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# TLS Elliptic Curve Cipher Suites with SHA-256/384 and AES Galois Counter Mode (GCM)

## Status of This Memo



## Abstract

RFC 4492 describes elliptic curve cipher suites for Transport Layer Security (TLS). However, all those cipher suites use HMAC-SHA-1 as their Message Authentication Code (MAC) algorithm. This document describes sixteen new cipher suites for TLS that specify stronger MAC algorithms. Eight use Hashed Message Authentication Code (HMAC) with SHA-256 or SHA-384, and eight use AES in Galois Counter Mode (GCM).

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## 1. Introduction

RFC 4492 [RFC4492] describes Elliptic Curve Cryptography (ECC) cipher suites for Transport Layer Security (TLS). However, all of the RFC 4492 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. This document specifies TLS ECC cipher suites that use SHA-256 and SHA-384 [SHS] rather than SHA-1.

TLS 1.2 [RFC5246], adds support for authenticated encryption with additional data (AEAD) cipher modes [RFC5116]. This document also specifies a set of ECC cipher suites using one such mode, Galois Counter Mode (GCM) [GCM]. Another document [RFC5288] provides support for GCM with other key establishment methods.

## 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].

## 3. Cipher Suites

This document defines 16 new cipher suites to be added to TLS. All use Elliptic Curve Cryptography for key exchange and digital signature, as defined in RFC 4492.

### 3.1. HMAC-Based Cipher Suites

The first eight cipher suites use AES [AES] in Cipher Block Chaining (CBC) [CBC] mode with an HMAC-based MAC:

```
  CipherSuite TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256  = {0xC0,0x23};
  CipherSuite TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384  = {0xC0,0x24};
  CipherSuite TLS_ECDH_ECDSA_WITH_AES_128_CBC_SHA256   = {0xC0,0x25};
  CipherSuite TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA384   = {0xC0,0x26};
  CipherSuite TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256    = {0xC0,0x27};
  CipherSuite TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384    = {0xC0,0x28};
  CipherSuite TLS_ECDH_RSA_WITH_AES_128_CBC_SHA256     = {0xC0,0x29};
  CipherSuite TLS_ECDH_RSA_WITH_AES_256_CBC_SHA384     = {0xC0,0x2A};
```

These eight cipher suites are the same as the corresponding cipher suites in RFC 4492 (with names ending in "_SHA" in place of "_SHA256" or "_SHA384"), except for the MAC and Pseudo Random Function (PRF) algorithms.

These SHALL be as follows:

- For cipher suites ending with _SHA256, the PRF is the TLS PRF [RFC5246] with SHA-256 as the hash function. The MAC is HMAC [RFC2104] 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. The MAC is HMAC [RFC2104] with SHA-384 as the hash function.

## 3.2. Galois Counter Mode-Based Cipher Suites

The second eight cipher suites use the same asymmetric algorithms as those in the previous section but use the new authenticated encryption modes defined in TLS 1.2 with AES in Galois Counter Mode (GCM) [GCM]:

```
  CipherSuite TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256  = {0xC0,0x2B};
  CipherSuite TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384  = {0xC0,0x2C};
  CipherSuite TLS_ECDH_ECDSA_WITH_AES_128_GCM_SHA256   = {0xC0,0x2D};
  CipherSuite TLS_ECDH_ECDSA_WITH_AES_256_GCM_SHA384   = {0xC0,0x2E};
  CipherSuite TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256    = {0xC0,0x2F};
  CipherSuite TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384    = {0xC0,0x30};
  CipherSuite TLS_ECDH_RSA_WITH_AES_128_GCM_SHA256     = {0xC0,0x31};
  CipherSuite TLS_ECDH_RSA_WITH_AES_256_GCM_SHA384     = {0xC0,0x32};
```

These cipher suites use authenticated encryption with additional data algorithms AEAD_AES_128_GCM and AEAD_AES_256_GCM described in [RFC5116]. GCM is used as described in [RFC5288].

The PRFs 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.

# 4. Security Considerations

The security considerations in RFC 4346, RFC 4492, and [RFC5288] apply to this document as well. In addition, as described in [RFC5288], these cipher suites may only be used with TLS 1.2 or greater.

## 5. IANA Considerations

IANA has assigned the following values for these cipher suites:

```
CipherSuite TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256  = {0xC0,0x23};
CipherSuite TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384  = {0xC0,0x24};
CipherSuite TLS_ECDH_ECDSA_WITH_AES_128_CBC_SHA256   = {0xC0,0x25};
CipherSuite TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA384   = {0xC0,0x26};
CipherSuite TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256    = {0xC0,0x27};
CipherSuite TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384    = {0xC0,0x28};
CipherSuite TLS_ECDH_RSA_WITH_AES_128_CBC_SHA256     = {0xC0,0x29};
CipherSuite TLS_ECDH_RSA_WITH_AES_256_CBC_SHA384     = {0xC0,0x2A};
CipherSuite TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256  = {0xC0,0x2B};
CipherSuite TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384  = {0xC0,0x2C};
CipherSuite TLS_ECDH_ECDSA_WITH_AES_128_GCM_SHA256   = {0xC0,0x2D};
CipherSuite TLS_ECDH_ECDSA_WITH_AES_256_GCM_SHA384   = {0xC0,0x2E};
CipherSuite TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256    = {0xC0,0x2F};
CipherSuite TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384    = {0xC0,0x30};
CipherSuite TLS_ECDH_RSA_WITH_AES_128_GCM_SHA256     = {0xC0,0x31};
CipherSuite TLS_ECDH_RSA_WITH_AES_256_GCM_SHA384     = {0xC0,0x32};
```

## 6. Acknowledgements

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## 7. References

### 7.1. Normative References

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[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC4492] Blake-Wilson, S., Bolyard, N., Gupta, V., Hawk, C., and B. Moeller, "Elliptic Curve Cryptography (ECC) Cipher Suites for Transport Layer Security (TLS)", RFC 4492, May 2006.

[RFC5116] McGrew, D., "An Interface and Algorithms for Authenticated Encryption", RFC 5116, January 2008.

[RFC5246] Dierks, T. and E. Rescorla, "The Transport Layer Security (TLS) Protocol Version 1.2", RFC 5246, August 2008.

[RFC5288] Salowey, J., Choudhury, A., and D. McGrew, "AES-GCM Cipher Suites for TLS", RFC 5288, August 2008.

[AES] National Institute of Standards and Technology, "Specification for the Advanced Encryption Standard (AES)", FIPS 197, November 2001.

[SHS] National Institute of Standards and Technology, "Secure Hash Standard", FIPS 180-2, August 2002.

[CBC] National Institute of Standards and Technology, "Recommendation for Block Cipher Modes of Operation - Methods and Techniques", SP 800-38A, December 2001.

[GCM] National Institute of Standards and Technology, "Recommendation for Block Cipher Modes of Operation: Galois/Counter Mode (GCM) for Confidentiality and Authentication", SP 800-38D, November 2007.

## 7.2. Informative References

[Wang05] Wang, X., Yin, Y., and H. Yu, "Finding Collisions in the Full SHA-1", CRYPTO 2005, August 2005.

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