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Pre-Shared Key Ciphersuites for Transport Layer Security (TLS)
draft-ietf-tls-psk-00.txt

Status of this Memo

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Abstract

This document specifies new ciphersuites for the Transport Layer Security (TLS) protocol to support authentication based on pre-shared keys. These pre-shared keys are symmetric keys, shared in advance among the communicating parties, and do not require any public key operations.

1. Introduction

Usually TLS uses public key certificates [TLS] or Kerberos [TLS-KRB] for authentication. This document describes how to use symmetric keys (later called pre-shared keys or PSKs), shared in advance among the communicating parties, to establish a TLS connection.

There are basically two reasons why one might want to do this:

- First, TLS may be used in performance-constrained environments where the CPU power needed for public key operations is not available.

- Second, pre-shared keys may be more convenient from a key management point of view. For instance, in closed environments where the connections are mostly configured manually in advance, it may be easier to configure a PSK than to use certificates. Another case is when the parties already have a mechanism for setting up a shared secret key, and that mechanism could be used to "bootstrap" a key for authenticating a TLS connection.

This document specifies a number of new ciphersuites for TLS. These ciphersuites use a new authentication and key exchange algorithm for PSKs, and re-use existing cipher and MAC algorithms from [TLS] and [TLS-AES].

1.1 Applicability statement

The ciphersuites defined in this document are intended for a rather limited set of applications, usually involving only a very small number of clients and servers. Even in such environments, other alternatives may be more appropriate.

If the main goal is to avoid PKIs, another possibility worth considering is to use self-signed certificates with public key fingerprints. Instead of manually configuring a shared secret in, for instance, some configuration file, a fingerprint (hash) of the other party's public key (or certificate) could be placed there instead.

It is also possible to use the SRP (Secure Remote Password) ciphersuites for shared secret authentication [TLS-SRP]. While SRP

protects against dictionary attacks, it requires more computational resources.

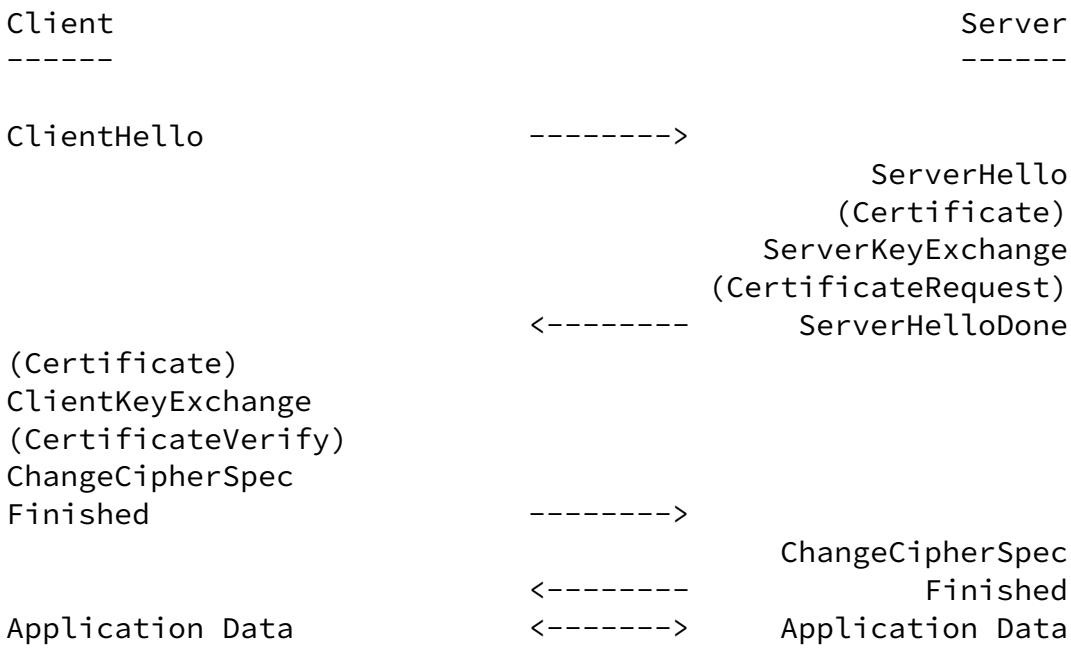
1.2 Conventions used in this document

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 [KEYWORDS].

2. Protocol

It is assumed that the reader is familiar with ordinary TLS handshake, shown below. The elements in parenthesis are not included in PSK-based ciphersuites.



The client indicates its willingness to use pre-shared key authentication by including one or more PSK-based ciphersuites in the ClientHello message. The following ciphersuites are defined in this document:

```
CipherSuite TLS_PSK_WITH_RC4_128_SHA        = { 0x00, 0xTBD };
CipherSuite TLS_PSK_WITH_3DES_EDE_CBC_SHA   = { 0x00, 0xTBD };
```

```
   CipherSuite TLS_PSK_WITH_AES_128_CBC_SHA    = { 0x00, 0xTBD };
   CipherSuite TLS_PSK_WITH_AES_256_CBC_SHA    = { 0x00, 0xTBD };
```

Note that this document defines only a new authentication and key exchange algorithm; see [TLS] and [TLS-AES] for description of the cipher and MAC algorithms.

If the TLS server also wants to use pre-shared keys, it selects one of the PSK ciphersuites, places the selected ciphersuite in the ServerHello message, and includes an appropriate ServerKeyExchange message (see below). The Certificate and CertificateRequest payloads are omitted from the response.

Both clients and servers may have pre-shared keys with several different parties. The client indicates which key to use by including a "PSK identity" in the ClientKeyExchange message (note that unlike in [TLS-SHAREDKEYS], the session_id field in ClientHello message keeps its usual meaning). To help the client in selecting which identity to use, the server can provide a "PSK identity hint" in the ServerKeyExchange message (note that if no hint is provided, a ServerKeyExchange message is still sent).

This document does not specify the format of the PSK identity or PSK identity hint; neither is specified how exactly the client uses the hint (if it uses it at all). The parties have to agree on the identities when the shared secret is configured (however, see Section 4 for related security considerations). In situations where the identity is entered by a person, it is RECOMMENDED that the input is processed using an appropriate stringprep [STRINGPREP] profile and encoded in octets using UTF-8 encoding [UTF8]. One possible stringprep profile is described in [SASLPREP].

The format of the ServerKeyExchange and ClientKeyExchange messages is shown below.

```
   struct {
       select (KeyExchangeAlgorithm) {
           case diffie_hellman:
               ServerDHParams params;
               Signature signed_params;
           case rsa:
```

```
                ServerRSAParams params;
                Signature signed_params;
            case psk:  /* NEW */
                opaque psk_identity_hint<0..2^16-1>;
        };
    } ServerKeyExchange;

    struct {
        select (KeyExchangeAlgorithm) {
            case rsa: EncryptedPreMasterSecret;
            case diffie_hellman: ClientDiffieHellmanPublic;
            case psk: opaque psk_identity<0..2^16-1>;  /* NEW */
        } exchange_keys;
    } ClientKeyExchange;
```

The premaster secret is formed as follows: concatenate 24 zero octets, followed by SHA-1 hash [FIPS180-2] of the PSK itself, followed by 4 zero octets.

> Note: This effectively means that only the HMAC-SHA1 part of the TLS PRF is used, and the HMAC-MD5 part is not used. See [Krawczyk20040113] for a more detailed rationale. The PSK is first hashed so that PSKs longer than 24 octets can be used; this is similar to what is done in [HMAC] if the key length is longer than the hash block size.

If the server does not recognize the PSK identity, it SHOULD respond with a decrypt_error alert message. This alert is also sent if validating the Finished message fails. The use of the same alert message makes it more difficult to find out which PSK identities are known to the server.

3. IANA considerations

This document does not define any new namespaces to be managed by IANA. It does require assignment of several new ciphersuite numbers, but it is unclear how this is done, since the TLS spec does not say who is responsible for assigning them :-)

4. Security Considerations

As with all schemes involving shared keys, special care should be taken to protect the shared values and to limit their exposure over time.

The ciphersuites defined in this document do not provide Perfect Forward Secrecy (PFS). That is, if the shared secret key is somehow compromised, an attacker can decrypt old conversations. (Note that the most popular TLS key exchange algorithm, RSA, does not provide PFS either.)

Use of a fixed shared secret of limited entropy (such as a password) allows an attacker to perform a brute-force or dictionary attack to recover the secret. This may be either an off-line attack (against a captured TLS conversation), or an on-line attack where the attacker attempts to connect to the server and tries different keys. An attacker can also get the information required for an off-line attack if a valid client attempts to connect with the attacker. It is RECOMMENDED that implementations that allow the administrator to manually configure the PSK also provide a functionality for generating a new random PSK, taking [RANDOMNESS] into account.

The PSK identity is sent in cleartext. While using a user name or other similar string as the PSK identity is the most straightforward option, it may lead to problems in some environments since an eavesdropper is able to identify the communicating parties. Even when the identity does not reveal any information itself, reusing the

same identity over time may eventually allow an attacker to perform traffic analysis to the identify parties. It should be noted that this is no worse than client certificates, since they are also sent in cleartext.

5. Acknowledgments

The protocol defined in this document is heavily based on work by Tim Dierks and Peter Gutmann, and borrows some text from [TLS-SHAREDKEYS] and [TLS-AES]. Valuable feedback was also provided by Philip Ginzboorg, Peter Gutmann, David Jablon, Nikos Mavroyanopoulos, Bodo Moeller, and Mika Tervonen.

When the first version of this draft was almost ready, the authors

learned that something similar had been proposed already in 1996 [TLS-PASSAUTH]. However, this draft is not intended for web password authentication, but rather for other uses of TLS.

6. References

6.1 Normative References

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6.2 Informative References

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Appendix A. Changelog

(This section should be removed by the RFC Editor before publication.)

Changes from draft-eronen-tls-psk-00 to draft-ietf-tls-psk-00:

- Updated dictionary attack considerations based on comments from David Jablon.
- Added a recommendation about using UTF-8 in the identity field.
- Removed Appendix A comparing this document with draft-ietf-tls-sharedkeys-02.
- Removed IPR comment about SPR.
- Minor editorial changes.

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Acknowledgment

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