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Mail User Agent Strict Transport Security (MUA-STS) draft-ietf-uta-email-deep-06

Abstract

This specification defines a set of requirements and facilities designed to improve email confidentiality between a mail user agent (MUA) and a mail submission or mail access server. This provides mechanisms intended to increase use of already deployed Transport Layer Security (TLS) technology and provides a model for a mail user agent's confidentiality assurance. This enables mail service providers to advertise strict transport security (STS) policies that request MUAs increase confidentiality assurance.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

Software that provides email service via Internet Message Access Protocol (IMAP) [RFC3501], Post Office Protocol (POP) [RFC1939] and/or Simple Mail Transfer Protocol (SMTP) Submission [RFC6409] usually has Transport Layer Security (TLS) [RFC5246] support but often does not use it in a way that maximizes end-user confidentiality. This specification proposes changes to email software and deployments intended to increase the use of TLS and record when that use occurs. This adapts the strict transport security (STS) model described in [RFC6797] to cover mail user agents (MUAs).

In brief, this memo now recommends that:

- MUAs associate a minimum confidentiality assurance level with each mail account, and disconnections associated with that account that do not provide the minimum confidentiality assurance level associated with that account.

- By default, MUAs assign a minimum confidentiality assurance level that requires use of TLS with certificate validation for all TCP connections;

- TLS on a well-known port ("Implicit TLS") be supported for IMAP, POP, and SMTP Submission [RFC6409] for all electronic mail user agents (MUAs), servers, and service providers;

- MUAs and mail protocol servers cooperate (via mechanisms defined in this specification) to upgrade security feature use and record/indicate that usage appropriately. The security upgrade model is aligned with the HTTP STS specification [RFC6797].

This does not address use of TLS with SMTP for message relay (where Message Submission [RFC6409] does not apply). Improved use of TLS with SMTP for message relay requires a different approach. One approach to address that topic is described in [RFC7672].

The recommendations in this memo do not replace the functionality of, and are not intended as a substitute for, end-to-end encryption of electronic mail.

This draft is subject to change. Implementation of this proposal is not recommended at this time. Please discuss this proposal on the ietf-uta mailing list.

2. Conventions and Terminology 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].

This specification expresses syntax using the Augmented Backus-Naur Form (ABNF) as described in [RFC5234], including the core rules in Appendix B and rules from [RFC5322].

In examples, "C:" and "S:" indicate lines sent by the client and server respectively. If a single "C:" or "S:" label applies to multiple lines, then the line breaks between those lines are for editorial clarity only and are not part of the actual protocol exchange.

3. Mail Account Confidentiality Assurance Level

A "mail account" refers to the network services an end user uses to read, submit and manage email communications on the Internet. This typically involves at least one mail access server (IMAP or POP) and at least one SMTP submission server. An end user uses a mail user agent (MUA) to access a mail account. (Most MUAs support the ability to access multiple mail accounts.) This document uses the term "confidentiality assurance level" to indicate the degree to which the network connections between an MUA and a mail account have

confidentiality protection from both passive and active attackers on the network.

The configuration necessary for a mail account includes an email address, connection information, and authentication credentials for network services. MUAs compliant with this specification MUST also associate a minimum confidentiality assurance level with each mail account. If during a session with a network service, the requirements for the minimum confidentiality assurance level associated with that mail account are not met, the MUA MUST NOT continue the session with the network service. MUAs MUST support at least the ability to detect whether a session with a network service implements confidentiality assurance level 1 as described in the next section. Note that the minimum confidentiality assurance level associated with an account applies to all protocol interactions and all servers associated with the account.

MUAs SHOULD continuously indicate to the user the current confidentiality assurance level of any account currently in use when reading, submitting and managing mail (e.g., via a lock icon, background colors, or other indications similar to those commonly used in web browsers for a similar purpose) and SHOULD indicate the minimum confidentiality assurance level for each account whenever displaying a list of mail accounts. Note that the displayed confidentiality assurance level for a current session could be higher than the minimum confidentiality assurance level set at account configuration, but never lower. If multiple active connections are associated with an account or view, the indication of the current confidentiality assurance level associated with the account should reflect the level provided by the least confidential connection. It is therefore possible that at any given instant some services associated with a mail account meet the minimum confidentiality assurance level associated with the account, and other services do not. An MUA MAY continue to interact with those services for which the minimum confidentiality assurance level is met, while refusing to interact with those services for which the minimum confidentiality assurance level is not met. For example, if the IMAP service associated with a mail account meets the minimum confidentiality assurance level, but the Mail Submission service associated with that account does not, the MUA MAY continue to permit reading mail from that account but MUST NOT send mail until it can do so using a Submission service that meets the minimum confidentiality assurance level for that account.

Account configuration occurs when an MUA is first used to access a particular service, when a user wishes to access or submit mail through servers in addition to those specified or found during first use, or when a user explicitly requests to change account

configuration parameters such as server names, user names, passwords, client certificates, etc. Account configuration can be entirely manual (entering server names explicitly) or partially automated via a mechanism such as DNS SRV records [RFC6186]. MUAs SHOULD require a minimum confidentiality assurance level of 1 as the default for newly configured accounts.

This document defines two initial confidentiality assurance levels, 1 and 0. It is expected that other levels may be defined in the future, as needed to thwart increasingly sophisticated and/or pervasive attacks.

3.1. Confidentiality Assurance Level 1

A mail account has a confidentiality assurance level of 1 when the following conditions are met on all TCP server connections associated with an account. This includes connections to POP, IMAP and SMTP submission servers as well as any other associated protocols defined now or in the future. Examples of protocols associated with a mail account include managesieve [RFC5804] and MTQP [RFC3887].

- TCP connections MUST successfully negotiate TLS via either Implicit TLS Section 4 or STARTTLS.

- For protocols using TCP, both client and server must support, and negotiate, a TLS version of 1.1 or greater.

- MUAs MUST implement [RFC7817] and PKIX [RFC5280].

- MUAs MAY implement DANE [RFC6698] as an alternate means of verifying TLS server certificates. For confidentiality assurance level 1, a certificate may be considered valid if it can be validated using either DANE or PKIX.

- User agents MUST abort a TLS session if the TLS negotiation fails or the server's certificate or identity fails to verify. A user may reconfigure the account to lower the expected level of confidentiality if he/she chooses. Reduction of expected account confidentiality MUST NOT be done on a click-through basis.

The end user is part of the system that protects the user's confidentiality and security. As a result, it's critical not to present the end user with a simple action that reduces their confidentiality in response to certificate validation failure. An MUA which offers a user actions such as "connect anyway", "trust certificate for future connections" or "lower confidentiality assurance for this account" in response to certificate validation failure is not implementing a minimum confidentiality assurance of 1

as defined in this section and thus does not comply with this document. Examples of acceptable actions to offer would be "work offline", "try again later", and "open service provider status web page".

3.2. Confidentiality Assurance Level 0

MUAs MAY support the ability to configure accounts with a minimum confidentiality assurance level of 0. At this level, the MUA MUST attempt to negotiate TLS, but MAY ignore server certificate validation failures. MUAs MAY support use of connections without TLS, or using TLS versions prior to TLS 1.1, for accounts with a minimum confidentiality assurance level of 0. Even for accounts with a minimum confidentiality assurance level of 0, MUAs SHOULD attempt TLS first if available, and MUST implement the ability to reconnect without TLS if TLS negotiation fails for reasons other than server certificate validity.

Note that if TLS is not used, or a version of TLS prior to TLS 1.1 is negotiated, or the TLS server certificate is not successfully validated as described in Section 3.1, the client MUST clearly indicate to the user that there is currently no assurance of confidentiality for the mail account or connection.

3.3. Other Confidentiality Assurance Levels

This specification is not intended to limit experimentation and innovation with respect to user confidentiality. As a result, an implementation MAY implement confidentiality assurance levels other than those defined in this document, as long as those levels are distinguished in user interfaces from those defined in this document, and the ordering associated with them reflects the actual expectation of confidentiality provided. However, implementation of levels below confidentiality assurance level 0, as described in the previous section, is discouraged. Implementers are also cautioned that end users may be confused by too many confidentiality assurance levels.

As stated above, higher confidentiality assurance levels may be standardized in the future. For example, a future confidentiality assurance levels might require multiple independent trust anchors for server certificate validation.

4. Implicit TLS

Previous standards for use of email protocols with TLS used the STARTTLS mechanism: [RFC2595], [RFC3207], and [RFC3501]. With STARTTLS, the client establishes a clear text application session and determines whether to issue a STARTTLS command based on server

capabilities and client configuration. If the client issues a STARTTLS command, a TLS handshake follows that can upgrade the connection. While this mechanism has been deployed, an alternate mechanism where TLS is negotiated immediately at connection start on a separate port (referred to in this document as "Implicit TLS") has been deployed more successfully. To increase use of TLS, this specification recommends use of implicit TLS by new POP, IMAP and SMTP Submission software.

4.1. Implicit TLS for POP

When a TCP connection is established for the "pop3s" service (default port 995), a TLS handshake begins immediately. Clients MUST implement the certificate validation mechanism described in [RFC7817]. Once the TLS session is established, POP3 [RFC1939] protocol messages are exchanged as TLS application data for the remainder of the TCP connection. After the server sends a +OK greeting, the server and client MUST enter AUTHORIZATION state, even if client credentials were supplied during the TLS handshake.

See Section 11.1.1 for additional information on client certificate authentication. See Section 13.3 for port registration information.

4.2. Implicit TLS for IMAP

When a TCP connection is established for the "imaps" service (default port 993), a TLS handshake begins immediately. Clients MUST implement the certificate validation mechanism described in [RFC3501] and SHOULD implement the certificate validation mechanism described in [RFC7817]. Once the TLS session is established, IMAP [RFC3501] protocol messages are exchanged as TLS application data for the remainder of the TCP connection. If client credentials were provided during the TLS handshake that the server finds acceptable, the server MAY issue a PREAUTH greeting in which case both the server and client enter AUTHENTICATED state. If the server issues an OK greeting then both server and client enter NOT AUTHENTICATED state.

See Section 11.1.1 for additional information on client certificate authentication. See Section 13.4 for port registration information.

4.3. Implicit TLS for SMTP Submission

When a TCP connection is established for the "submissions" service (default port 465), a TLS handshake begins immediately. Clients MUST implement the certificate validation mechanism described in [RFC7817]. Once a TLS session is established, message submission protocol data [RFC6409] is exchanged as TLS application data for the remainder of the TCP connection. (Note: the "submissions" service

name is defined in section 10.3 of this document, and follows the usual convention that the name of a service layered on top of Implicit TLS consists of the name of the service as used without TLS, with an "s" appended.)

The STARTTLS mechanism on port 587 is relatively widely deployed due to the situation with port 465 (discussed in Section 13.5). This differs from IMAP and POP services where implicit TLS is more widely deployed on servers than STARTTLS. It is desirable to migrate core protocols used by MUA software to implicit TLS over time for consistency as well as the additional reasons discussed in Appendix A. However, to maximize use of encryption for submission it is desirable to support both mechanisms for Message Submission over TLS for a transition period of several years. As a result, clients and servers SHOULD implement both STARTTLS on port 587 and implicit TLS on port 465 for this transition period. Note that there is no significant difference between the security properties of STARTTLS on port 587 and implicit TLS on port 465 if the implementations are correct and both client and server are configured to require successful negotiation of TLS prior to message submission (as required in Section 11.1).

Note that the submissions port provides access to a Mail Submission Agent (MSA) as defined in [RFC6409] so requirements and recommendations for MSAs in that document apply to the submissions port, including the requirement to implement SMTP AUTH [RFC4954].

See Section 11.1.1 for additional information on client certificate authentication. See Section 13.5 for port registration information.

4.4. Implicit TLS Connection Closure for POP, IMAP and SMTP

When a client or server wishes to close the connection, it SHOULD initiate the exchange of TLS close alerts before TCP connection termination. The client MAY, after sending a TLS close alert, gracefully close the TCP connection without waiting for a TLS response from the server.

5. Email Security Upgrading Using Security Directives

Once an improved email security mechanism is deployed and ready for general use, it is desirable to continue using it for all future email service. For example, TLS is widely deployed in email software, but use of TLS is often not required. At the time this is written, deployed mail user agents (MUAs) [RFC5598] usually make a determination if TLS is available when an account is first configured and may require use of TLS with that account if and only if it was initially available. If the service provider makes TLS available

after initial client configuration, many MUAs will not notice the change.

Alternatively, a security feature may be purely opportunistic and thus subject to downgrade attacks. For example, at the time this was written, most TLS stacks that support TLS 1.2 will use an older TLS version if the peer does not support TLS 1.2 and many do so without alerting the user of the reduced security. Thus a variety of active attacks could cause the loss of TLS 1.2 benefits. Only if client policy is upgraded to require TLS 1.2 can the client prevent all downgrade attacks. However, this sort of security policy upgrade will be ignored by most users unless it is automated.

This section describes a mechanism, called "security directives", which is designed to permit an MUA to recognize when a service provider has committed to provide certain server security features, and that it's safe for the client to change its configuration for that account to require that such features be present in future sessions with that server. Once the client has changed the configuration for a mail service to require specific server security features, those features are said to be "latched".

Note that security directives are a separate mechanism from minimum confidentiality assurance levels. A connection between a client and a service MUST meet the requirements of both the minimum confidentiality assurance level associated with the account, and the conditions of any security directives established for that service. Otherwise the client MUST abandon the connection. When an MUA implements both minimum confidentiality assurance levels and security directives, then both the end-user and the service provider independently have the ability to improve the end-user's confidentiality.

A security directive has the following formal syntax:

```
  directive       =  directive-name [ "=" directive-value ]

  directive-name  =  token

  directive-value =  token

  token           =  <As defined in RFC 7230>
```

This is a subset of the syntax used by HSTS [RFC6797] as revised in [RFC7230]; but simplified for use by protocols other than HTTP.

6. Server Strict Transport Security Policy

Servers supporting this extension MUST advertise an STS policy. This includes a list of security directives the server administrator has explicitly configured as recommended for use by clients (the list MAY be empty). When a server advertises a security directive associated with a security facility, it is making a commitment to support that facility (or a revised version of that facility) indefinitely and recommending that the client save that directive with the account configuration and require that security facility for future connections to that server.

Server STS policy may also include a "sts-url" directive with a value containing an https Uniform Resource Locator (URL) [RFC2818] that the client can save and subsequently resolve for the user in the event of a security connection problem. Server STS policy has the following formal syntax:

```
sts-policy        =  [directive *(";" [SP] directive)]
```

Protocol extensions to advertise STS policy for email servers are defined in Section 9.

The IANA Considerations Section 13 defines a registry so that more directives can be defined in the future. Three initial directives are defined for use by MUAs in Section 13.2: tls-version, sts-url, and tls-cert.

7. Client Storage of Email Security Directives

Before a client can consider storing any security directives, it MUST verify that the connection to the server uses TLS, the server has been authenticated, and any requirements for any previously saved security directives are met. Then the client performs the following steps for each security directive in the STS policy:

1. If the security directive name is not known to the client, skip to the next directive.

2. If the security directive is already saved with the same value (or a value considered greater than the current value in the directive's definition), the client skips the security directive and moves on to the next one.

3. The client verifies the connection meets the requirements of the security directive. If the connection does not, then the directive will not be saved. For example, a security directive claiming that the server supports tls-version 1.2 will not be

saved by a client if the currently negotiated TLS session is using TLS 1.1.

4. If previous steps pass, the client SHOULD update the current account configuration to save the security directive.

Once a security directive is saved, all subsequent connections to that host require any associated security feature. For this confidentiality protection to work as desired clients MUST NOT offer a click-through-to-connect action when unable to achieve connection security matching the saved security directives.

7.1. Security Directive Upgrade Example

Suppose a server advertises the "tls-version" directive name with value "1.1". A client that successfully negotiates either TLS 1.1 or TLS 1.2 SHOULD save this directive. The server may subsequently change the value to "1.2". When a client with "1.1" saved value connects and negotiates TLS 1.2, it will upgrade the saved directive value to "1.2". However, a client that only supports TLS 1.1 will continue to require use of TLS 1.1 and work with that server as long as it permits TLS 1.1. This way individual clients can require the newer/stronger protocol (e.g., TLS 1.2), while older clients can continue to communicate securely (albeit potentially less so) using the older protocol.

7.2. Security Policy Failures

When a security directive has been saved for connections from a client to a server and the facility identified by that directive is no longer available, this results in a connection failure. An MUA SHOULD inform the user of a potential threat to their confidentiality and offer to resolve a previously-recorded sts-url https URL if one is available. MUAs are discouraged from offering a lightweight option to reset or ignore directives as this defeats the benefit they provide to end users.

8. Recording TLS Cipher Suite in Received Header

The ESMTPS transmission type [RFC3848] provides trace information that can indicate TLS was used when transferring mail. However, TLS usage by itself is not a guarantee of confidentiality or security. The TLS cipher suite provides additional information about the level of security made available for a connection. This defines a new SMTP "tls" Received header additional-registered-clause that is used to record the TLS cipher suite that was negotiated for the connection. The value included in this additional clause SHOULD be the registered cipher suite name (e.g., TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256)

included in the TLS cipher suite registry. In the event the implementation does not know the name of the cipher suite (a situation that should be remedied promptly), a four-digit hexadecimal cipher suite identifier MAY be used. The ABNF for the field follows:

```
tls-cipher-clause  =  CFWS "tls" FWS tls-cipher

tls-cipher         =  tls-cipher-suite-name / tls-cipher-suite-hex

tls-cipher-name    =  ALPHA *(ALPHA / DIGIT / "_")
                      ; as registered in IANA cipher suite registry

tls-cipher-hex     =  "0x" 4HEXDIG
```

9. Extensions for STS Policy and Reporting

This memo defines optional mechanisms for use by MUAs to communicate saved STS policy to servers and for servers to advertise policy. One purpose of such mechanisms is to permit servers to determine which and how many clients have saved security directives, and thus, to permit operators to be aware of potential impact to their users should support for such facilities be changed. For IMAP, the existing ID command is extended to provide this capability. For SMTP Submission, a new CLIENT command is defined. No similar mechanism is defined for POP in this version of the memo to keep POP simpler, but one may be added in the future if deemed necessary.

In addition, for each of IMAP, POP, and SMTP, a new STS capability is defined so the client can access the server's STS policy.

9.1. IMAP STS Extension

When an IMAP server advertises the STS capability, that indicates the IMAP server implements IMAP4 ID [RFC2971] with additional field values defined here. This is grouped with the ID command because that is the existing IMAP mechanism for clients to report data for server logging, and provides a way for the server to report the STS policy.

sts From server to client, the argument to this ID field is the server STS policy. Servers MUST provide this information in response to an ID command.

saved From client to server, this is a list of security directives the client has saved for this server (the client MAY omit the value for the sts-url directive in this context). Servers MAY record this information so administrators know the expected security properties of the client and can thus act to avoid

security policy failures (e.g., by renewing server certificates on time, etc).

policy-fail From client to server, a list including one or more security directives the client has saved that the client was unable to achieve. This allows clients to report errors to the server prior to terminating the connection in the event an acceptable security level is unavailable.

directives From client to server, this is a list of security directive names the client supports that are not saved.

tls Server-side IMAP proxies that accept TLS connections from clients and connect in-the-clear over a fully private secure network to the server SHOULD use this field to report the tls-cipher (syntax as defined in Section 8) to the server.

IMAP clients SHOULD use the IMAP ID command to report policy failures and determine the server STS policy. Clients MAY use the ID command to report other security directive information. IMAP servers MUST implement the ID command at least to report STS policy to clients.

```
<client connected to port 993 and negotiated TLS successfully>
S: * OK [CAPABILITY IMAP4rev1 STS ID AUTH=PLAIN
        AUTH=SCRAM-SHA-1] hello
C: a001 ID ("name" "Demo Mail" "version" "1.5" "saved"
        "tls-version=1.1; tls-cert"
        "directives" "tls-version=1.2")
S: * ID ("name" "Demo Server" "version" "1.7" "sts-policy"
         "tls-version=1.1; tls-cert;
         sts-url=https://www.example.com/security-support.html")
S: a001 OK ID completed
```

Example 1

This example shows a client that successfully negotiated TLS version 1.1 or later and verified the server's certificate as required by IMAP. Even if the client successfully validates the server certificate, it will not require tls-version 1.2 in the future as the server does not advertise that version as policy. The client has not yet saved an STS URL, but if the client successfully validated the server certificate, it will save the provided URL.

```
  <client connected to port 993 and negotiated TLS successfully>
  S: * OK [CAPABILITY IMAP4rev1 DEEP ID AUTH=PLAIN
          AUTH=SCRAM-SHA-1] hello
  C: a001 ID ("name" "Demo Mail" "version" "1.5" "policy-failure"
          "tls-cert=pkix")
  S: * ID ("name" "Demo Server" "version" "1.7" "sts-policy"
           "tls-version=1.1;
            sts-url=<https://www.example.com/security-support.html>")
  S: a001 OK ID completed
  C: a002 LOGOUT
```

Example 2

This example shows a client that negotiated TLS, but was unable to verify the server's certificate using PKIX. The policy-failure informs the server of this problem, at which point the client can disconnect. If the client had previously saved the sts-url security directive from this server, it could offer to resolve that URI. However, the sts-policy in this exchange is ignored due to the failure to meet the conditions of the tls-version security directive.

```
  <IMAP Proxy connected over private network on port 143, there is
  a client connected to the proxy on port 993 that negotiated TLS>
  S: * OK [CAPABILITY IMAP4rev1 DEEP ID AUTH=PLAIN
          AUTH=SCRAM-SHA-1] hello
  C: a001 ID ("name" "Demo Mail" "version" "1.5" "saved"
          "tls-version=1.1; tls-cert=pkix"
          "tls" "TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256")
  S: * ID ("name" "Demo Server" "version" "1.7" "sts-policy"
           "tls-version=1.1; tls-cert=pkix;
           sts-url=https://www.example.com/support.html")
  S: a001 OK ID completed
```

Example 3

This example shows the connection from an IMAP proxy to a back-end server. The client connected to the proxy and sent the ID command shown in example 1, and the proxy has added the "tls" item to the ID command so the back-end server can log the cipher suite that was used on the connection from the client.

9.2. POP DEEP Extension

POP servers supporting this specification MUST implement the POP3 extension mechanism [RFC2449]. POP servers MUST advertise the DEEP capability with an argument indicating the server's DEEP status. (Note: DEEP is an ancronym for the original name of this

specification, before the terms were changed to align better with those used in HSTS.)

```
<client connected to port 995 and negotiated TLS successfully>
S: +OK POP server ready
C: CAPA
S: +OK Capability list follows
S: TOP
S: SASL PLAIN SCRAM-SHA-1
S: RESP-CODES
S: PIPELINING
S: UIDL
S: STS tls-version=1.2
   sts-url=<https://www.example.com/security-support.html>
S: .
```

Example 4

After verifying the TLS server certificate and issuing CAPA, the client can save any or all of the STS policy. If the client connects to this same server later and has a security failure, the client can direct the user's browser to the previously-saved URL where the service provider can provide advice to the end user.

9.3. SMTP MSTS Extension

SMTP Submission servers supporting this specification MUST implement the MSTS SMTP extension. The name of this extension is MSTS. The EHLO keyword value is MSTS and the sts-policy ABNF is the syntax of the EHLO keyword parameters. This does not add parameters to the MAIL FROM or RCPT TO commands. This also adds a CLIENT command to SMTP which is used to report client information to the server. The formal syntax for the command follows:

```
   deep-cmd            = "CLIENT" 1*(SP deep-parameter)

   deep-parameter      = name / version / policy-fail
                       / directives / tls / future-extension

   name                = "name" SP esmtp-value

   version             = "version" SP esmtp-value

   saved               = "saved" SP directive-list

   policy-fail         = "policy-fail" SP directive-list

   directive-list      = DQUOTE [directive
                       *(";" [SP] directive)] DQUOTE

   directives          = "directives" SP directive-list

   tls                 = "tls" SP tls-cipher

   future-extension    = Atom SP String

   Atom                = <as defined in RFC 5321>

   String              = <as defined in RFC 5321>
```

The CLIENT command parameters listed here have the same meaning as the parameters used in the IMAP STS extension (Section 9.1). The server responds to the CLIENT command with a "250" if the command has correct syntax and a "501" if the command has incorrect syntax.

```
<client connected to port 465 and negotiated TLS successfully>
S: 220 example.com Demo SMTP Submission Server
C: EHLO client.example.com
S: 250-example.com
S: 250-8BITMIME
S: 250-PIPELINING
S: 250-DSN
S: 250-AUTH PLAIN LOGIN
S: 250-MSTS tls-version=1.2; tls-cert;
   sts-url=<https://www.example.com/status.html>
S: 250-BURL imap
S: 250 SIZE 0
C: CLIENT name demo_submit version 1.5 saved "tls-version=1.1;
   tls-cert=pkix+dane" directives "tls-version=1.2"
S: 250 OK
```

Example 5

10. Account Setup Considerations

10.1. Use of SRV records in Establishing Configuration

This section updates [RFC6186] by changing the preference rules and adding a new SRV service label _submissions._tcp to refer to Message Submission with implicit TLS.

User-configurable MUAs SHOULD support use of [RFC6186] for account setup. However, when using configuration information obtained by this method, MUAs SHOULD default to a minimum confidentiality assurance level of 1, unless the user has explicitly requested reduced confidentiality. This will have the effect of causing the MUA to ignore advertised configurations that do not support TLS, even when those advertised configurations have a higher priority than other advertised configurations.

When using [RFC6186] configuration information, Mail User Agents SHOULD NOT automatically establish new configurations that do not require TLS for all servers, unless there are no advertised configurations using TLS. If such a configuration is chosen, prior to attempting to authenticate to the server or use the server for message submission, the MUA SHOULD warn the user that traffic to that server will not be encrypted and that it will therefore likely be intercepted by unauthorized parties. The specific wording is to be determined by the implementation, but it should adequately capture the sense of risk given the widespread incidence of mass surveillance of email traffic.

When establishing a new configuration for connecting to an IMAP, POP, or SMTP Submission server, an MUA SHOULD NOT blindly trust SRV records unless they are signed by DNSSEC and have a valid signature. Instead, the MUA SHOULD warn the user that the DNS-advertised mechanism for connecting to the server is not authenticated, and request the user to manually verify the connection details by reference to his or her mail service provider's documentation.

Similarly, an MUA MUST NOT consult SRV records to determine which servers to use on every connection attempt, unless those SRV records are signed by DNSSEC and have a valid signature. However, an MUA MAY consult SRV records from time to time to determine if an MSP's server configuration has changed, and alert the user if it appears that this has happened. This can also serve as a means to encourage users to upgrade their configurations to require TLS if and when their MSPs support it.

10.2. Certificate Pinning

During account setup, the MUA will identify servers that provide account services such as mail access and mail submission (the previous section describes one way to do this). The certificates for these servers are verified using the rules described in [RFC7817] and PKIX [RFC5280]. In the event the certificate does not validate due to an expired certificate, lack of appropriate chain of trust or lack of identifier match, the MUA MAY create a persistent binding between that certificate and the saved host name for the server. This is called certificate pinning. Certificate pinning is only appropriate during account setup and MUST NOT be offered in response to a failed certificate validation for an existing account. An MUA that allows certificate pinning MUST NOT allow a certificate pinned for one account to validate connections for other accounts.

A pinned certificate is subject to a man-in-the-middle attack at account setup time, and lacks a mechanism to revoke or securely refresh the certificate. Therefore use of a pinned certificate does not meet the requirement for a minimum confidentiality assurance level of 1, and an MUA MUST NOT indicate a confidentiality assurance level of 1 for an account or connection using a pinned certificate. Additional advice on certificate pinning is present in [RFC6125].

11. Implementation Requirements

This section details requirements for implementations of electronic mail protocol clients and servers. A requirement for a client or server implementation to support a particular feature is not the same thing as a requirement that a client or server running a conforming implementation be configured to use that feature. Requirements for Mail Service Providers (MSPs) are distinct from requirements for protocol implementations, and are listed in a separate section.

11.1. All Implementations (Client and Server)

These requirements apply to MUAs as well as POP, IMAP and SMTP Submission servers.

- All implementations MUST implement TLS 1.2 or later, and be configurable to support implicit TLS using the TLS 1.2 protocol or later [RFC5246].

- All implementations MUST implement the recommended cipher suites described in [RFC7525] or a future BCP or standards track revision of that document.

- All implementations MUST be configurable to require TLS before performing any operation other than capability discovery and STARTTLS.

- The IMAP specification [RFC3501] is hereby modified to revoke the second paragraph of section 11.1 and replace it with the text from the first three bullet items in this list. See Appendix B of [RFC7817] to see additional modifications to IMAP certificate validation rules.

- The standard for use of TLS with IMAP, POP3 and ACAP [RFC2595] is modified to revoke section 2.1 and replace it with the text from the first three bullet items in this list. See Appendix B of [RFC7817] to see additional modifications to RFC 2595 certificate validation rules.

- The standard for Message Submission [RFC6409] is updated to add the first three bullet items above to section 4.3 as well as to require implementation of the TLS server identity check as described in [RFC7817] and PKIX [RFC5280].

11.1.1. Client Certificate Authentication

MUAs and mail servers MAY implement client certificate authentication on the implicit TLS port. Servers MUST NOT request a client certificate during the TLS handshake unless the server is configured to accept some client certificates as sufficient for authentication and the server has the ability to determine a mail server authorization identity matching such certificates. How to make this determination is presently implementation specific. Clients MUST NOT provide a client certificate during the TLS handshake unless the server requests one and the client has determined the certificate can be safely used with that specific server, OR the client has been explicitly configured by the user to use that particular certificate with that server. How to make this determination is presently implementation specific. If the server accepts the client's certificate as sufficient for authorization, it MUST enable the SASL EXTERNAL [RFC4422] mechanism. An IMAPS server MAY issue a PREAUTH greeting instead of enabling SASL EXTERNAL. A client supporting client certificate authentication with implicit TLS MUST implement the SASL EXTERNAL [RFC4422] mechanism using the appropriate authentication command (AUTH for POP3 [RFC5034], AUTH for SMTP Submission [RFC4954], AUTHENTICATE for IMAP [RFC3501]).

11.2. Mail Server Implementation Requirements

These requirements apply to servers that implement POP, IMAP or SMTP Submission.

- Servers MUST implement the appropriate STS Policy and Reporting extensions described in Section 9

- IMAP and SMTP submission servers SHOULD implement and be configurable to support STARTTLS. This enables discovery of new TLS availability, and can increase usage of TLS by legacy clients.

- Servers MUST NOT advertise STARTTLS capability if it is unlikely to succeed based on server configuration (e.g., there is no server certificate installed).

- SMTP message submission servers that have negotiated TLS SHOULD add a Received header field to the message including the tls clause described in Section 8.

- Servers MUST be configurable to include the TLS cipher information in any connection or user logging or auditing facility they provide.

11.3. Mail User Agent Implementation Requirements

This section describes requirements on Mail User Agents (MUAs) using IMAP, POP, and/or Submission protocols. Note: Requirements pertaining to use of Submission servers are also applicable when using SMTP servers (e.g., port 25) for mail submission.

- User agents SHOULD indicate to users at configuration time, the minimum expected level of confidentiality based on appropriate security inputs such as which security directives are pre-set, the number of trust anchors, certificate validity, use of an extended validation certificate, TLS version supported, and TLS cipher suites supported by both server and client. This indication SHOULD also be present when editing or viewing account configuration.

- For any mail service not initially configured to require TLS, MUAs SHOULD detect when STARTTLS and/or implicit TLS becomes available for a protocol and set the tls-version security directive if the server advertises the tls-version=1.1 or higher security policy after a successful negotiation (including certificate validation) of TLS 1.1.

- Whenever requested to establish any configuration that does not require both TLS and server certificate verification to talk to a server or account, an MUA SHOULD warn its user that his or her mail traffic (including password, if applicable) will be exposed to attackers, and give the user an opportunity to abort the connection prior to transmission of any such password or traffic.

- MUAs SHOULD support the ability to save the "tls-version=1.2" security directive (the TLS library has to provide an API that controls permissible TLS versions, and communicates the negotiated TLS protocol version to the application, for this to be possible).

- See Section 3 for additional requirements.

11.4. Non-configurable MUAs and nonstandard access protocols

MUAs which are not configurable to use user-specified servers MUST implement TLS or similarly other strong encryption mechanism when communicating with their mail servers. This generally applies to MUAs that are pre-configured to operate with one or more specific services, whether or not supplied by the vendor of those services.

MUAs using protocols other than IMAP, POP, and Submission to communicate with mail servers, MUST implement TLS or other similarly robust encryption mechanism in conjunction with those protocols.

11.5. Compliance for Anti-Virus/Anti-Spam Software and Services

There are multiple ways to connect an Anti-Virus and/or Anti-Spam (AVAS) service to a mail server. Some mechanisms, such as the de-facto milter protocol, are out of scope for this specification. However, some services use an SMTP relay proxy that intercepts mail at the application layer to perform a scan and proxy or forward to another MTA. Deploying AVAS services in this way can cause many problems [RFC2979] including direct interference with this specification, and other forms of confidentiality or security reduction. An AVAS product or service is considered compliant with this specification if all IMAP, POP and SMTP-related software (including proxies) it includes are compliant with this specification, and each of these services advertise and support all security directives that the actual end-servers advertise.

Note that end-to-end email encryption prevents AVAS software and services from using email content as part of a spam or virus assessment. Furthermore, while a minimum confidentiality assurance level of 1 or better can prevent a man-in-the-middle from introducing spam or virus content between the MUA and Submission server, it does

not prevent other forms of client or account compromise. Use of AVAS services for submitted email therefore remains necessary.

12. Mail Service Provider Requirements

This section details requirements for providers of IMAP, POP, and/or SMTP submission services, for providers who claim to conform to this specification.

12.1. Server Requirements

Mail Service Providers MUST use server implementations that conform to this specification.

12.2. MSPs MUST provide Submission Servers

This document updates the advice in [RFC5068] by making Implicit TLS on port 465 the preferred submission port.

Mail Service Providers that accept mail submissions from end-users using the Internet Protocol MUST provide one or more SMTP Submission services, separate from the SMTP MTA services used to process incoming mail. Those submission services MUST be configured to support Implicit TLS on port 465 and SHOULD support STARTTLS if port 587 is used.

MSPs MAY also support submission of messages via one or more designated SMTP servers to facilitate compatibility with legacy MUAs.

Discussion: SMTP servers used to accept incoming mail or to relay mail are expected to accept mail in cleartext. This is incompatible with the purpose of this memo which is to encourage encryption of traffic between mail servers. There is no such requirement for mail submission servers to accept mail in cleartext or without authentication. For other reasons, use of separate SMTP submission servers has been best practice for many years.

12.3. TLS Server Certificate Requirements

MSPs MUST maintain valid server certificates for all servers. See [RFC7817] for the recommendations and requirements necessary to achieve this.

If a protocol server provides service for more than one mail domain, it MAY use a separate IP address for each domain and/or a server certificate that advertises multiple domains. This will generally be necessary unless and until it is acceptable to impose the constraint that the server and all clients support the Server Name Indication

extension to TLS [RFC6066]. For more discussion of this problem, see section 5.1 of [RFC7817].

12.4. Recommended DNS records for mail protocol servers

This section discusses not only the DNS records that are recommended, but also implications of DNS records for server configuration and TLS server certificates.

12.4.1. MX records

It is recommended that MSPs advertise MX records for handling of inbound mail (instead of relying entirely on A or AAAA records), and that those MX records be signed using DNSSEC. This is mentioned here only for completeness, as handling of inbound mail is out of scope for this document.

12.4.2. SRV records

MSPs SHOULD advertise SRV records to aid MUAs in determination of proper configuration of servers, per the instructions in [RFC6186].

MSPs SHOULD advertise servers that support Implicit TLS in preference to those which support cleartext and/or STARTTLS operation.

12.4.3. DNSSEC

All DNS records advertised by an MSP as a means of aiding clients in communicating with the MSP's servers, SHOULD be signed using DNSSEC.

12.4.4. TLSA records

MSPs SHOULD advertise TLSA records to provide an additional trust anchor for public keys used in TLS server certificates. However, TLSA records MUST NOT be advertised unless they are signed using DNSSEC.

12.5. MSP Server Monitoring

MSPs SHOULD regularly and frequently monitor their various servers to make sure that: TLS server certificates remain valid and are not about to expire, TLSA records match the public keys advertised in server certificates, are signed using DNSSEC, server configurations are consistent with SRV advertisements, and DNSSEC signatures are valid and verifiable. Failure to detect expired certificates and DNS configuration errors in a timely fashion can result in significant loss of service for an MSP's users and a significant support burden for the MSP.

12.6. Advertisement of STS policies

MSPs SHOULD advertise STS policies that include at least tls11, tls-cert and sts-url, with the latter having an associated https URL that can be used to inform clients of service outages or problems impacting client confidentiality. Note that advertising tls-cert is a commitment to maintain and renew server certificates. A MSP MAY also specifically indicate a commitment to support PKIX validation, DANE validation, or both, using tls-cert=pkix, tls-cert=dane, or tls-cert=pkix+dane, respectively.

12.7. Require TLS

New servers and services SHOULD be configured to require TLS unless it's necessary to support legacy clients or existing client configurations.

12.8. Changes to Internet Facing Servers

When an MSP changes the Internet Facing Servers providing mail access and mail submission services, including SMTP-based spam/virus filters, it is generally necessary to support the same and/or a newer version of TLS and the same security directives that were previously advertised.

13. IANA Considerations

13.1. Security Directive Registry

IANA shall create (has created) the registry "STS Security Directives". This registry is a single table and will use an expert review process [RFC5226]. Each registration will contain the following fields:

Name: The name of the security directive. This follows the directive-name ABNF.

Value: The permitted values of the security directive. This should also explain if the value is optional or mandatory and what to do if the value is not recognized.

Description: This describes the meaning of the security directive and the conditions under which the directive is saved.

Scope: The protocols to which this security directive applies. Presently this may be MSTS (for MUA STS), HSTS (for HTTP STS), or ALL.

Intended Usage: One of COMMON, LIMITED USE or OBSOLETE.

Reference: Optional reference to specification.

Submitter: The identify of the submitter or submitters.

Change Controller: The identity of the change controller for the registration. This will be "IESG" in case of registrations in IETF-produced documents.

The expert reviewer will verify the directive name follows the ABNF, and that the value and description fields are clear, unambiguous, do not overlap existing deployed technology, do not create security problems and appropriately considers interoperability issues. Email security directives intended for LIMITED USE have a lower review bar (interoperability and overlap issues are less of a concern). The reviewer may approve a registration, reject for a stated reason or recommend the proposal have standards track review due to importance or difficult subtleties.

Standards-track registrations may be updated if the relevant standards are updated as a consequence of that action. Non-standards-track entries may be updated by the listed change controller. The entry's name and submitter may not be changed. In exceptional cases, any aspect of any registered entity may be updated at the direction of the IESG (for example, to correct a conflict).

13.2. Initial Set of Security Directives

This document defines three initial security directives for the registry as follows, and registers the two additional directives specified in [RFC6797].

Name: tls-version

Value: Mandatory; 1.1 refers to [RFC4346] or later and 1.2 refers to [RFC5246] or later. Future versions may be added; this is ignored if the version is unrecognized.

Description: This directive indicates that the TLS version negotiated must be the specified version or later. In the event this directive is saved and only an older TLS version is available, that results in STS policy failure.

Scope: MUA only

Intended Usage: COMMON

Reference: RFC XXXX (this document once published)

Submitter: Authors of this document

Change Controller: IESG

Name: tls-cert

Value: Optional; pkix refers to PKIX certificate validation; dane refers to DANE certificate validation; pkix+dane refers to use of both PKIX and DANE validation; any refers to any validation method the client considers acceptable. If no value is supplied, "any" is assumed.

Description: This directive indicates that TLS was successfully negotiated and the server certificate was successfully verified by the client [RFC5280] and the server certificate identity was verified using the algorithm appropriate for the protocol (see Section 4). This directive is saved if the client sees this in the advertised server STS policy after successfully negotiating TLS and verifying the certificate and server identity using a means consistent with the associated (or implied) value. Note that an advertisement of either tls-cert=pkix or tls-cert=pkix+dane in a server's STS policy indicates that the server commits to using certificates that are verifiable using PKIX in the future, but tls-cert=pkix implies no commitment regarding DANE support. Similarly, an advertisement of either tls-cert=dane or tls-cert=pkix+dane indicates that the server commits to using certificates that are verifiable using DANE in the future, but tls-cert=dane implies no commitment regarding PKIX support. An advertisement of tls-cert or tls-cert=any indicates only that the server will continue to provide valid server certificates, but makes no commitment about the means of verifiability. (For the HSTS protocol, the presence of a Strict-Transport-Security response header serves as an indication that the certificate should be valid, so the tls-cert directive is never specified in that protocol.)

Scope: MUA only

Intended Usage: COMMON

Reference: RFC XXXX (this document once published)

Submitter: Authors of this document

Change Controller: IESG

Name: sts-url

Value: Mandatory for server-policy, optional for client reporting. The value is an https URL.

Description: This directive indicates that the client SHOULD resolve (with appropriate certificate validation) and display the URL in the event of a policy failure.

Scope: MUA only

Intended Usage: COMMON

Reference: RFC XXXX (this document once published)

Submitter: Authors of this document

Change Controller: IESG

Name: max-age

Value: see [RFC6797].

Description: see [RFC6797].

Scope: HSTS only

Intended Usage: COMMON

Reference: [RFC6797]

Submitter: Authors of this document

Change Controller: IESG

Name: includeSubDomains

Value: None

Description: see [RFC6797].

Scope: HSTS only

Intended Usage: COMMON

Reference: [RFC6797]

Submitter: Authors of this document

Change Controller: IESG

13.3. POP3S Port Registration Update

IANA is asked to update the registration of the TCP well-known port 995 using the following template ([RFC6335]):

Service Name: pop3s
Transport Protocol: TCP
Assignee: IETF <iesg@ietf.org>
Contact: IESG <iesg@ietf.org>
Description: POP3 over TLS protocol
Reference: RFC XXXX (this document once published)
Port Number: 995

13.4. IMAPS Port Registration Update

IANA is asked to update the registration of the TCP well-known port 993 using the following template ([RFC6335]):

Service Name: imaps
Transport Protocol: TCP
Assignee: IETF <iesg@ietf.org>
Contact: IESG <iesg@ietf.org>
Description: IMAP over TLS protocol
Reference: RFC XXXX (this document once published)
Port Number: 993

13.5. Submissions Port Registration

IANA is asked to assign an alternate usage of port 465 in addition to the current assignment using the following template ([RFC6335]):

Service Name: submissions
Transport Protocol: TCP
Assignee: IETF <iesg@ietf.org>
Contact: IESG <iesg@ietf.org>
Description: Message Submission over TLS protocol
Reference: RFC XXXX (this document once published)
Port Number: 465

This is a one time procedural exception to the rules in RFC 6335. This requires explicit IESG approval and does not set a precedent. Historically, port 465 was briefly registered as the "smtps" port. This registration made no sense as the SMTP transport MX infrastructure has no way to specify a port so port 25 is always used. As a result, the registration was revoked and was subsequently reassigned to a different service. In hindsight, the "smtps"

registration should have been renamed or reserved rather than revoked. Unfortunately, some widely deployed mail software interpreted "smtps" as "submissions" [RFC6409] and used that port for email submission by default when an end-user requests security during account setup. If a new port is assigned for the submissions service, email software will either continue with unregistered use of port 465 (leaving the port registry inaccurate relative to de-facto practice and wasting a well-known port), or confusion between the de-facto and registered ports will cause harmful interoperability problems that will deter use of TLS for message submission. The authors believe both of these outcomes are less desirable than a wart in the registry documenting real-world usage of a port for two purposes. Although STARTTLS-on-port-587 has deployed, it has not replaced deployed use of implicit TLS submission on port 465.

13.6. STS IMAP Capability

This document adds the STS capability to the IMAP capabilities registry. This is described in Section 9.1.

13.7. STS POP3 Capability

This document adds the STS capability to the POP3 capabilities registry.

CAPA Tag: STS

Arguments: sts-policy

Added Commands: none

Standard Commands affected: none

Announced status / possible differences: both / may change after STLS

Commands Valid in States: N/A

Specification Reference: This document

Discussion: See Section 9.2.

13.8. MSTS SMTP EHLO Keyword

This document adds the MSTS EHLO Keyword to the SMTP Service Extension registry. This is described in Section 9.3.

13.9. MAIL Parameters Additional-registered-clauses Sub-Registry

This document adds the following entry to the "Additional-registered-clauses" sub-registry of the "MAIL Parameters" registry, created by [RFC5321]:

Clause Name: tls

Description: Indicates the TLS cipher suite used for a transport connection.

Syntax Summary: See tls-cipher ABNF Section 8

Reference: This document.

14. Security Considerations

This entire document is about security considerations. In general, this is targeted to improve mail confidentiality and to mitigate threats external to the email system such as network-level snooping or interception; this is not intended to mitigate active attackers who have compromised service provider systems.

It could be argued that sharing the name and version of the client software with the server has privacy implications. Although providing this information is not required, it is encouraged so that mail service providers can more effectively inform end-users running old clients that they need to upgrade to protect their security, or know which clients to use in a test deployment prior to upgrading a server to have higher security requirements.

15. References

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Appendix A. Design Considerations

This section is not normative.

The first version of this was written independently from draft-moore-email-tls-00.txt; subsequent versions merge ideas from both drafts.

One author of this document was also the author of RFC 2595 that became the standard for TLS usage with POP and IMAP, and the other author was perhaps the first to propose that idea. In hindsight both authors now believe that that approach was a mistake. At this point the authors believe that while anything that makes it easier to deploy TLS is good, the desirable end state is that these protocols always use TLS, leaving no need for a separate port for cleartext operation except to support legacy clients while they continue to be used. The separate port model for TLS is inherently simpler to implement, debug and deploy. It also enables a "generic TLS load-balancer" that accepts secure client connections for arbitrary foo-over-TLS protocols and forwards them to a server that may or may not support TLS. Such load-balancers cause many problems because they violate the end-to-end principle and the server loses the ability to log security-relevant information about the client unless the protocol is designed to forward that information (as this specification does for the cipher suite). However, they can result in TLS deployment where it would not otherwise happen which is a sufficiently important goal that it overrides the problems.

Although STARTTLS appears only slightly more complex than separate-port TLS, we again learned the lesson that complexity is the enemy of

security in the form of the STARTTLS command injection vulnerability (CERT vulnerability ID #555316). Although there's nothing inherently wrong with STARTTLS, the fact it resulted in a common implementation error (made independently by multiple implementers) suggests it is a less secure architecture than Implicit TLS.

Section 7 of RFC 2595 critiques the separate-port approach to TLS. The first bullet was a correct critique. There are proposals in the http community to address that, and use of SRV records as described in RFC 6186 resolves that critique for email. The second bullet is correct as well, but not very important because useful deployment of security layers other than TLS in email is small enough to be effectively irrelevant. The third bullet is incorrect because it misses the desirable option of "use and latch-on TLS if available". The fourth bullet may be correct, but is not a problem yet with current port consumption rates. The fundamental error was prioritizing a perceived better design based on a mostly valid critique over real-world deployability. But getting security and confidentiality facilities actually deployed is so important it should trump design purity considerations.

Port 465 is presently used for two purposes: for submissions by a large number of clients and service providers and for the "urd" protocol by one vendor. Actually documenting this current state is controversial as discussed in the IANA considerations section. However, there is no good alternative. Registering a new port for submissions when port 465 is widely used for that purpose already will just create interoperability problems. Registering a port that's only used if advertised by an SRV record (RFC 6186) would not create interoperability problems but would require all client and server deployments and software to change significantly which is contrary to the goal of promoting more TLS use. Encouraging use of STARTTLS on port 587 would not create interoperability problems, but is unlikely to have impact on current undocumented use of port 465 and makes the guidance in this document less consistent. The remaining option is to document the current state of the world and support future use of port 465 for submission as this increases consistency and ease-of-deployment for TLS email submission.

Appendix B. Change Log

Changes since draft-ietf-uta-email-deep-05:

- Clarify throughout that the confidentiality assurance level associated with a mail account is a minimum level; attempt to distinguish this from the current confidentiality level provided by a connection between client and server.

- Change naming for confidentiality assurance levels: instead of "high" or "no" confidence, assign numbers 1 and 0 to them respectively. This because it seems likely that in the not-too-distant future, what was defined in -05 as "high" confidence will be considered insufficient, and calling that "high" confidence will become misleading. For example, relying entirely on a list of trusted CAs to validate server certificates from arbitrary parties, appears to be less and less reliable in practice at thwarting MITM attacks.

- Clarify that if some services associated with a mail account don't meet the minimium confidentiality assurance level assigned to that account, other services that do meet that minimum confidentiality assurance level may continue to be used.

- Clarify that successful negotiation of at least TLS version 1.1 is required as a condition of meeting confidentiality assurance level 1.

- Clarify that validation of a server certificate using either DANE or PKIX is sufficient to meet the certificate validation requirement of confidentiality assurance level 1.

- Clarify that minimum confidentiality assurance levels are separate from security directives, and that the requrements of both mechanisms must be met.

- Explicitly cite an example that a security directive of tls-version=1.2 won't be saved if the currently negotiated tls-version is 1.1. (This example already appeared a bit later in the text, but for author KM it seemed to make the mechanism clearer to use this example earlier.)

- Clarify some protocol examples as to whether PKIX or DANE was used to verify a server's certificate.

- Remove most references to DEEP as the conversion from DEEP to MUA-STS seemed incomplete, but kept the DEEP command for use in POP3 on the assumption that author CN wanted it that way.

- Removed most references to "latch" and derivative words.

- Added pkix+dane as a value for the tls-cert directive, to indicate (from a server) that both PKIX and DANE validation will be supported, or (from a client) that both PKIX and DANE were used to validate a certificate. Also clarified what each of any, pkix, dane, and pkix+dane mean when advertised by a server and in particular that tls-cert=any provides no assurance of future PKIX

verifiability in contrast to tls-cert=pkix or tls-cert=pkix+dane. It seemed important to support the ability to evolve to using multiple trust anchors for certificate validation, but also to allow servers to have the option to migrate from PKIX to DANE if that made sense for them. This change seemed less disruptive than either defining additional directives, or allowing multiple instances of the same directive with different values to appear in the same advertisement.

- Clarify interaction of this specification with anti-virus / anti-spam mechanisms.

Changes since draft-ietf-uta-email-deep-04:

- Swap sections 5.1 and 5.3 ("Email Security Tags" and "Server DEEP Status") as that order may aid understanding of the model. Also rewrote parts of these two sections to try to make the model clearer.

- Add text about versioning of security tags to make the model clearer.

- Add example of security tag upgrade.

- Convert remaining mention of TLS 1.0 to TLS 1.1.

- Change document title from DEEP to MUA STS to align with SMTP relay STS.

  * Slight updates to abstract and introductions.

  * Rename security latches/tags to security directives.

  * Rename server DEEP status to STS policy.

  * Change syntax to use directive-style HSTS syntax.

- Make HSTS reference normative.

- Remove SMTP DSN header as that belongs in SMTP relay STS document.

Changes since draft-ietf-uta-email-deep-03:

- Add more references to ietf-uta-email-tls-certs in implementation requirements section.

- Replace primary reference to RFC 6125 with ietf-uta-email-tls-certs, so move RFC 6125 to informative list for this specification.

Changes since draft-ietf-uta-email-deep-02:

- Make reference to design considerations explicit rather than "elsewhere in this document".

- Change provider requirement so SMTP submission services are separate from SMTP MTA services as opposed to the previous phrasing that required the servers be separate (which is too restrictive).

- Update DANE SMTP reference

Changes since draft-ietf-uta-email-deep-01:

- Change text in tls11 and tls12 registrations to clarify certificate rules, including additional PKIX and DANE references.

- Change from tls10 to tls11 (including reference) as the minimum.

- Fix typo in example 5.

- Remove open issues section; enough time has passed so not worth waiting for more input.

Changes since draft-ietf-uta-email-deep-00:

- Update and clarify abstract

- use term confidentiality instead of privacy in most cases.

- update open issues to request input for missing text.

- move certificate pinning sub-section to account setup section and attempt to define it more precisely.

- Add note about end-to-end encryption in AVAS section.

- swap order of DNSSEC and TLSA sub-sections.

- change meaning of 'tls10' and 'tls12' latches to require certificate validation.

- Replace cipher suite advice with reference to RFC 7525. Change examples to use TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256 as cipher suite.
- Add text to update IMAP, POP3 and Message Submission standards with newer TLS advice.
- Add clearer text in introduction that this does not cover SMTP relay.
- Update references to uta-tls-certs.
- Add paragraph to Implicit TLS for SMTP Submission section recommending that STARTTLS also be implemented.

Changes since draft-newman-email-deep-02:

- Changed "privacy assurance" to "confidentiality assurance"
- Changed "low privacy assurance" to "no confidentiality assurance"
- Attempt to improve definition of confidentiality assurance level.
- Add SHOULD indicate when MUA is showing list of mail accounts.
- Add SHOULD NOT latch tls10, tls12 tags until TLS negotiated.
- Removed sentence about deleting and re-creating the account in latch failure section.
- Remove use of word "fallback" with respect to TLS version negotiation.
- Added bullet about changes to Internet facing servers to MSP section.
- minor wording improvements based on feedback

Changes since -01:

- Updated abstract, introduction and document structure to focus more on mail user agent privacy assurance.
- Added email account privacy section, also moving section on account setup using SRV records to that section.
- Finished writing IANA considerations section

- Remove provisional concept and instead have server explicitly list security tags clients should latch.
- Added note that rules for the submissions port follow the same rules as those for the submit port.
- Reference and update advice in [RFC5068].
- Fixed typo in Client Certificate Authentication section.
- Removed tls-pfs security latch and all mention of perfect forward secrecy as it was controversial.
- Added reference to HSTS.

Changes since -00:

- Rewrote introduction to merge ideas from draft-moore-email-tls-00.
- Added Implicit TLS section, Account configuration section and IANA port registration updates based on draft-moore-email-tls-00.
- Add protocol details necessary to standardize implicit TLS for POP/IMAP/submission, using ideas from draft-melnikov-pop3-over-tls.
- Reduce initial set of security tags based on feedback.
- Add deep status concept to allow a window for software updates to be backed out before latches make that problematic, as well as to provide service providers with a mechanism they can use to assist customers in the event of a privacy failure.
- Add DNS SRV section from draft-moore-email-tls-00.
- Write most of the missing IANA considerations section.
- Rewrite most of implementation requirements section based more on draft-moore-email-tls-00. Remove new cipher requirements for now because those may be dealt with elsewhere.

Appendix C. Acknowledgements

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