInfo      DVCSCertInfo ,
    dvErrorNote     [0] DVCSErrorNotice }

9.1. Data Validation Certificate

A Data Validation Certificate is a signedData object containing a
DVCSResponse with a ‘dvCertInfo’ choice.

DVCSCertInfo ::= SEQUENCE {
    version             Integer DEFAULT 1 ,
    dvReqInfo           DVCSRequestInformation,
    messageImprint      DigestInfo,
    serialNumber        Integer,
    responseTime        DVCSTime,
    dvStatus            [0] PKIStatusInfo OPTIONAL,
    policy              [1] PolicyInformation OPTIONAL,
    reqSignature        [2] SignerInfos  OPTIONAL,
    certs               [3] SEQUENCE SIZE (1..MAX) OF
                         TargetEtcChain OPTIONAL,
    extensions          Extensions OPTIONAL }

The DVCSCertInfo structure is returned as a result of successful
execution of data validation service. It contains the results of the
data validation, a reference to the original request, and other
parameters. Please note that ‘successful execution’ does not
necessarily mean that the validation itself was successful - a
DVCSCertInfo may contain both the ‘valid’ and ‘invalid’ results.

The DVCS creates a DVCSCertInfo as follows:

- The ‘version’ field is never present in this version of the
  protocol.

The ‘dvReqInfo’ is essentially a copy of the ‘requestInformation’
field of the corresponding request. The DVCS MAY modify the fields
‘dvcs’, ‘requester’, ‘dataLocations’, and ‘nonce’ of the ReqInfo
structure, e.g., if the request was processed by a chain of DVCS,
if the request needs to indicate DVCS, or to indicate where to find
a copy of the data from a ‘vpd’ request. The only modification
allowed to a ‘nonce’ is the inclusion of a new field if it was not
present, or to concatenate other data to the end (right) of an
existing value.
- The 'DVCSCertInfo.messageImprint' field is computed from the 'data' field of the corresponding request as follows:

For the 'certs' choice (the 'vpkc' service), the digest is computed over the DER encoded data value. For a 'message' choice (the 'vsd' and the 'vpd' services) the digest is computed over the value octets (not including tag and length octets) of the OCTET STRING. It is up to the DVCS to choose an appropriate digest algorithm.

For a 'messageImprint' choice (the 'vcpd' service), the 'messageImprint' of the DVCSRequest is copied as is.

- The 'DVCSCertInfo.serialNumber' field contains a unique identifier of the request.

- The field 'responseTime' indicates a time value associated with the response. The value MAY be a locally generated one, or a signed TimeStampToken (TST) or DVC obtained from an external service. Before using a value obtained from an external service, the DVCS must validate it according the rules of the external service.

- The field 'DVCSCertInfo.dvStatus' reflects a collective result of the validation.

  If the field is missing, it is an equivalent of the SUCCESS status.

  For a vkpc, if the status field is present and set to SUCCESS, it indicates that all certificates were successfully validated. If it is present and set to FAILED, it indicates that all or some of the certificates failed validation, and the specific status of the 'certs' should be investigated, at least one of the elements of the 'certs' TargetEtcChain structures MUST have a failure status.

  If the field 'dvStatus' does not indicate success ('granted' or 'granted with mods') the element 'failInfo' MAY indicate the reason for the failure. Note that the field 'certs' MAY contain additional information about verification failures.

  A failure of the verification of one of the signatures does not necessarily result in failing to validate a signed document. For example, as long as a sufficient number of signature was successfully verified, a DVC with status 'grantedWithMods' may be produced. A DVC with status 'granted' MUST only be produced if all signatures verified successfully.
The field MUST be present, and the status must be set to WAITING, if no final response can be immediately available. It is assumed that the DVCS provides an additional final status some time later. The details of the necessary procedures are part of the DVCS policy.

In case of failure, the requester can further investigate the cause of the failure, by looking into the TargetEtcChain fields. ‘CertEtcToken.pkisStatus’ fields will indicate which item(s) has failed or succeeded the validation and for what reason.

- The ‘DVCSCertInfo.policy’ field indicates the policy under which the DVCS operates.

- If present, ‘DVCSCertInfo.reqSignature’ MUST be the same value as the signerInfos field of the corresponding request. It is a policy decision whether to include this field.

- The ‘DVCSCertInfo.certs’ field contains the results of the verifications made by the DVCS. For the cpkc service, each element contains a copy of a corresponding field of the request with the selected subset in the targetAndChain subfield and the results of the verifications, and additional certificates or certificate references, e.g., from certification authorities or as described in appendix C.3. For a vsd service, each element contains the result of the validation of one signature of the signed document to be validated.

In case of a global status of WAITING, the DVCS MAY choose to return an individual status of waiting in some of the ‘certs’ field, or not to return such a TargetEtcChain at all.

The ‘acceptablePolicySet’ sequence indicates the policies and mappings that were processed during X.509 public key certificate path validation. PolicyMapingsSyntax is defined in [RFC2459].

- The ‘extensions’ field MAY be used to return additional information to the client. Extensions MAY be marked critical or not in order to indicate whether the client MUST understand them. This document does not define extensions.
9.2. DVCS Error Notification

A DVCS Error Notification is a CMS signedData object containing a DVCS Response with a 'dvErrorNote' choice.

DVCSErrorNotice ::= SEQUENCE {
    transactionStatus   PKIStatusInfo,
    transactionIdentifier   GeneralName OPTIONAL
}

The PKIStatusInfo is defined in [RFC2511]. For the purposes of communicating the DVCSErrorNotice, the following subset of PKIFailureInfo values is used:

PKIFailureInfo ::= BITSTRING {
    badRequest   (2),
    -- transaction not permitted or supported
    badTime   (3),
    -- messageTime was not sufficiently close to the system time,
    -- as defined by local policy
    badDataFormat   (5),
    -- the data submitted has the wrong format
    wrongAuthority   (6),
    -- the DVCS indicated in the request is different from the
    -- one creating the response token
    incorrectData   (7)
    -- the requester’s data (i.e., signature) is incorrect
}

In the DVCSErrorNotice, the PKIStatus field of the PKIStatusInfo must be set to REJECTED.

The 'statusString' field of PKIStatusInfo can be used to accommodate extra text, such as a reason for the failure, for example "I have gone out of service". The DVCS initializes the 'DVCSErrorNotice.transactionIdentifier' with a copy of the 'DVCSRequest.transactionIdentifier' field of the corresponding request.

In certain circumstances, a DVCS may not be able to produce a valid response to a request (for example, if it is unable to compute signatures for a period of time). In these situations the DVCS MAY create a response with an DVCSErrorNotice but no signature.

DVCS clients SHOULD NOT trust unsigned responses. A DVCS client MAY trust unsigned responses, if the communication channel provides for server authentication (e.g., by services defined by TLS [RFC2246]).
10. Transports

There is no mandatory transport mechanism in this document. All mechanisms are optional. Two examples of transport protocols are given which allow online exchange of request and a response, and asynchronous communication between a client and a DVCS.

A DVCS MAY use a combination of protocols, for example in order to return additional DVCs.

10.1 DVCS Protocol via HTTP or HTTPS

This subsection specifies a means for conveying ASN.1-encoded messages for the DVCS protocol exchanges via the HyperText Transfer Protocol.

The DER encoded DVCS requests and responses are encapsulated using a simple MIME object with Content-Type application/dvcs (and with the default binary encoding).

This MIME object can be sent and received using common HTTP or HTTPS processing engines over WWW links and provides a simple client-server transport for DVCS messages.

10.2 DVCS Protocol Using Email

This section specifies a means for conveying ASN.1-encoded messages for the protocol exchanges described in Section 8 via Internet mail.

The DER encoded DVCS requests and responses are encapsulated using a simple MIME object with Content-Type application/dvcs with an appropriate Content-Transfer-Encoding.

This MIME object can be sent and received using MIME processing engines and provides a simple Internet mail transport for DVCS messages.

In order to be able to associate a possible error response with a request, the requester SHOULD use the field ‘transactionIdentifier’. The requester SHOULD not make any assumption about the usage of message header fields by the responding service, in particular the usage of fields like Subject, Message-ID or References.
11. Security Considerations

This entire chapter discusses security considerations.

When designing a data validation and certification service, the following considerations have been identified that have an impact upon the validity or "trust" in the data validation certificate.

It is imperative that keys used to sign DVCs are guarded with proper security and controls in order to minimize the possibility of compromise. Nevertheless, in case the private key does become compromised, an audit trail of all the DVC generated by the DVCS SHOULD be kept as a means to help discriminate between genuine and false DVCs. A DVCS MAY provide for a vsd service to validate DVCs created by this DVCS or another one solely based on the audit trail.

When confidentiality and server authentication is required, requests and responses MAY be protected using appropriate mechanisms (e.g., CMS encapsulation [RFC 2630] or TLS [RFC 2246]).

Server authentication is highly recommended for the vsd and cpd service.

Client identification and authentication MAY use services defined by TLS [RFC 2246]) instead of, or in addition to, using a CMS format providing authentication.

12. Patent Information

The following United States Patents related to data validation and certification services, listed in chronological order, are known by the authors to exist at this time. This may not be an exhaustive list. Other patents may exist or be issued at any time. Implementers of the DVCS protocol and applications using the protocol SHOULD perform their own patent search and determine whether or not any encumbrances exist on their implementation.

# 4,309,569 Method of Providing Digital Signatures
(issued) January 5, 1982
(inventor) Ralph C. Merkle
(assignee) The Board of Trustees of the Leland Stanford Junior University

# 5,001,752 Public/Key Date-Time Notary Facility
(issued) March 19, 1991
(inventor) Addison M. Fischer
RFC 3029

DVCS Protocols

February 2001

# 5,022,080     Electronic Notary
(issued) June 4, 1991
(inventors) Robert T. Durst, Kevin D. Hunter

# 5,136,643     Public/Key Date-Time Notary Facility
(issued) August 4, 1992
(inventor) Addison M. Fischer
(Note: This is a continuation of patent # 5,001,752.)

# 5,136,646     Digital Document Time-Stamping with Catenate Certificate
(issued) August 4, 1992
(inventors) Stuart A. Haber, Wakefield S. Stornetta Jr.
(assignee) Bell Communications Research, Inc.,

# 5,136,647     Method for Secure Time-Stamping of Digital Documents
(issued) August 4, 1992
(inventors) Stuart A. Haber, Wakefield S. Stornetta Jr.
(assignee) Bell Communications Research, Inc.,

# 5,373,561     Method of Extending the Validity of a Cryptographic
Certificate
(issued) December 13, 1994
(inventors) Stuart A. Haber, Wakefield S. Stornetta Jr.
(assignee) Bell Communications Research, Inc.,

# 5,422,95 Personal Date/Time Notary Device
(issued) June 6, 1995
(inventor) Addison M. Fischer

# 5,781,629     Digital Document Authentication System
(issued) July 14, 1998
(inventor) Stuart A. Haber, Wakefield S. Stornetta Jr.
(assignee) Surety Technologies, Inc.,
13. References


14. Authors’ Addresses

Carlisle Adams
Entrust Technologies
1000 Innovation Drive
Ottawa, Ontario
K2K 3E7
CANADA
EMail: cadams@entrust.com

Michael Zolotarev
Baltimore Technologies Pty Limited
5th Floor, 1 James Place
North Sydney, NSW 2060
AUSTRALIA
EMail: mzolotarev@baltimore.com

Peter Sylvester
EdelWeb SA - Groupe ON-X Consulting
15, Quai de Dion Bouton
F-92816 Puteaux Cedex
FRANCE
EMail: peter.sylvester@edelweb.fr

Robert Zuccherato
Entrust Technologies
1000 Innovation Drive
Ottawa, Ontario
K2K 3E7
CANADA
EMail: robert.zuccherato@entrust.com
APPENDIX A - PKCS #9 Attribute

We define a PKCS #9 [PKCS9] attribute type. The attribute type has ASN.1 type SignedData and contains a data validation certificate.

The object identifier id-aa-dvcs-dvc identifies the data validation certificate attribute type.

id-aa-dvcs-dvc OBJECT IDENTIFIER ::= {iso(1) member-body(2) us(840) rsadsi(113549) pkcs(1) pkcs-9(9) smime(16) aa(2) 29}

The attribute may be used as an authenticated or unauthenticated attribute in CMS SignedData documents.

APPENDIX B - Signed document validation.

We present some examples of a possible use of DVCS in the context of validation of signed documents.

B.1 Signed document validation

The example covers the case where a DVCS is used by a signer to obtain a proof that a document’s structure, including one or more attached signatures, is/was correct, after the document was signed.

The DVC can be produced either by a DVCS that is trusted by the signer, or by a DVCS that is trusted by an intended verifier of the document.

The signer uses the obtained DVC as an evidence that its intentions were good and it produced a signed document using the environment(keys, algorithms, etc) that was known to be OK.

It produces a stand-alone document that can be used to extend the life of a signature. This example assumes that we have total trust in the Data Validation and Certification Server.

Signature algorithms and keys have a finite lifetime. Therefore, signatures have a finite lifetime. The Data Certification Server can be used to extend the lifetime of a signature.

In order to extend the lifetime of a signature in this way, the following technique can be used:

1) The signature needs to be certified:

    The signed message is presented to the Data Validation and Certification Server in a 'vsd' service request.
The DVCS verifies that the signature and certificates are valid at that time by checking expiry dates, status information, or DVCs, and returns a DVC.

2) The DVC SHOULD be verified.

The signature of the Data Validation and Certification Server in data certification token SHALL be verified using the Data Certification Server’s valid verification key.

A signer’s signing key (and therefore, its signature) is only valid until some specified time T1. The DVCS’s signing key (and therefore, its signature) is valid until some specified time T2 that is (usually) after time T1. Without certification, the signer’s signature would only be valid until time T1. With certification, the signer’s signature remains valid until time T2, regardless of subsequent revocation or expiry at time T1.

If the signature of the DVCS is valid, the trust we have in the DVCS allows us to conclude that the original signature on the data was valid at the time included in the DVC.

The DVCS signing key MUST be of a sufficient length to allow for a sufficiently long lifetime. Even if this is done, the key will have a finite lifetime. Since data validation certificates are just another type of signed documents, they can be validated using (another) DVCS.

APPENDIX C - Verifying the Status of a Public Key Certificate

We now present three examples of how to produce a data validation certificate that can be used to assert that a public key certificate is valid, trusted, and can be used for a particular purpose.

A client wants to use a given public key certificate either to use it to verify a signature on a document or to use it for document encryption.

A DVCS MUST have access to current information regarding public certificate status, it can therefore be used to verify the revocation status of a certificate at the current time.

The following technique can be used:

A) The public key certificate needs to be validated.

The certificate is presented to the Data Certification Server using a ‘vpkc’ service.
The Data Validation and Certification Server verifies that the public key certificate is valid and that it hasn’t been revoked and then returns a data validation certificate.

B) The data validation certificate MUST be verified.

The signature of the Data Certification Server in the data certification token SHALL be verified using the Data Validation and Certification Server’s valid certificate.

C) The public key certificate is used:

C.1) A client’s own public key certificate (i.e., the corresponding private key) can be used to add a signature to a document. The signing certificate and the data validation certificate can be added as signed attributes to the signature.

A data validation certificate can now be used during the validation signatures using the key contained in the public key certificate. This service provided by the DVCS can be thought of as a supplement to the usual method of checking revocation status.

In other words, signature validation at a later time does not necessarily require access to the revocation status of the user’s signing certificate, access to a DVCS service and validation of the DVC is sufficient to verify a signature. Note that the DVC does not tell when the signature had been created, it only indicates when the signing certificate was valid.

C.2) A public key certificate for key exchange can be used after having obtained a data validation certification certificate to encrypt data. The DVC can be stored with the data and/or stored by the creator of the encrypted document.

If an intended recipient of the document claims that the creator did not use an appropriate encryption key, the DVC (obtained by a recipient’s DVCS) can be used as evidence that the recipient’s DVCS has authorized the usage of the public key.

C.3) The procedure described in the previous paragraph can be enhanced to provide domain encryption in several ways. Organizations require that encrypted documents need to be recoverable. One simple way is to always encrypt documents with additional recipients that act as ‘domain encryption centers’ or ‘recovery centers’. This is not a technically difficult
problem, but may require complicated and difficult interactions with the end user, in particular when the document’s recipients are in several different organizations.

One possible solution consists of adding additional certificates to the dvc that validates the usage of a particular public key certificate used for encryption. In an environment of several organizations, one of the possible procedures may be:

The client asks its local dvcs to validate the public key certificate. The dvcs forwards the request to a dvcs of a remote organization. The remote organization’s dvcs verifies the certificate and provides a dvc assertion validating the certificate. It adds additional certificates usable for key exchange to the certEtcChain structure indicating additional required recipients. The local dvcs creates a dvc containing the dvc of the remote dvcs. It may add additional certificates or references to the dvc. The clients use all validated certificates to be usable for key exchange to enhance its list of recipients.

In the local dvcs may as well use local information about the remote organization’s need for additional recipients.

Appendix D - MIME Registration

To: ietf-types@iana.org Subject: Registration of MIME media type application/timestamp

MIME media type name: application
MIME subtype name: dvcs
Required parameters: None
Optional parameters: None
Encoding considerations: binary or Base64
Security considerations: Carries a request for a data validation and certification service and the response. A request may be cryptographically signed. The response will be cryptographically signed.

Interoperability considerations: None

Published specification:
RFC 3029 on Data Validation and Certification Server Protocols
Applications which use this media type: Data Validation and Certification Servers and Clients

Additional information:

Magic number(s): None
File extension(s): .dvc
Macintosh File Type Code(s): none

Person & email address to contact for further information: Peter Sylvester <peter.sylvester@edelweb.fr>

Intended usage: COMMON

Author/Change controller: Peter Sylvester <peter.sylvester@edelweb.fr>

Appendix E - ASN.1 Module using 1988 Syntax

PKIXDVCS {iso(1) identified-organization(3) dod(6) internet(1)
  security(5) mechanisms(5) pkix(7) id-mod(0) id-mod-dvcs(15)}

DEFINITIONS IMPLICIT TAGS ::=
ESSCertID FROM ExtendedSecurityServices
{ iso(1) member-body(2) us(840) rsadsi(113549) pkcs(1) pkcs-9(9) smime(16) modules(0) ess(2) } 

CertId, OCSPResponse, CertStatus FROM OCSP
{ iso(1) identified-organization(3) dod(6) internet(1) security(5) mechanisms(5) pkix(7) id-mod(0) id-mod-ocsp(14) } 

SMIMECapabilities FROM SecureMimeMessageV3
{ iso(1) member-body(2) us(840) rsadsi(113549) pkcs(1) pkcs-9(9) smime(16) modules(0) smime(4) } 

; 

-- Authority Information Access for DVCS 

id-ad-dvcs OBJECT IDENTIFIER ::= {id-pkix id-ad(48) 4} 

-- Key Purpose for DVCS 

id-kp-dvcs OBJECT IDENTIFIER ::= {id-pkix id-kp(3) 10} 

-- eContentType for a dvcs requests and responses 

id-ct-DVCSRequestData OBJECT IDENTIFIER ::= { id-smime ct(1) 7 } 

id-ct-DVCSResponseData OBJECT IDENTIFIER ::= { id-smime ct(1) 8 } 

-- Data validation certificate attribute 

id-aa-dvcs-dvc OBJECT IDENTIFIER ::= { id-smime aa(2) 29 } 

-- using the following bases : 

id-pkix OBJECT IDENTIFIER ::= {iso(1) identified-organization(3) dod(6) internet(1) security(5) mechanisms(5) pkix(7)} 

id-smime OBJECT IDENTIFIER ::= { iso(1) member-body(2) us(840) rsadsi(113549) pkcs(1) pkcs-9(9) 16 } 

Version ::= Integer 

DigestInfo ::= SEQUENCE {
   digestAlgorithm DigestAlgorithmIdentifier,
   digest Digest
}
Digest ::= OCTET STRING

Nonce ::= Integer

DVCSTime ::= CHOICE {
    genTime          GeneralizedTime,
    timeStampToken  ContentInfo
}

TargetEtcChain ::= SEQUENCE {
    target           CertEtcToken,
    chain            SEQUENCE SIZE (1..MAX) OF CertEtcToken OPTIONAL,
    pathProcInput    [0] PathProcInput OPTIONAL
}

PathProcInput ::= SEQUENCE {
    acceptablePolicySet          SEQUENCE SIZE (1..MAX) OF PolicyInformation,
    inhibitPolicyMapping         BOOLEAN DEFAULT FALSE,
    explicitPolicyReqd           BOOLEAN DEFAULT FALSE
}

CertEtcToken ::= CHOICE {
    certificate                  [0] IMPLICIT Certificate ,
    esscertid                    [1] ESSCertId ,
    pkistatus                    [2] IMPLICIT PKIStatusInfo ,
    assertion                    [3] ContentInfo ,
    crl                          [4] IMPLICIT CertificateList,
    oscpcertstatus               [5] IMPLICIT CertStatus,
    oscpcertid                   [6] IMPLICIT CertId ,
    oscprespone                  [7] IMPLICIT OCSPResponse,
    capabilities                 [8] SMIMECapabilities,
    extension                    Extension
}

DVCSRequestInformation ::= SEQUENCE {
    version                      INTEGER DEFAULT 1 ,
    service                      ServiceType,
    nonce                        Nonce OPTIONAL,
    requestTime                  DVCSTime OPTIONAL,
    requester                    [0] GeneralNames OPTIONAL,
    requestPolicy                [1] PolicyInformation OPTIONAL,
    dvcscs                       [2] GeneralNames OPTIONAL,
    dataLocations                [3] GeneralNames OPTIONAL,
    extensions                   [4] IMPLICIT Extensions OPTIONAL
}

ServiceType ::= ENUMERATED { cpd(1), vsd(2), cpkc(3), ccpd(4) }
DVCSRequest ::= SEQUENCE {  
  requestInformation  DVCSRequestInformation,  
  data Data,  
  transactionIdentifier GeneralName OPTIONAL  
}

Data ::= CHOICE {  
  message OCTET STRING ,  
  messageImprint DigestInfo,  
  certs SEQUENCE SIZE (1..MAX) OF  
    TargetEtcChain  
}

DVCSResponse ::= CHOICE {  
  dvCertInfo DVSCCertInfo ,  
  dvErrorNote [0] DVCSErrorNotice  
}

DVSCCertInfo ::= SEQUENCE {  
  version Integer DEFAULT 1 ,  
  dvReqInfo DVCSRequestInformation,  
  messageImprint DigestInfo,  
  serialNumber Integer,  
  responseTime DVCSTime,  
  dvStatus [0] PKIStatusInfo OPTIONAL,  
  policy [1] PolicyInformation OPTIONAL,  
  reqSignature [2] SignerInfos OPTIONAL,  
  certs [3] SEQUENCE SIZE (1..MAX) OF  
    TargetEtcChain OPTIONAL,  
  extensions Extensions OPTIONAL  
}

DVCSErrorNotice ::= SEQUENCE {  
  transactionStatus PKIStatusInfo ,  
  transactionIdentifier GeneralName OPTIONAL  
}

END

Appendix F - Examples

This chapter contains an example of a request and a response of a 'Certify Claim of Possession of Data' transaction of the Clepsydré Demonstration Project sponsored by La Poste, France.

The information has been formatted with a slightly modified version of Peter Gutmann’s dumpasn1 program.
The response Data Validation Certificate contains the signing certificate.

The data that are time stamped is the binary of the client program used to make the request.

Request:

```
0 30 582: SEQUENCE {
  4 06  9:  OBJECT IDENTIFIER signedData (1 2 840 113549 1 7 2)
    : . (PKCS #7)
  15 A0 567: [0] {
  19 30 563: . SEQUENCE {
  23 02  1: .  INTEGER 3
  26 31  11: .  SET {
  28 30  9: .  SEQUENCE {
  30 06  5: . .  OBJECT IDENTIFIER sha1 (1 3 14 3 2 26)
  37 05  0: . .  NULL
    : . . }
    : . . }
  39 30 153: . SEQUENCE {
  42 06  11: . .  OBJECT IDENTIFIER
    : . .  id-ct-DVCSRequestData (1 2 840 113549 1 9 16 1 7)
    : . .  (S/MIME Content Types (1 2 840 113549 1 9 16 1))
  55 A0 137: . [0] {
  58 04 134: . OCTET STRING, encapsulates {
  61 30 131: . .  SEQUENCE {
  64 30  96: . . . .  SEQUENCE {
  66 0A  1: . . . .  ENUMERATED CCPD (4)
  69 A0  77: . . . .  [0] {
  71 A4  75: . . . .  [4] {
  73 30  12: . . . .  SET {
  77 30  9: . . . .  SEQUENCE {
  79 06  3: . . . .  OBJECT IDENTIFIER
    : . . . .  countryName (2 5 4 6)
    : . . . .  (X.520 id-at (2 5 4))
  84 13  2: . . . .  PrintableString 'FR'
    : . . . .  }
    : . . . }
  88 31  14: . . . .  SET {
  90 30 12: . . . .  SEQUENCE {
  92 06  3: . . . .  OBJECT IDENTIFIER
    : . . . .  localityName (2 5 4 7)
    : . . . .  (X.520 id-at (2 5 4))
  97 13  5: . . . .  PrintableString 'Paris'
    : . . . .  }
    : . . . }
```

104 31 16: ....... SET {
106 30 14: ....... SEQUENCE {
108 06 3: ........ OBJECT IDENTIFIER
: ........ organizationName (2 5 4 10)
: ........ (X.520 id-at (2 5 4))
113 13 7: ........ PrintableString 'EdelWeb'
: ........ }
: ........ }
122 31 24: ....... SET {
124 30 22: ....... SEQUENCE {
126 06 3: ........ OBJECT IDENTIFIER
: ........ commonName (2 5 4 3)
: ........ (X.520 id-at (2 5 4))
131 13 15: ........ PrintableString 'Peter Sylvester'
: ........ }
: ........ }
150 06 10: .... OBJECT IDENTIFIER '1 3 6 1 4 1 5309 1 2 1'
: .... }
: .... }
162 30 31: .... SEQUENCE {
164 30 7: .... SEQUENCE {
166 06 5: .... OBJECT IDENTIFIER sha1 (1 3 14 3 2 26)
: .... (OIW)
: .... }
173 04 20: .... OCTET STRING
: .... 75 B6 85 AF 6F 89 46 7D E8 07 15 25 1E 45 8F
: .... CD 1F A5 66
: .... }
: .... }
: ...
: ...
195 31 387: . SET {
199 30 383: . SEQUENCE {
203 02 1: ... INTEGER 1
206 30 124: ... SEQUENCE {
208 30 112: ... SEQUENCE {
210 31 11: ... SET {
212 30 9: ... SEQUENCE {
214 06 3: ... OBJECT IDENTIFIER countryName (2 5 4 6)
: ... (X.520 id-at (2 5 4))
219 13 2: ... PrintableString 'FR'
: ... }
: ... }
SET {
  SEQUENCE {
    OBJECT IDENTIFIER organizationName (2 5 4 10) (X.520 id-at (2 5 4))
    PrintableString 'EdelWeb S.A.'
  }
  SEQUENCE {
    OBJECT IDENTIFIER organizationalUnitName (2 5 4 11) (X.520 id-at (2 5 4))
    PrintableString 'Clepsydre Demonstration Service'
  }
  SEQUENCE {
    OBJECT IDENTIFIER commonName (2 5 4 3) (X.520 id-at (2 5 4))
    PrintableString 'Time Stamping Authority'
  }
  INTEGER 00 94 88 17 21 34 37 76
  SEQUENCE {
    OBJECT IDENTIFIER sha1 (1 3 14 3 2 26) (OIW)
    NULL
  }
  SEQUENCE {
    OBJECT IDENTIFIER contentType (1 2 840 113549 1 9 3) (PKCS #9 (1 2 840 113549 1 9))
    SET {
      OBJECT IDENTIFIER id-ct-dvcsrequest (1 2 840 113549 1 9 16 1 7)
      (S/MIME Content Types (1 2 840 113549 1 9 16 1))
    }
  }
  SEQUENCE {
    OBJECT IDENTIFIER signingTime (1 2 840 113549 1 9 5) (PKCS #9 (1 2 840 113549 1 9))
    UTCTime '000417171457Z'
  }
: . . . )

: . . . )

403 30  35: . . . . SEQUENCE {  
405 06  9: . . . . OBJECT IDENTIFIER  
: . . . . . messageDigest (1 2 840 113549 1 9 4)  
: . . . . . (PKCS #9 (1 2 840 113549 1 9))

416 31  22: . . . . SET {  
418 04  20: . . . . OCTET STRING  
: . . . . . 4D A8 C2 D2 CE 7C 0D 04 41 2F 44 13 33 75 DB 2F  
: . . . . . 5B 2D F9 DC  
: . . . . )

440 30  13: . . . . SEQUENCE {  
442 06  9: . . . . OBJECT IDENTIFIER  
: . . . . . rsaEncryption (1 2 840 113549 1 1 1)  
: . . . . . (PKCS #1)

453 05  0: . . . . NULL  
: . . . )

455 04  128: . . . . OCTET STRING  
: . . . . . 6E 7B 0E 36 F5 08 5F 16 3C 31 7B 28 BB 0B C2 C6  
: . . . . . 17 67 A6 B5 54 F1 98 E2 6F 89 96 0E 0C 99 E6 CB  
: . . . . . 40 C1 9B 8D D8 D7 8E D3 2B 41 F7 16 26 5B B7 08  
: . . . . . BF E6 95 B2 D9 01 6C FE B1 2C 52 C1 5A D2 31 F3  
: . . . . . 8E CA DD 10 41 6D E9 4D E6 0D  
: . . . . . 4E 53 6E 50 20 99 7C 94 C2 44 25 1B 06 C0 99 96  
: . . . )

The corresponding data in PEM format are:

-----BEGIN PKCS7-----
MIICQgYJKoZIhvcNAQcCoIICNzCCAjMCAQMxCzAJBgUrDgMCGgUAuMIGZBgsq inhibitkiG9w0BCRAAB6CBiQSnSjcbjCBqzBqCgEEO2kSzbBJMQswCQYDVQQGEwJGUeOMAwGA1UE
BxMFUGFyaXMxBgoBnvAcTB0vKZwxZ2WiZGDAbwNvBAMTDI1bGvyIv5SbH2L
C3RlcqEmbgorBqEAAk9AQIBM88wBwYFkw4DahoEFHW2ha9viU296AcVJR5F14/N
H6VMyYIBgzcCAAX8CAQWwDwMPSwCQYDVQQGEwJGUjEvMBGA1UECgMMRWN1bFdl
YiBTlknMsqlgjYDYVQQLW90hZhb25zdHJhdGlvdBZJ2ANL
MS4wHgYDVQQLExdUeA1101wF0whw25nIEF1dGhvcm10e0IJAJSFyE0N3YuCQYF
Kw4DahoFABfMBoBcsSgSsZbJAAzEwNbsqkhik9w0BICRAABzAcBkgckhik9w0B
CQUXdxcNMDAwNDE3MTcxNDU3WjajBkgqkhik9w0BCRQxGQUTajC0s5BDQRBLOQT
M3XbL1+dsDwDYJKoZIhvcNAQEBBQAegYBueu429QhFJwxeyi7C8LG2emtVlx
moJvii2YODJnmyODnm43Yl47TK0H3F12btw5/5pWw2QFs/rEsUsFa0jHzjsrdEaFy

Adams, et al.  Experimental  [Page 38]
Response:

0 30 2039: SEQUENCE {
  4 06 9: OBJECT IDENTIFIER signedData (1 2 840 113549 1 7 2) 
    :. (PKCS #7)
  15 A0 2024: [0] {
  19 30 2020: . SEQUENCE {
  23 02 1: . INTEGER 3
  26 31 11: . SET {
  28 30 9: . SEQUENCE {
  30 06 5: . OBJECT IDENTIFIER sha1 (1 3 14 3 2 26) 
    :. . (OIW)
  37 05 0: . NULL
    :.. }
    :. }
  39 30 301: . SEQUENCE {
  43 06 11: . OBJECT IDENTIFIER 
    :. id-ct-DVCSResponseData (1 2 840 113549 1 9 16 1 8)
    :. (S/MIME Content Types (1 2 840 113549 1 9 16 1))
  56 A0 284: . [0] {
  60 04 280: . OCTET STRING, encapsulates {
  64 30 276: . . SEQUENCE {
  68 30 214: . . . . . SEQUENCE {
  71 0A 1: . . . . . ENUMERATED CCPD (4)
  74 A0 77: . . . . . [0] {
  76 A4 75: . . . . . [4] {
  78 30 73: . . . . . . SEQUENCE {
  80 31 11: . . . . . . . SET {
  82 30 9: . . . . . . . SEQUENCE {
  84 06 3: . . . . . . OBJECT IDENTIFIER 
    :. . . . . . . countryName (2 5 4 6)
    :. . . . . . . (X.520 id-at (2 5 4))
  89 13 2: . . . . . . PrintableString ‘FR’
    :. . . . . . }
    :. . . . . }
  93 31 14: . . . . . . SET {
  95 30 12: . . . . . . SEQUENCE {
  97 06 3: . . . . . . OBJECT IDENTIFIER 
    :. . . . . . . localityName (2 5 4 7)
    :. . . . . . . (X.520 id-at (2 5 4))
  102 13 5: . . . . . . PrintableString ‘Paris’
    :. . . . . . }
    :. . . . . }
  109 31 16: . . . . . . SET {

SEQUENCE {
   OBJECT IDENTIFIER
   organizationName (2 5 4 10)
   (X.520 id-at (2 5 4))
   PrintableString 'EdelWeb'
}

SET {
   OBJECT IDENTIFIER
   commonName (2 5 4 3)
   (X.520 id-at (2 5 4))
   PrintableString 'Peter Sylvester'
}

SET {
   OBJECT IDENTIFIER
   countryName (2 5 4 6)
   (X.520 id-at (2 5 4))
   PrintableString 'FR'
}

SET {
   OBJECT IDENTIFIER
   organizationName (2 5 4 10)
   (X.520 id-at (2 5 4))
   PrintableString 'EdelWeb S.A.'
}

SET {
   OBJECT IDENTIFIER
   organizationalUnitName (2 5 4 11)
   (X.520 id-at (2 5 4))
   PrintableString 'Clepsydre Demonstration Service'
}
251 31 32: . . . . . . SET {
253 30 30: . . . . . . SEQUENCE {
255 06 3: . . . . . . OBJECT IDENTIFIER
: . . . . . . commonName (2 5 4 3)
: . . . . . . (X.520 id-at (2 5 4))
260 13 23: . . . . . . PrintableString 'Time Stamping Authority'
: . . . . . . }
: . . . . . . }
: . . . . . . }
: . . . . . . }
: . . . . . . }
285 30 31: . . . . SEQUENCE {
287 30 7: . . . . SEQUENCE {
289 06 5: . . . . . OBJECT IDENTIFIER sha1 (1 3 14 3 2 26)
: . . . . . }
296 04 20: . . . . OCTET STRING
: . . . . 75 B6 85 AF 6F 89 46 7D E8 07 15 25 1E 45 97 8F
: . . . . 0D 1F A5 66
: . . . . }
318 02 7: . . . . INTEGER
: . . . . 01 7B 0A 1E CA 88 23
327 18 15: . . . . GeneralizedTime '20000417171617Z'
: . . . . }
: . . . . }
: . . . . }
344 A0 992: . [0] {
348 30 988: . . SEQUENCE {
352 30 708: . . SEQUENCE {
356 A0 3: . . . . [0] {
358 02 1: . . . . INTEGER 2
: . . . . }
361 02 8: . . . . INTEGER
: . . . . 00 94 88 17 17 64 37 32
371 30 13: . . . . SEQUENCE {
373 06 9: . . . . OBJECT IDENTIFIER
: . . . . md5WithRSAEncryption (1 2 840 113549 1 1 4)
: . . . . (PKCS #1)
384 05 0: . . . . NULL
: . . . . }
386 30 112: . . . . SEQUENCE {
388 31 11: . . . . SET {
390 30 9: . . . . SEQUENCE {
392 06 3: . . . . OBJECT IDENTIFIER countryName (2 5 4 6)
: . . . . (X.520 id-at (2 5 4))
397 13 2: . . . . PrintableString 'FR'
: . . . . }
Adams, et al. Experimental [Page 41]
401 31  21: . . . SET {  
403 30  19: . . . SEQUENCE {  
405  6  3: . . . OBJECT IDENTIFIER organizationName (2 5 4 10)  
410 13  12: . . . PrintableString 'EdelWeb S.A.'  
424 31  40: . . . SET {  
426 30  38: . . . SEQUENCE {  
428  6  3: . . . OBJECT IDENTIFIER  
433 13  31: . . . PrintableString 'Clepsydre Demonstration Service'  
466 31  32: . . . SET {  
468 30  30: . . . SEQUENCE {  
470  6  3: . . . OBJECT IDENTIFIER commonName (2 5 4 3)  
475 13  23: . . . PrintableString 'Time Stamping Authority'  
500 30  30: . . . SEQUENCE {  
502 17  13: . . . UTCTime '000125161938Z'  
504 17  13: . . . UTCTime '200120161938Z'  
532 30 112: . . . SEQUENCE {  
534 31  11: . . . SET {  
536 30  9: . . . SEQUENCE {  
538  6  3: . . . OBJECT IDENTIFIER countryName (2 5 4 6)  
543 13  2: . . . PrintableString 'FR'  
547 31  21: . . . SET {  
549 30  19: . . . SEQUENCE {  
551  6  3: . . . OBJECT IDENTIFIER organizationName (2 5 4 10)  
556 13  12: . . . PrintableString 'EdelWeb S.A.'  
570 31  40: . . . SET {  
572 30  38: . . . SEQUENCE {  
574  6  3: . . . OBJECT IDENTIFIER  
578  6  3: . . . OBJECT IDENTIFIER organizationalUnitName (2 5 4 11)  

PrintableString 'Clepsydré Demonstration Service'

PrintableString 'Time Stamping Authority'

Sequence {
  SET {
    OBJECT IDENTIFIER commonName (2 5 4 3)
    (X.520 id-at (2 5 4))

    PRINTABLE STRING 'Time Stamping Authority'
  }
}

Sequence {
  SEQUENCE {
    OBJECT IDENTIFIER basicConstraints (2 5 29 19)
    (X.509 id-ce (2 5 29))

    OCTET STRING, encapsulates {
      SEQUENCE {
        BOOLEAN TRUE
      }
    }
  }
}

Sequence {
  OCTET STRING, encapsulates {
    SEQUENCE {
      BOOLEAN TRUE
    }
  }
}

Sequence {
  OCTET STRING, encapsulates {
    SEQUENCE {
      BOOLEAN TRUE
    }
  }
}
SEQUENCE {
    authorityInfoAccess (1 3 6 1 5 5 7 1 1)
    (PKIX private extension)
    BOOLEAN TRUE
    OCTET STRING, encapsulates {
    SEQUENCE {
        SEQUENCE {
            OBJECT IDENTIFIER '1 3 6 1 5 5 7 48 4'
        }
        'https://clepsydre.edelweb.fr/dvcs/service-ccpd'
    }
    md5withRSAEncryption (1 2 840 113549 1 1 4)
    (PKCS #1)
    NULL
    BIT STRING 0 unused bits
    [ Another 128 bytes skipped ]
    }
    INTEGER 1
    SEQUENCE {
    SET {
    INTEGER 1
    SEQUENCE {
    INTEGER 124
    SEQUENCE {
    SET {
    INTEGER 112
    SEQUENCE {
    INTEGER 3
    OBJECT IDENTIFIER countryName (2 5 4 6)
    (X.520 id-at (2 5 4))
    }
    }
    }
    }
    }
    }
    INTEGER 1
1364 13  2: . . .  PrintableString ‘FR’
  : . . .  }
  : . . . }
1368 31 21: . . .  SET {
1370 30 19: . . .  SEQUENCE {
1372 06  3: . . .  OBJECT IDENTIFIER organizationName (2 5 4 10)
  : . . .  (X.520 id-at (2 5 4))
1377 13 12: . . .  PrintableString ‘EdelWeb S.A.’
  : . . .  }
  : . . . }
1391 31 40: . . .  SET {
1393 30 38: . . .  SEQUENCE {
1395 06  3: . . .  OBJECT IDENTIFIER
  : . . .  organizationalUnitName (2 5 4 11)
  : . . .  (X.520 id-at (2 5 4))
1400 13 31: . . .  PrintableString ‘Clepsydre Demonstration Service’
  : . . .  }
  : . . . }
1433 31 32: . . .  SET {
1435 30 30: . . .  SEQUENCE {
1437 06  3: . . .  OBJECT IDENTIFIER commonName (2 5 4 3)
  : . . .  (X.520 id-at (2 5 4))
1442 13 23: . . .  PrintableString ‘Time Stamping Authority’
  : . . .  }
  : . . . }
1467 02  8: . . . INTEGER
  : . . .  00 94 88 25 72 35 27 50
  : . . . }
1477 30  9: . .  SEQUENCE {
1479 06  5: . .  OBJECT IDENTIFIER sha1 (1 3 14 3 2 26)
  : . .  (OIW)
1486 05  0: . .  NULL
  : . . }
1488 A0 276: . .  [0] {
1492 30 26: . .  SEQUENCE {
1494 06  9: . .  OBJECT IDENTIFIER
  : . .  contentType (1 2 840 113549 1 9 3)
  : . .  (PKCS #9 (1 2 840 113549 1 9))
1505 31 13: . .  SET {
1507 06 11: . .  OBJECT IDENTIFIER
  : . .  id-ct-dvcsresponse (1 2 840 113549 1 9 16 1 8)
  : . .  (S/MIME Content Types (1 2 840 113549 1 9 16 1))
  : . . }
  : . . }
1520 30 28: . .  SEQUENCE {
1522 06  9: . .  OBJECT IDENTIFIER
  : . .  signingTime (1 2 840 113549 1 9 5)
(): 

1533 31 15: . . . . SET {
1535 17 13: . . . . UTCTime '000417171619Z'
: . . . . }
1550 30 35: . . . . SEQUENCE {
1552 06 9: . . . . OBJECT IDENTIFIER
: . . . . . . messageDigest (1 2 840 113549 1 9 4)
: . . . . . . (PKCS #9 (1 2 840 113549 1 9))
1563 31 22: . . . . SET {
1565 04 20: . . . . OCTET STRING
: . . . . . . . . 68 50 DC 90 20 2E C2 F0 55 15 7F 77 A9 A6 0C 34
: . . . . . . . .  CC 13 06 FA
: . . . . . . . . }
1587 30 178: . . . . SEQUENCE {
1590 06 11: . . . . OBJECT IDENTIFIER
: . . . . . . id-aa-signingCertificate (1 2 840 113549 1 9 16 2 12)
: . . . . . . (S/MIME Authenticated Attributes (1 2 840 113549 1 9 16 2))
1603 31 162: . . . . SET {
1606 30 159: . . . . SEQUENCE {
1609 30 156: . . . . OCTET STRING
: . . . . . . . . 5C F1 18 F3 4A CA B4 67 D6 D8 E7 F8 3B 4A D9 7A
: . . . . . . . . 32 A5 43 A5
1637 30 128: . . . . SEQUENCE {
1640 30 116: . . . . SEQUENCE {
1644 30 112: . . . . SEQUENCE {
1646 31 111: . . . . SET {
1648 30 9: . . . . . . SEQUENCE {
1650 06 3: . . . . . . . . . . OBJECT IDENTIFIER
: . . . . . . . . . . . . countryName (2 5 4 6)
: . . . . . . . . . . . . (X.520 id-at (2 5 4))
1655 13 2: . . . . . . . . . . PrintableString 'FR'
: . . . . . . . . . . . . . . . . . . }
1659 31 21: . . . . . . . . . . SEQUENCE {
1661 30 19: . . . . . . . . . . SEQUENCE {
1663 06 3: . . . . . . . . . . . . OBJECT IDENTIFIER
: . . . . . . . . . . . . . . . . . . organizationName (2 5 4 10)
: . . . . . . . . . . . . . . . . . . (X.520 id-at (2 5 4))
1668 13 12: . . . . . . . . . . PrintableString 'EdelWeb S.A.'
: . . . . . . . . . . . . . . . . . . }
1682 31 40: . . . . . . . . . . SEQUENCE {
1684 30 38: . . . . . . . . . . SEQUENCE {

3: . . . . . . . . OBJECT IDENTIFIER
: . . . . . . . . organizationalUnitName (2 5 4 11)
: . . . . . . . . (X.520 id-at (2 5 4))

PrintableString 'Clepsydre Demonstration Service'
: . . . . . . . .

PrintableString 'Time Stamping Authority'
: . . . . . . . .

INTEGER
: . . . . 00 94 88 25 72 35 27 50
: . . . .

SEQUENCE
: . . . .

SEQUENCE
: . . . .

OBJECT IDENTIFIER
: . . . . rsaEncryption (1 2 840 113549 1 1 1)
: . . . (PKCS #1)

NULL
: . . .

OCTET STRING
: . . . [ Another 128 bytes skipped ]
: . . .
The corresponding data in PEM format (together with a technical textual description) are:

Data Validation Certificate:
Request Information:
  Service: Certify Claim of Possession of Data - ccpd(4)
  Policy: EdelWeb Customer Policy Clepsydra
  Requester:  
    DirName:/C=FR/L=Paris/O=EdelWeb/CN=Peter Sylvester
  DVCS:  
    DirName:/C=FR/O=EdelWeb S.A./
    OU=Clepsydra Demonstration Service/CN=Time Stamping Authority
  SerialNumber: 01780aleca8823
MessageDigest:
  Algorithm: sha1
  Data : 75B685AF6F89467DE80715251E45978FCD1FA566
Asserted Time:
Certificate:
  Data:
    Version: 3 (0x2)
    Serial Number:
      94:88:17:17:64:37:32
    Signature Algorithm: md5WithRSAEncryption
    Issuer: C=FR, O=EdelWeb S.A.,
    OU=Clepsydra Demonstration Service, CN=Time Stamping Authority
    Not Before: Jan 25 16:19:38 2000 GMT
    Not After : Jan 20 16:19:38 2020 GMT
    Subject: C=FR, O=EdelWeb S.A.,
    OU=Clepsydra Demonstration Service, CN=Time Stamping Authority
    Subject Public Key Info:
      Public Key Algorithm: rsaEncryption
      RSA Public Key: (2048 bit)
      Modulus (2048 bit):
        00:fa:c3:17:ae:eb:b7:9d:eb:ab:bd:05:7e:39:43:
        e8:a9:d6:0f:dd:12:44:15:e7:8b:2e:af:51:c0:0c:
Exponent: 65537 (0x10001)
X509v3 extensions:
  X509v3 Basic Constraints:
    CA:TRUE, pathlen:0
  X509v3 Extended Key Usage: critical
    DVCS Signing
  Authority Information Access: critical
    DVCS - URI:https://clepsydre.edelweb.fr/dvcs/service-ccpd

Signature Algorithm: md5WithRSAEncryption
  7d:bb:e0:03:ae:8f:ff:28:1c:ff:0d:03:eb:48:bf:5c:
  0:e1:10:05:

-----BEGIN PKCS7-----
MIIH9wYJKoZIhvcNAQCoIiI6D6CBB+CQAGQMxMzA7BGvUrDgMCcGUGfILLBLQYLoZI
hvcNAQkQAgggEcBiIBGDCACARQwYKAQSQgTaRLEmcxCAJBGvNBAYTAKzSMQ4w
DAYDQVQQEwVXYjpczEQM4A1gUEHCMRWrLbFdlYjEYMVYGA1EAmMPUGV0ZXIg
U3lsdvmVzGBGYoQwGCCisQAABgQTB0Agd1KRYMAxCAJBGvNBAYTAKzSMRwEwYD
VQKExwxF2GvVEv2iiFMQo4xKDAmBqNVBAstHN0NzXBEwRy2SBEZ1vbnbNcF0
aW9uIFJnCzPYUxIDEAeBgNVBAMTFR1pbWUgU3RhxbBpmgcQXVoQaGyaXRSMB8w
BwYFkw4AhoEFHW2ha9v1U296AcVJRF14/NH6VmAqoceAeoeycogiGAY8MDABhDQx
NzE3MTYxNlqgggPqIMIiD3DAAsSgAIBaGIALI3JFdxkNzIvQYJKoZIhvcNAQEE
BQAwcDELMaGA1EUEhMCR1IxFTATBgNVBAoTEVkyZXWZIgy5BLjEoMCYGA1UE
CxfMfQ2xLchNs52HJ1ER1lbW9uc3RyYXRpb24gU2YdmljZTEgMB4GA1ECEEXVg1t
ZSBD7GfcCgL2uYBBdcXR0b3JpdkHwKhdNMDAaMjMTiMTyOTM4WhcNMjAIWMTiWMTy
OTM4WjBwMQswCQQVQQQ3EGJUyEVMVBGA1UEcHMRRWRLbPbYiBTLOuESmgJYG
VQOLE90dBGw31kamQrRGVTb25zdHJhdmFjbiBTZJ2aWNIbAHgYDVQQDExGU
aw11IFN0YW1w50n5IF1dGhvcmen08TCCASIwDQYJKoZIhvclNAQEBBQADg4EPADCC
AQoCggEBAFprD67rt53qrg70Fj1DBQFmWQyPCqzzbC-MJnd+w885VEx9274JkQjQ
0qvGgorz936ZppkhpiQuic+n106vVdBcKajjyRZzf9m67JF/xKpfLkTG7jahyS
Appendix G - Acknowledgements

This document is based on two initial works from Robert Zuccherato and Carlisle Adams, both at Entrust Technologies, for time stamping and for notary and data certification services.

Thanks to Denis Pinkas, Bull and Bruno Salgueiro, SIBS for valuable comments.

Adams, et al.                     Experimental                     [Page 50]
Full Copyright Statement

Copyright (C) The Internet Society (2001). All Rights Reserved.

This document and translations of it may be copied and furnished to others, and derivative works that comment on or otherwise explain it or assist in its implementation may be prepared, copied, published and distributed, in whole or in part, without restriction of any kind, provided that the above copyright notice and this paragraph are included on all such copies and derivative works. However, this document itself may not be modified in any way, such as by removing the copyright notice or references to the Internet Society or other Internet organizations, except as needed for the purpose of developing Internet standards in which case the procedures for copyrights defined in the Internet Standards process must be followed, or as required to translate it into languages other than English.

The limited permissions granted above are perpetual and will not be revoked by the Internet Society or its successors or assigns.

This document and the information contained herein is provided on an "AS IS" basis and THE INTERNET SOCIETY AND THE INTERNET ENGINEERING TASK FORCE DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Acknowledgement

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