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Domain-based signing and encryption using S/MIME
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Abstract

The S/MIME protocols Message Specification ([RFC 5751](#)), Cryptographic Message Syntax ([RFC 5652](#)), S/MIME Certificate Handling ([RFC 5750](#)) and Enhanced Security Services for S/MIME ([RFC 2634](#)) specify a consistent way to securely send and receive MIME messages providing end to end integrity, authentication, non-repudiation and confidentiality. This document identifies a number of interoperability, technical, procedural and policy related issues that may result in end-to-end security services not being achievable. To resolve such issues, this document profiles domain-based signing and encryption using S/MIME, such as specifying how S/MIME signing and encryption can be applied between a Message Submission Agent (MSA) and a Message Delivery Agent (MDA) or between 2 Message Transfer Agents (MTA).

This document is also registering 2 URI scheme: "smtp" and "submit" which are used for designating SMTP/SMTP Submission servers (respectively), as well as SMTP/Submission client accounts.

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MSA-to-MDA S/MIME

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Table of Contents

1.	Introduction	3
2.	Conventions Used in This Document	5
2.1.	Domain Signature	6
2.2.	Review Signature	6
2.3.	Additional Attributes Signature	6
2.4.	Domain Encryption and Decryption	6
2.5.	Signature Encapsulation	7
2.6.	Naming Conventions	8
3.	Domain-Based S/MIME Signing	8
3.1.	General	8
3.2.	Signature Type Attribute	9
3.3.	Domain Signature Generation and Verification	11
3.4.	Additional Attributes Signature Generation and Verification	12

3.5.	Review Signature Generation and Verification	13
3.6.	Originator Signature	13
3.7.	Delegated Originator Signature	13
4.	Domain-based S/MIME Encryption and Decryption	14
4.1.	Key Management for DCA Encryption	15

4.2.	Key Management for DCA Decryption	16
5.	Applying a Domain Signature when Mail List Agents are Present	16
5.1.	Examples of Rule Processing	19
6.	IANA Considerations	21
6.1.	SMTP URI registration	21
6.2.	SUBMIT URI registration	22
7.	Security Considerations	23
8.	References	24
8.1.	Normative References	24
8.2.	Informative References	24
Appendix A.	Changes from RFC 3183	26
Appendix B.	Acknowledgements	26

[1.](#) Introduction

The S/MIME [[RFC5750](#)][RFC5751] series of standards define a data encapsulation format for the provision of a number of security services including data integrity, confidentiality, and authentication. S/MIME is designed for use by messaging clients to deliver security services to distributed messaging applications.

The mechanisms described in this document are designed to solve a number of interoperability problems and technical limitations that arise when different security domains wish to communicate securely, for example when two domains use incompatible messaging technologies such as the X.400 series and SMTP/MIME [[RFC5322](#)], or when a single domain wishes to communicate securely with one of its members residing on an untrusted domain. The main scenario covered by this document is domain-to-domain, although it is also applicable to individual-to-domain and domain-to-individual communications. This document is also applicable to organizations and enterprises that have internal PKIs which are not accessible by the outside world, but wish to interoperate securely using the S/MIME protocol.

There are many circumstances when it is not desirable or practical to provide end-to-end (MUA-to-MUA) security services, particularly

between different security domains. An organization that is considering providing end-to-end security services will typically have to deal with some if not all of the following issues:

1. Message screening and audit: Server-based mechanisms such as searching for prohibited words or other unauthorized content, virus scanning, and audit, are incompatible with end-to-end encryption. It is generally not acceptable to allow content in/out of an organization without checking, so boundary decryption is vital.

2. PKI deployment issues: There may not be any certificate paths between two organizations. Or an organization may be sensitive about aspects of its PKI and unwilling to expose them to outside access. Also, full PKI deployment for all employees, may be expensive, not necessary or impractical for large organizations. For any of these reasons, direct end-to-end signature validation and encryption are impossible.
3. Heterogeneous message formats: One organization using X.400 series protocols wishes to communicate with another using SMTP [[RFC5321](#)]. Message reformatting at gateways makes end-to-end encryption and signature validation impossible.
4. Heterogeneous message access methods: Users are accessing mail using mechanisms which re-format messages, such as using Web browsers. Message reformatting in the Message Store makes end-to-end encryption and signature validation impossible.
5. Problems deploying fully S/MIME capable email clients on some platforms. Signature verification at a border MTA can be coupled with use of Authentication-Results header field [[RFC7001](#)] to convey results of verification.

This document describes an approach to solving these problems by providing message security services at the level of a domain or an organization. Such domain-based or organization-based message security services are referred to as domain security services. This document specifies how these 'domain security services' can be provided using the S/MIME protocol. Domain security services may

replace or complement mechanisms at the desktop/mobile device. For example, a domain may decide to provide MUA-to-MUA signatures but domain-to-domain encryption services. Or it may allow MUA-to-MUA services for intra-domain use, but enforce domain-based services for communication with other domains.

Domain services can also be used by individual members of a corporation who are geographically remote and who wish to exchange encrypted and/or signed messages with their base.

Whether or not a domain based service is inherently better or worse than desktop based solutions is an open question. Some experts believe that only end-to-end solutions can be truly made secure, while others believe that the benefits offered by such things as content checking at domain boundaries offers considerable increase in practical security for many real systems. The additional service of allowing signature checking at several points on a communications path is also an extra benefit in many situations. This debate is outside the scope of this document. What is offered is a

specification for how domain-based S/MIME signing and encryption can be applied in different ways to meet different needs in different circumstances.

Message Transfer Agents (MTAs), Message Submission Agents (MSAs), Message Delivery Agents (MDAs), guards, firewalls and protocol translation gateways can provide domain security services. As with MUA based solutions, these components must be resilient against a wide variety of attacks intended to subvert the security services. Therefore, careful consideration should be given to security of these components, to make sure that their siting and configuration minimises the possibility of attack.

2. Conventions Used in This Document

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 [[RFC2119](#)].

The signature types defined in this document are referred to as DOMSEC defined signatures.

The term 'security domain' as used in this document is defined as a collection of hardware and personnel operating under a single security authority and performing a common business function. Members of a security domain will of necessity share a high degree of mutual trust, due to their shared aims and objectives.

A security domain is typically protected from direct outside attack by physical measures and from indirect (electronic) attack by a combination of firewalls and guards at network boundaries. The interface between two security domains is termed a 'security boundary'. One example of a security domain is an organizational network ('Intranet').

Domain-based Sending Agent - an MSA or sending domain MTA performing Domain-based service(s).

Domain-based Receiving Agent - a receiving domain MTA or MDA performing Domain-based service(s).

Message encryption may be performed by a third party on behalf of a set of originators in a domain. This is referred to as domain encryption. Message decryption may be performed by a third party on behalf of a set of recipients in a domain. This is referred to as domain decryption. The third party that performs these processes is referred to in this document as a "Domain Confidentiality Authority"

(DCA). As per above, a DCA can be a Domain-based Sending Agent or a Domain-based Receiving Agent.

[2.1.](#) Domain Signature

A domain signature is an S/MIME signature generated on behalf of a set of users in a domain. A domain signature can be used to authenticate information sent between domains or between a certain domain and one of its individuals, for example, when two 'Intranets' are connected using the Internet, or when an Intranet is connected to a remote user over the Internet. It can be used when two domains employ incompatible signature schemes internally or when there are no certification links between their PKIs. In both cases messages from the originator's domain are signed over the original message and signature (if present) using an algorithm, key, and certificate which

can be processed by the recipient(s) or the recipient(s) domain. A domain signature is sometimes referred to as an "organizational signature".

[2.2.](#) Review Signature

A third party may review messages before they are forwarded to the final recipient(s) who may be in the same or a different security domain. Organizational policy and security practice often require that messages be reviewed before they are released to external recipients. Having reviewed a message, an S/MIME signature is added to it - a review signature. An agent could check the review signature at the domain boundary, to ensure that only reviewed messages are released.

[2.3.](#) Additional Attributes Signature

A third party can add additional attributes to a signed message. An S/MIME signature is used for this purpose - an additional attributes signature. An example of an additional attribute is the 'Equivalent Label' attribute defined in ESS [[RFC2634](#)].

[2.4.](#) Domain Encryption and Decryption

Domain encryption is S/MIME encryption performed on behalf of a collection of users in a domain. Domain encryption can be used to protect information between domains, for example, when two 'Intranets' are connected using the Internet. It can also be used when end users do not have PKI/encryption capabilities at the desktop, or when two domains employ incompatible encryption schemes internally. In the latter case messages from the originator's domain are encrypted (or re-encrypted) using an algorithm, key, and certificate which can be decrypted by the recipient(s) or an entity

in their domain. This scheme also applies to protecting information between a single domain and one of its members when both are connected using an untrusted network, e.g., the Internet.

[2.5.](#) Signature Encapsulation

ESS [[RFC2634](#)] introduces the concept of triple-wrapped messages that are first signed, then encrypted, then signed again. This document

also uses this concept of triple-wrapping. In addition, this document also uses the concept of 'signature encapsulation'. 'Signature encapsulation' denotes a signed or unsigned message that is wrapped in a signature, this signature covering both the content and the first (inner) signature, if present.

Signature encapsulation can be performed on the inner and/or the outer signature of a triple-wrapped message.

For example, the originator signs a message which is then encapsulated with an 'additional attributes' signature. This is then encrypted. A reviewer then signs this encrypted data, which is then encapsulated by a domain signature.

There is a possibility that some policies will require signatures to be added in a specific order. By only allowing signatures to be added by encapsulation it is possible to determine the order in which the signatures have been added.

A DOMSEC defined signature MAY encapsulate a message in one of the following ways:

1. An unsigned message has an empty signature layer added to it (i.e., the message is wrapped in a signedData that has a signerInfos which contains no elements). This is to enable backward compatibility with S/MIME software that does not have a DOMSEC capability. Since the signerInfos will contain no signers the eContentType, within the EncapsulatedContentInfo, MUST be id-data as described in CMS [RFC5652]. However, the eContent field will contain the unsigned message instead of being left empty as suggested in [section 5.2](#) in CMS [RFC5652]. This is so that when the DOMSEC defined signature is added, as defined in method 2) below, the signature will cover the unsigned message.
2. Signature Encapsulation is used to wrap the original signed message with a DOMSEC defined signature. This is so that the DOMSEC defined signature covers the message and all the previously added signatures. Also, it is possible to determine that the DOMSEC defined signature was added after the signatures that are already there.

The subject name of the Domain-based sending agent's X.509 certificate is not restricted as specified in [RFC 3183](#) [[RFC3183](#)]. In order for a verifier to recognize a signing/encrypting certificate as the Domain-based sending agent's certificate, it MUST contain uniformResourceIdentifier GeneralName of the format "<protocol>://<fully-qualified-domain>" and/or dNSName of the format <fully-qualified-domain> in its SubjectAltName [[RFC5280](#)]. (Here <fully-qualified-domain> is the domain that is being served by the signing/encrypting MSA/MTA. <protocol> is "submit" for MSAs and "smtp" for MTAs.)

Any message received where the domain part of the domain signing agent's name does not match, or is not an ascendant of, the originator's domain name MUST be flagged to the user.

This naming rule prevents agents from one organization masquerading as domain signing or encryption authorities on behalf of another. For the other types of signature defined in future documents, no such naming rule is defined.

Implementations conforming to this standard MUST support this naming convention as a minimum. Implementations MAY choose to supplement this convention with other locally defined conventions. However, these MUST be agreed between sender and recipient domains prior to secure exchange of messages.

On verifying the signature, a receiving agent MUST ensure that the naming convention has been adhered to. Any message that violates the convention MUST be flagged to the user.

Note that a X.509 certificate of a signing Domain-based sending agent can be distinguished from a certificate of encrypting domain-based sending agent by checking for keyUsage as specified in [\[RFC5280\]](#) [Section 4.2.1.3](#).

[3.](#) Domain-Based S/MIME Signing

[3.1.](#) General

An entity receiving an S/MIME signed message would normally expect the signature to be that of the originator of the message. However, the message security services defined in this document require the recipient to be able to accept messages signed by other entities and/or the originator. When other entities sign the message the name in the certificate will not match the message sender's name. An S/MIME compliant implementation would normally flag a warning if there were

a mismatch between the name in the certificate and the message sender's name. (This check prevents a number of types of masquerade attack.)

In the case of domain security services, this warning condition SHOULD be suppressed under certain circumstances. These circumstances are defined by a naming convention that specifies the form that the signers name SHOULD adhere to. Adherence to this naming convention avoids the problems of uncontrolled naming and the possible masquerade attacks that this would produce.

As an assistance to implementation, a signed attribute is defined to be included in the S/MIME signature - the 'signature type' attribute [Section 3.2](#). On receiving a message containing this attribute, the naming convention (see [Section 2.6](#)) checks are invoked.

Implementations conforming to this standard MUST support the naming convention specified in [Section 2.6](#) for signature generation and verification. Implementations conforming to this standard MUST recognize the signature type attribute for signature verification. Implementations conforming to this standard MUST support the signature type attribute for signature generation.

[3.2](#). Signature Type Attribute

An S/MIME signed attribute is used to indicate the type of signature. This should be used in conjunction with the naming conventions specified in [Section 2.6](#). When an S/MIME signed message containing the signature type attribute is received it triggers the software to verify that the correct naming convention has been used.

The following object identifier identifies the SignatureType attribute:

```
id-aa-signatureType OBJECT IDENTIFIER ::= { iso(1)
    member-body(2) us(840) rsadsi(113549) pkcs(1) pkcs9(9) 28 }
```

The ASN.1 [[ASN.1](#)] notation of this attribute is: -

```
SignatureType ::= SEQUENCE OF OBJECT IDENTIFIER
```

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

If present, the SignatureType attribute MUST be a signed attribute,

as defined in [[RFC5652](#)]. If the SignatureType attribute is absent

and there are no further encapsulated signatures the recipient SHOULD assume that the signature is that of the message originator.

All of the signatures defined here are generated and processed as described in [[RFC5652](#)]. They are distinguished by the presence of the following values in the SignatureType signed attribute:

```
id-sti-domainSig OBJECT IDENTIFIER ::= { id-sti 2 }  
    -- domain signature.
```

```
id-sti-addAttribSig OBJECT IDENTIFIER ::= { id-sti 3 }  
    -- additional attributes signature.
```

```
id-sti-reviewSig OBJECT IDENTIFIER ::= { id-sti 4 }  
    -- review signature.
```

```
id-sti-delegatedOriginatorSig OBJECT IDENTIFIER ::= { id-sti 5 }  
    -- delegated originator signature.
```

For completeness, an attribute type is also specified for an originator signature. However, this signature type is optional. It is defined as follows:

```
id-sti-originatorSig OBJECT IDENTIFIER ::= { id-sti 1 }  
    -- originator's signature.
```

All signature types, except the originator and the delegated originator types, MUST encapsulate other signatures. Note a DOMSEC defined signature could be encapsulating an empty signature as defined in [Section 2.5](#).

A SignerInfo MUST NOT include multiple instances of SignatureType. A signed attribute representing a SignatureType MAY include multiple instances of different SignatureType values as an AttributeValue of attrValues [[RFC5652](#)], as long as the SignatureType 'additional attributes' is not present.

If there is more than one SignerInfo in a signerInfos (i.e., when different algorithms are used) then the SignatureType attribute in

all the SignerInfos MUST contain the same content.

The following sections describe the conditions under which each of these types of signature may be generated, and how they are processed.

[3.3.](#) Domain Signature Generation and Verification

A 'domain signature' is a signature generated on behalf of a set of users who belong to the specific domain. The signature MUST adhere to the naming conventions in [Section 2.6](#). A 'domain signature' on a message authenticates the fact that the message has been released from that domain. (It also provides integrity and non-repudiation of message between Domain-based Sending Agents and Receiving Agents.) Before signing, a process generating a 'domain signature' MUST first satisfy itself of the authenticity of the message originator. This is achieved by one of two methods. Either the 'originator's signature' is checked, if S/MIME signatures are used inside a domain. Or if not, some mechanism external to S/MIME is used, such as SMTP authentication credentials [[RFC4954](#)], authentication provided by STARTTLS [[RFC3207](#)] (possibly combined with SMTP authentication), the physical address of the originating client or an authenticated IP link, etc.

If the originator's authenticity is successfully verified by one of the above methods and all other signatures present are valid, including those that have been encrypted, a 'domain signature' can be added to a message.

If a 'domain signature' is added and the message is received by a Mail List Agent (MLA) there is a possibility that the 'domain signature' will be removed. To stop the 'domain signature' from being removed the steps in [Section 5](#) MUST be followed.

An entity generating a domain signature MUST do so using a certificate containing a subject name that follows the naming convention specified in [Section 2.6](#).

If the originator's authenticity is not successfully verified or all the signatures present are not valid, a 'domain signature' MUST NOT be generated.

On reception, the 'domain signature' SHOULD be used to verify the authenticity of a message. A check MUST be made to ensure that the naming convention has been used as specified in [Section 2.6](#).

A recipient can assume that successful verification of the domain signature also authenticates the message originator.

If there is an originator signature present, the name in that certificate SHOULD be used to identify the originator. This information can then be displayed to the recipient.

If there is no originator signature present, the only assumption that can be made is the domain the message originated from.

A domain signer can be assumed to have verified any signatures that it encapsulates. Therefore, it is not necessary to verify these signatures before treating the message as authentic. However, this standard does not preclude a recipient from attempting to verify any other signatures that are present.

The 'domain signature' is indicated by the presence of the value `id-sti-domainSig` in a 'signature type' signed attribute.

There MAY be one or more 'domain signature' signatures in an S/MIME encoding.

[3.4](#). Additional Attributes Signature Generation and Verification

The 'additional attributes' signature type indicates that the `SignerInfo` contains additional attributes that are associated with the message.

All attributes in the applicable `SignerInfo` MUST be treated as additional attributes. Successful verification of an 'additional attributes' signature means only that the attributes are authentically bound to the message. A recipient MUST NOT assume that

its successful verification also authenticates the message originator.

An entity generating an 'additional attributes' signature MUST do so using a certificate that follows the naming convention specified in [Section 2.6](#). On reception, a check MUST be made to ensure that the naming convention has been used.

A signer MAY include any of the attributes listed in [\[RFC2634\]](#) or in this document when generating an 'additional attributes' signature. The following attributes have a special meaning, when present in an 'additional attributes' signature:

1. Equivalent Label: label values in this attribute are to be treated as equivalent to the security label contained in an encapsulated SignerInfo, if present.
2. Security Label: the label value indicates the aggregate sensitivity of the inner message content plus any encapsulated signedData and envelopedData containers. The label on the original data is indicated by the value in the originator's signature, if present.

An 'additional attributes' signature is indicated by the presence of the value id-sti-addAttribSig in a 'signature type' signed attribute. Other Object Identifiers MUST NOT be included in the sequence of OIDs if this value is present.

There can be multiple 'additional attributes' signatures in an S/MIME encoding.

[3.5](#). Review Signature Generation and Verification

The review signature indicates that the signer has reviewed the message. Successful verification of a review signature means only that the signer has approved the message for onward transmission to the recipient(s). When the recipient is in another domain, an agent on a domain boundary such as a Mail Guard or firewall may be configured to check review signatures. A recipient MUST NOT assume that its successful verification also authenticates the message originator.

An entity generating a review signature MUST do so using a certificate that follows the naming convention specified in [Section 2.6](#). On reception, a check MUST be made to ensure that the naming convention has been used.

A review signature is indicated by the presence of the value id-sti-reviewSig in a 'signature type' signed attribute.

There can be multiple review signatures in an S/MIME encoding.

[3.6](#). Originator Signature

The 'originator signature' is used to indicate that the signer is the originator of the message and its contents. It is included in this document for completeness only. An originator signature is indicated either by the absence of the signature type attribute, or by the presence of the value id-sti-originatorSig in a 'signature type' signed attribute.

[3.7](#). Delegated Originator Signature

The 'delegated originator signature' is similar to the 'domain signature' ([Section 3.3](#)), but it also indicates that MSA signed message with a unique originator-specific key.

If the originator's authenticity is successfully verified as specified in [Section 3.3](#) and all other signatures present are valid, including those that have been encrypted, a 'delegated originator signature' can be added to a message.

If a 'delegated originator signature' is added and the message is received by a Mail List Agent (MLA) there is a possibility that the 'delegated originator signature' will be removed. To stop the 'delegated originator signature' from being removed the steps in [Section 5](#) MUST be followed.

An entity generating a delegated originator signature MUST do so using a certificate that follows the naming convention specified in [Section 2.6](#). On reception, a check MUST be made to ensure that the naming convention has been used.

If the originator's authenticity is not successfully verified or all the signatures present are not valid, a 'delegated originator signature' MUST NOT be generated.

A delegated originator signature is indicated by the presence of the value id-sti-delegatedOriginatorSig in a 'signature type' signed attribute.

4. Domain-based S/MIME Encryption and Decryption

Messages may be encrypted for decryption by the final recipient and/or by a DCA in the recipient's domain. The message may also be encrypted for decryption by a DCA in the originator's domain (e.g., for content analysis, audit, key word scanning, etc.). The choice of which of these is actually performed is a system specific issue that depends on system security policy. It is therefore outside the scope of this document. These processes of encryption and decryption are shown in the following table.

	Recipient Decryption	Domain Decryption
Originator Encryption	Case(a)	Case(b)
Domain Encryption	Case(c)	Case(d)

Case (a), encryption of messages by the originator for decryption by the final recipient(s), is described in CMS [\[RFC5652\]](#). In cases (c) and (d), encryption is performed not by the originator but by the DCA in the originator's domain. In cases (b) and (d), decryption is performed not by the recipient(s) but by the DCA in the recipient's domain.

A client implementation that conforms to this standard MUST support case (b) for transmission, case (c) for reception and case (a) for transmission and reception.

A DCA implementation that conforms to this standard MUST support cases (c) and (d), for transmission, and cases (b) and (d) for reception. In cases (c) and (d) the 'domain signature' SHOULD be applied before the encryption. In cases (b) and (d) the message

SHOULD be decrypted before the originators 'domain signature' is obtained and verified.

The process of encryption and decryption is documented in CMS [[RFC5652](#)]. The only additional requirement introduced by domain encryption and decryption is for greater flexibility in the management of keys, as described in the following subsections. As with signatures, a naming convention is used to locate the correct public key.

The mechanisms described below are applicable both to key agreement and key transport systems, as documented in CMS [[RFC5652](#)]. The phrase 'encryption key' is used as a collective term to cover the key management keys used by both techniques.

The mechanisms below are also applicable to individual roving users who wish to encrypt messages that are sent back to base.

4.1. Key Management for DCA Encryption

At the sender's domain, DCA encryption is achieved using the recipient DCA's certificate or the end recipient's certificate. For this, the encrypting process must be able to correctly locate the certificate for the corresponding DCA in the recipient's domain or the one corresponding to the end recipient. Having located the correct certificate, the encryption process is then performed and additional information required for decryption is conveyed to the recipient in the recipientInfo field as specified in CMS [[RFC5652](#)]. A DCA encryption agent MUST be named according to the naming convention specified in [Section 2.6](#). This is so that the corresponding certificate can be found.

No specific method for locating the certificate to the corresponding DCA in the recipient's domain or the one corresponding to the end recipient is mandated in this document. An implementation may choose to access a local certificate store to locate the correct certificate. Alternatively, a X.500 or LDAP [[RFC4510](#)] directory may be used in one of the following ways:

1. The directory may store the DCA certificate in the recipient's directory entry. When the user certificate attribute is requested, this certificate is returned.

2. The encrypting agent maps the recipient's name to the DCA name in the manner specified in [Section 2.6](#). The user certificate attribute associated with the DCA's directory entry is then obtained.

This document does not mandate either of these processes. Whichever one is used, the naming conventions must be adhered to, in order to maintain confidentiality.

Having located the correct certificate, the encryption process is then performed. A recipientInfo for the DCA or end recipient is then generated, as described in CMS [[RFC5652](#)].

DCA encryption may be performed for decryption by the end recipient and/or by a DCA. End recipient decryption is described in CMS [[RFC5652](#)]. DCA decryption is described in [Section 4.2](#).

[4.2](#). Key Management for DCA Decryption

DCA decryption uses a private-key belonging to the DCA and the necessary information conveyed in the DCA's recipientInfo field.

It should be noted that domain decryption can be performed on messages encrypted by the originator and/or by a DCA in the originator's domain. In the first case, the encryption process is described in CMS [[RFC5652](#)]; in the second case, the encryption process is described in [Section 4.1](#).

[5](#). Applying a Domain Signature when Mail List Agents are Present

It is possible that a message leaving a DOMSEC domain may encounter a Mail List Agent (MLA) before it reaches the final recipient. There is a possibility that this would result in the 'domain signature' being stripped off the message. We do not want a MLA to remove the 'domain signature'. Therefore, the 'domain signature' must be applied to the message in such a way that will prevent a MLA from removing it.

A MLA will search a message for the "outer" signedData layer, as defined in ESS [[RFC2634](#)] [section 4.2](#), and strip off all signedData layers that encapsulate this "outer" signedData layer. Where this "outer" signedData layer is found will depend on whether the message contains a mlExpansionHistory attribute or an envelopedData layer.

There is a possibility that a message leaving a DOMSEC domain has already been processed by a MLA, in which case a 'mlExpansionHistory' attribute will be present within the message.

Internet-Draft

MSA-to-MDA S/MIME

March 2014

There is a possibility that the message will contain an envelopedData layer. This will be the case when the message has been encrypted within the domain for the domain's "Domain Confidentiality Authority" (see [Section 4](#)), and, possibly, the final recipient.

How the 'domain signature' is applied will depend on what is already present within the message. Before the 'domain signature' can be applied the message MUST be searched for the "outer" signedData layer, this search is complete when one of the following is found:

- o The "outer" signedData layer that includes an mlExpansionHistory attribute or encapsulates an envelopedData object.
- o An envelopedData layer.
- o The original content (that is, a layer that is neither envelopedData nor signedData).

If a signedData layer containing a mlExpansionHistory attribute has been found, then:

1. Strip off the signedData layer (after remembering the included signedAttributes).
2. Search the rest of the message until an envelopedData layer or the original content is found.
3.
 - A. If an envelopedData layer has been found, then:
 - + Strip off all the signedData layers down to the envelopedData layer.
 - + Locate the RecipientInfo for the local DCA and use the information it contains to obtain the message key.
 - + Decrypt the encryptedContent using the message key.
 - + Encapsulate the decrypted message with a 'domain

signature'.

- + If local policy requires the message to be encrypted using S/MIME encryption before leaving the domain then encapsulate the 'domain signature' with an envelopedData layer containing RecipientInfo structures for each of the recipients and an originatorInfo value built from information describing this DCA.

If local policy does not require the message to be encrypted using S/MIME encryption but there is an envelopedData at a lower level within the message then the 'domain signature' MUST be encapsulated by an envelopedData as described above.

An example when it may not be local policy to require S/MIME encryption is when there is a link crypto present.

B. If an envelopedData layer has not been found, then:

- Encapsulate the new message with a 'domain signature'.

4. Encapsulate the new message in a signedData layer, adding the signedAttributes from the signedData layer that contained the mlExpansionHistory attribute.

If no signedData layer containing a mlExpansionHistory attribute has been found but an envelopedData has been found, then: -

1. Strip off all the signedData layers down to the envelopedData layer.
2. Locate the RecipientInfo for the local DCA and use the information it contains to obtain the message key.
3. Decrypt the encryptedContent using the message key.
4. Encapsulate the decrypted message with a 'domain signature'.
5. If local policy requires the message to be encrypted before leaving the domain then encapsulate the 'domain signature' with an envelopedData layer containing RecipientInfo structures for

each of the recipients and an originatorInfo value built from information describing this DCA.

6. If local policy does not require the message to be encrypted using S/MIME encryption but there is an envelopedData at a lower level within the message then the 'domain signature' MUST be encapsulated by an envelopedData as described above.

If no signedData layer containing a mlExpansionHistory attribute has been found and no envelopedData has been found, then: -

1. Strip off all the signedData layers down to the envelopedData
Encapsulate the message in a 'domain signature'.

[5.1](#). Examples of Rule Processing

The following examples help explain the above rules. All of the signedData objects are valid and none of them are a domain signature. If a signedData object was a domain signature then it would not be necessary to validate any further signedData objects.

1. A message (S1 (Original Content)) (where S = signedData) in which the signedData does not include an mlExpansionHistory attribute is to have a 'domain signature' applied. The signedData, S1, is verified. No "outer" signedData is found, after searching for one as defined above, since the original content is found, nor is an envelopedData or a mlExpansionHistory attribute found. A new signedData layer, S2, is created that contains a 'domain signature', resulting in the following message sent out of the domain (S2 (S1 (Original Content))).
2. A message (S3 (S2 (S1 (Original Content)))) in which none of the signedData layers includes an mlExpansionHistory attribute is to have a 'domain signature' applied. The signedData objects S1, S2 and S3 are verified. There is not an original, "outer" signedData layer since the original content is found, nor is an envelopedData or a mlExpansionHistory attribute found. A new signedData layer, S4, is created that contains a 'domain signature', resulting in the following message sent out of the domain (S4 (S3 (S2 (S1 (Original Content))))).

3. A message (E1 (S1 (Original Content))) (where E = envelopedData) in which S1 does not include a mlExpansionHistory attribute is to have a 'domain signature' applied. There is not an original, received "outer" signedData layer since the envelopedData, E1, is found at the outer layer. The encryptedContent is decrypted. The signedData, S1, is verified. The decrypted content is wrapped in a new signedData layer, S2, which contains a 'domain signature'. If local policy requires the message to be encrypted, using S/MIME encryption, before it leaves the domain then this new message is wrapped in an envelopedData layer, E2, resulting in the following message sent out of the domain (E2 (S2 (S1 (Original Content)))), else the message is not wrapped in an envelopedData layer resulting in the following message (S2 (S1 (Original Content))) being sent.
4. A message (S2 (E1 (S1 (Original Content)))) in which S2 includes a mlExpansionHistory attribute is to have a 'domain signature' applied. The signedData object S2 is verified. The mlExpansionHistory attribute is found in S2, so S2 is the "outer" signedData. The signed attributes in S2 are remembered for later inclusion in the new outer signedData that is applied to the

message. S2 is stripped off and the message is decrypted. The signedData object S1 is verified. The decrypted message is wrapped in a signedData layer, S3, which contains a 'domain signature'. If local policy requires the message to be encrypted, using S/MIME encryption, before it leaves the domain then this new message is wrapped in an envelopedData layer, E2. A new signedData layer, S4, is then wrapped around the envelopedData, E2, resulting in the following message sent out of the domain (S4 (E2 (S3 (S1 (Original Content))))). If local policy does not require the message to be encrypted, using S/MIME encryption, before it leaves the domain then the message is not wrapped in an envelopedData layer but is wrapped in a new signedData layer, S4, resulting in the following message sent out of the domain (S4 (S3 (S1 (Original Content))). The signedData S4, in both cases, contains the signed attributes from S2.

5. A message (S3 (S2 (E1 (S1 (Original Content)))))) in which none of the signedData layers include a mlExpansionHistory attribute is to have a 'domain signature' applied. The signedData objects S3

and S2 are verified. When the envelopedData E1 is found the signedData objects S3 and S2 are stripped off. The encryptedContent is decrypted. The signedData object S1 is verified. The decrypted content is wrapped in a new signedData layer, S4, which contains a 'domain signature'. If local policy requires the message to be encrypted, using S/MIME encryption, before it leaves the domain then this new message is wrapped in an envelopedData layer, E2, resulting in the following message sent out of the domain (E2 (S4 (S1 (Original Content)))), else the message is not wrapped in an envelopedData layer resulting in the following message (S4 (S1 (Original Content))) being sent.

6. A message (S3 (S2 (E1 (S1 (Original Content))))) in which S3 includes a mlExpansionHistory attribute is to have a 'domain signature' applied. The signedData objects S3 and S2 are verified. The mlExpansionHistory attribute is found in S3, so S3 is the "outer" signedData. The signed attributes in S3 are remembered for later inclusion in the new outer signedData that is applied to the message. The signedData object S3 is stripped off. When the envelopedData layer, E1, is found the signedData object S2 is stripped off. The encryptedContent is decrypted. The signedData object S1 is verified. The decrypted content is wrapped in a new signedData layer, S4, which contains a 'domain signature'. If local policy requires the message to be encrypted, using S/MIME encryption, before it leaves the domain then this new message is wrapped in an envelopedData layer, E2. A new signedData layer, S5, is then wrapped around the envelopedData, E2, resulting in the following message sent out of the domain (S5 (E2 (S4 (S1 (Original Content))))). If local

policy does not require the message to be encrypted, using S/MIME encryption, before it leaves the domain then the message is not wrapped in an envelopedData layer but is wrapped in a new signedData layer, S5, resulting in the following message sent out of the domain (S5 (S4 (S1 (Original Content))). The signedData S5, in both cases, contains the signed attributes from S3.

7. A message (S3 (E2 (S2 (E1 (S1 (Original Content))))) in which S3 does not include a mlExpansionHistory attribute is to have a 'domain signature' applied. The signedData object S3 is verified. When the envelopedData E2 is found the signedData object S3 is stripped off. The encryptedContent is decrypted.

The signedData object S2 is verified, the envelopedData E1 is decrypted and the signedData object S1 is verified. The signedData object S2 is wrapped in a new signedData layer S4, which contains a 'domain signature'. Since there is an envelopedData E1 lower down in the message, the new message is wrapped in an envelopedData layer, E3, resulting in the following message sent out of the domain (E3 (S4 (S2 (E1 (S1 (Original Content)))))).

[6.](#) IANA Considerations

This document registers 2 URI schemes, described in subsections of this section. IANA is requested to add them to the list of Permanent URI schemes.

[6.1.](#) SMTP URI registration

URI scheme name: smtp

Status: permanent

URI scheme syntax:

smtpuri = "smtp://" authority ["/" ["?" query]]

authority = <defined in [RFC 3986](#)>

query = <defined in [RFC 3986](#)>

If :<port> is omitted from authority, the port defaults to 25.

The query component is reserved for future extensions.

URI scheme semantics:

The smtp: URI scheme is used to designate SMTP servers (e.g. listener endpoints, S/MIME agents performing Domain signing), SMTP accounts.

There is no MIME type associated with this URI.

Encoding considerations:

SMTP user names are UTF-8 strings and MUST be percent-encoded as required by the URI specification [\[RFC3986\]](#), [Section 2.1](#).

Applications/protocols that use this URI scheme name:

The smtp: URI is intended to be used by applications that might

need access to an SMTP server (for example email clients or MTAs) or for SMTP servers to describe their listener endpoints.

Interoperability considerations:

Several implementations are already using smtp: URIs for server configuration.

Security considerations: Clients resolving smtp: URIs that wish to achieve data confidentiality and/or integrity SHOULD use the STARTTLS command (if supported by the server) before starting authentication, or use a SASL mechanism, such as GSSAPI, that provides a confidentiality security layer.

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References: [[This document]] and [[RFC5321](#)].

[6.2.](#) SUBMIT URI registration

URI scheme name: submit

Status: permanent

URI scheme syntax:

submituri = "submit://" authority ["/" ["?" query]]

authority = <defined in [RFC 3986](#)>

query = <defined in [RFC 3986](#)>

If :<port> is omitted from authority, the port defaults to 587.

The query component is reserved for future extensions.

URI scheme semantics:

The submit: URI scheme is used to designate SMTP Submission servers (e.g. listener endpoints, S/MIME agents performing Domain signing), SMTP accounts.

There is no MIME type associated with this URI.

Encoding considerations:

SMTP user names are UTF-8 strings and MUST be percent-encoded as required by the URI specification [[RFC3986](#)], [Section 2.1](#).

Applications/protocols that use this URI scheme name:

The submit: URI is intended to be used by applications that might need access to an SMTP Submission server (for example email clients) or for SMTP Submission servers to describe their listener endpoints.

Interoperability considerations:

None.

Security considerations: Clients resolving submit: URIs that wish to achieve data confidentiality and/or integrity SHOULD use the STARTTLS command (if supported by the server) before starting authentication, or use a SASL mechanism, such as GSSAPI, that provides a confidentiality security layer.

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References: [[This document]] and [[RFC6409](#)].

7. Security Considerations

Implementations MUST protect all private keys. Compromise of the signer's private key permits masquerade attacks.

Similarly, compromise of the content-encryption key may result in disclosure of the encrypted content.

Compromise of key material is regarded as an even more serious issue for domain security services than for an S/MIME client. This is because compromise of the private key may in turn compromise the security of a whole domain. Therefore, great care should be used when considering its protection.

Domain encryption alone is not secure and should be used in conjunction with a domain signature to avoid a masquerade attack, where an attacker that has obtained a DCA certificate can fake a message to that domain pretending to be another domain.

When an encrypted DOMSEC message is sent to an end user in such a way that the message is decrypted by the end users DCA the message will be in plain text and therefore confidentiality could be compromised. If the recipient's DCA is compromised then the recipient can not guarantee the integrity of the message. Furthermore, even if the recipient's DCA correctly verifies a message's signatures, then a

Internet-Draft

MSA-to-MDA S/MIME

March 2014

message could be undetectably modified, when there are no signatures on a message that the recipient can verify.

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Ottaway & Melnikov

Expires September 6, 2014

[Page 24]

Internet-Draft

MSA-to-MDA S/MIME

March 2014

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Internet-Draft

MSA-to-MDA S/MIME

March 2014

[Appendix A](#). Changes from [RFC 3183](#)

Unlike [RFC 3183](#), subject names of domain signing/encrypting X.509 certificates don't have to have a specific form. But Subject Alternative Names need to include URIs for domain being protected.

A new signature type was added for the case when MSA signs/encrypts a message on behalf of a user with a user specific key.

Incorporated erratum 3757 resolution.

Updated references and some minor editorial corrections.

[Appendix B](#). Acknowledgements

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