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Pre-Shared Key Cipher Suites for TLS with SHA-256/384 and AES Galois Counter Mode

Status of This Memo

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Abstract

RFC 4279 and RFC 4785 describe pre-shared key cipher suites for Transport Layer Security (TLS). However, all those cipher suites use SHA-1 in their Message Authentication Code (MAC) algorithm. This document describes a set of pre-shared key cipher suites for TLS that uses stronger digest algorithms (i.e., SHA-256 or SHA-384) and another set that uses the Advanced Encryption Standard (AES) in Galois Counter Mode (GCM).

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1. Introduction

The benefits of pre-shared symmetric-key vs. public-/private-key pair based authentication for the key exchange in TLS have been explained in the Introduction of [RFC4279]. This document leverages the already defined algorithms for the application of newer, generally regarded stronger, cryptographic primitives and building blocks.

TLS 1.2 [RFC5246] adds support for authenticated encryption with additional data (AEAD) cipher modes [RFC5116]. This document describes the use of Advanced Encryption Standard [AES] in Galois Counter Mode [GCM] (AES-GCM) with various pre-shared key (PSK) authenticated key exchange mechanisms ([RFC4279] and [RFC4785]) in cipher suites for TLS.

This document also specifies PSK cipher suites for TLS that replace SHA-1 by SHA-256 or SHA-384 [SHS]. RFC 4279 [RFC4279] and RFC 4785 [RFC4785] describe PSK cipher suites for TLS. However, all of the RFC 4279 and the RFC 4785 cipher suites use HMAC-SHA1 as their MAC algorithm. Due to recent analytic work on SHA-1 [Wang05], the IETF is gradually moving away from SHA-1 and towards stronger hash algorithms.

Related TLS cipher suites with key exchange algorithms that are authenticated using public/private key pairs have recently been specified:

- RSA-, DSS-, and Diffie-Hellman-based cipher suites in [RFC5288], and

- ECC-based cipher suites with SHA-256/384 and AES-GCM in [RFC5289].

The reader is expected to become familiar with these two memos prior to studying this document.

1.1. Applicability Statement

The cipher suites defined in Section 3 can be negotiated, whatever the negotiated TLS version is.

The cipher suites defined in Section 2 can be negotiated in TLS version 1.2 or higher.

The applicability statement in [RFC4279] applies to this document as well.

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 [RFC2119].

2. PSK, DHE_PSK, and RSA_PSK Key Exchange Algorithms with AES-GCM

The following six cipher suites use the new authenticated encryption modes defined in TLS 1.2 with AES in Galois Counter Mode [GCM]. The cipher suites with the DHE_PSK key exchange algorithm (TLS_DHE_PSK_WITH_AES_128_GCM_SHA256 and TLS_DHE_PSK_WITH_AES_256_GCM_SHA348) provide Perfect Forward Secrecy (PFS).

```
CipherSuite TLS_PSK_WITH_AES_128_GCM_SHA256        = {0x00,0xA8};
CipherSuite TLS_PSK_WITH_AES_256_GCM_SHA384        = {0x00,0xA9};
CipherSuite TLS_DHE_PSK_WITH_AES_128_GCM_SHA256    = {0x00,0xAA};
CipherSuite TLS_DHE_PSK_WITH_AES_256_GCM_SHA384    = {0x00,0xAB};
CipherSuite TLS_RSA_PSK_WITH_AES_128_GCM_SHA256    = {0x00,0xAC};
CipherSuite TLS_RSA_PSK_WITH_AES_256_GCM_SHA384    = {0x00,0xAD};
```

These cipher suites use authenticated encryption with additional data (AEAD) algorithms, AEAD_AES_128_GCM and AEAD_AES_256_GCM, as described in RFC 5116. GCM is used as described in [RFC5288].

The PSK, DHE_PSK, and RSA_PSK key exchanges are performed as defined in [RFC4279].

The Pseudo-Random Function (PRF) algorithms SHALL be as follows:

- For cipher suites ending with _SHA256, the PRF is the TLS PRF [RFC5246] with SHA-256 as the hash function.

- For cipher suites ending with _SHA384, the PRF is the TLS PRF [RFC5246] with SHA-384 as the hash function.

Implementations MUST send a TLS Alert 'bad_record_mac' for all types of failures encountered in processing the AES-GCM algorithm.

3. PSK, DHE_PSK, and RSA_PSK Key Exchange with SHA-256/384

The first two cipher suites described in each of the following three sections use AES [AES] in Cipher Block Chaining (CBC) mode [MODES] for data confidentiality, whereas the other two cipher suites do not provide data confidentiality; all cipher suites provide integrity protection and authentication using HMAC-based MACs.

3.1. PSK Key Exchange Algorithm with SHA-256/384

```
CipherSuite TLS_PSK_WITH_AES_128_CBC_SHA256       = {0x00,0xAE};
CipherSuite TLS_PSK_WITH_AES_256_CBC_SHA384       = {0x00,0xAF};
CipherSuite TLS_PSK_WITH_NULL_SHA256              = {0x00,0xB0};
CipherSuite TLS_PSK_WITH_NULL_SHA384              = {0x00,0xB1};
```

The above four cipher suites are the same as the corresponding cipher suites in RFC 4279 and RFC 4785 (with names ending in "_SHA" in place of "_SHA256" or "_SHA384"), except for the hash and PRF algorithms, as explained below.

- For cipher suites with names ending in "_SHA256":

  - The MAC is HMAC [RFC2104] with SHA-256 as the hash function.

  - When negotiated in a version of TLS prior to 1.2, the PRF from that version is used; otherwise, the PRF is the TLS PRF [RFC5246] with SHA-256 as the hash function.

- For cipher suites with names ending in "_SHA384":

  - The MAC is HMAC [RFC2104] with SHA-384 as the hash function.

  - When negotiated in a version of TLS prior to 1.2, the PRF from that version is used; otherwise, the PRF is the TLS PRF [RFC5246] with SHA-384 as the hash function.

3.2. DHE_PSK Key Exchange Algorithm with SHA-256/384

```
CipherSuite TLS_DHE_PSK_WITH_AES_128_CBC_SHA256    = {0x00,0xB2};
CipherSuite TLS_DHE_PSK_WITH_AES_256_CBC_SHA384    = {0x00,0xB3};
CipherSuite TLS_DHE_PSK_WITH_NULL_SHA256           = {0x00,0xB4};
CipherSuite TLS_DHE_PSK_WITH_NULL_SHA384           = {0x00,0xB5};
```

The above four cipher suites are the same as the corresponding cipher suites in RFC 4279 and RFC 4785 (with names ending in "_SHA" in place of "_SHA256" or "_SHA384"), except for the hash and PRF algorithms, as explained in Section 3.1.

3.3. RSA_PSK Key Exchange Algorithm with SHA-256/384

```
CipherSuite TLS_RSA_PSK_WITH_AES_128_CBC_SHA256    = {0x00,0xB6};
CipherSuite TLS_RSA_PSK_WITH_AES_256_CBC_SHA384    = {0x00,0xB7};
CipherSuite TLS_RSA_PSK_WITH_NULL_SHA256           = {0x00,0xB8};
CipherSuite TLS_RSA_PSK_WITH_NULL_SHA384           = {0x00,0xB9};
```

The above four cipher suites are the same as the corresponding cipher suites in RFC 4279 and RFC 4785 (with names ending in "_SHA" in place of "_SHA256" or "_SHA384"), except for the hash and PRF algorithms, as explained in Section 3.1.

4. Security Considerations

The security considerations in [RFC4279], [RFC4785], and [RFC5288] apply to this document as well. In particular, as authentication-only cipher suites (with no encryption) defined here do not support confidentiality, care should be taken not to send sensitive information (such as passwords) over connections protected with one of the cipher suites with NULL encryption defined in this document.

5. IANA Considerations

IANA has assigned the following values for the cipher suites defined in this document:

```
CipherSuite TLS_PSK_WITH_AES_128_GCM_SHA256        = {0x00,0xA8};
CipherSuite TLS_PSK_WITH_AES_256_GCM_SHA384        = {0x00,0xA9};
CipherSuite TLS_DHE_PSK_WITH_AES_128_GCM_SHA256    = {0x00,0xAA};
CipherSuite TLS_DHE_PSK_WITH_AES_256_GCM_SHA384    = {0x00,0xAB};
CipherSuite TLS_RSA_PSK_WITH_AES_128_GCM_SHA256    = {0x00,0xAC};
CipherSuite TLS_RSA_PSK_WITH_AES_256_GCM_SHA384    = {0x00,0xAD};
CipherSuite TLS_PSK_WITH_AES_128_CBC_SHA256        = {0x00,0xAE};
CipherSuite TLS_PSK_WITH_AES_256_CBC_SHA384        = {0x00,0xAF};
CipherSuite TLS_PSK_WITH_NULL_SHA256               = {0x00,0xB0};
CipherSuite TLS_PSK_WITH_NULL_SHA384               = {0x00,0xB1};
```

```
      CipherSuite TLS_DHE_PSK_WITH_AES_128_CBC_SHA256    = {0x00,0xB2};
      CipherSuite TLS_DHE_PSK_WITH_AES_256_CBC_SHA384    = {0x00,0xB3};
      CipherSuite TLS_DHE_PSK_WITH_NULL_SHA256           = {0x00,0xB4};
      CipherSuite TLS_DHE_PSK_WITH_NULL_SHA384           = {0x00,0xB5};
      CipherSuite TLS_RSA_PSK_WITH_AES_128_CBC_SHA256    = {0x00,0xB6};
      CipherSuite TLS_RSA_PSK_WITH_AES_256_CBC_SHA384    = {0x00,0xB7};
      CipherSuite TLS_RSA_PSK_WITH_NULL_SHA256           = {0x00,0xB8};
      CipherSuite TLS_RSA_PSK_WITH_NULL_SHA384           = {0x00,0xB9};
```

6. Acknowledgments

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7. References

7.1. Normative References

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[RFC5288] Salowey, J., Choudhury, A., and D. McGrew, "AES Galois Counter Mode (GCM) Cipher Suites for TLS", RFC 5288, August 2008.

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7.2. Informative References

[RFC5289] Rescorla, E., "TLS Elliptic Curve Cipher Suites with SHA-256/384 and AES Galois Counter Mode (GCM)", RFC 5289, August 2008.

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