

TLS Working Group  
Internet-Draft  
Intended status: Standards Track  
Expires: July 16, 2008

J. Salowey  
A. Choudhury  
D. McGrew  
Cisco Systems, Inc.  
January 13, 2008

RSA based AES-GCM Cipher Suites for TLS  
draft-ietf-tls-rsa-aes-gcm-01

Status of this Memo

By submitting this Internet-Draft, each author represents that any applicable patent or other IPR claims of which he or she is aware have been or will be disclosed, and any of which he or she becomes aware will be disclosed, in accordance with [Section 6 of BCP 79](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF), its areas, and its working groups. Note that other groups may also distribute working documents as Internet-Drafts.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

The list of current Internet-Drafts can be accessed at <http://www.ietf.org/ietf/lid-abstracts.txt>.

The list of Internet-Draft Shadow Directories can be accessed at <http://www.ietf.org/shadow.html>.

This Internet-Draft will expire on July 16, 2008.

Copyright Notice

Copyright (C) The IETF Trust (2008).

Abstract

This memo describes the use of the Advanced Encryption Standard (AES) in Galois/Counter Mode (GCM) as a Transport Layer Security (TLS) authenticated encryption operation. GCM provides both confidentiality and data origin authentication, can be efficiently implemented in hardware for speeds of 10 gigabits per second and above, and is also well-suited to software implementations. This memo defines TLS ciphersuites that use AES-GCM with RSA.

Internet-Draft

RSA AES-GCM Ciphersuites

January 2008

Table of Contents

- [1. Introduction . . . . .](#) [3](#)
- [2. Conventions Used In This Document . . . . .](#) [3](#)
- [3. RSA Based AES-GCM Cipher Suites . . . . .](#) [3](#)
  - [3.1. Recommendations for Multiple Cryptographic Processors . . .](#) [4](#)
- [4. TLS Versions . . . . .](#) [5](#)
- [5. IANA Considerations . . . . .](#) [6](#)
- [6. Security Considerations . . . . .](#) [6](#)
  - [6.1. Perfect Forward Secrecy . . . . .](#) [6](#)
  - [6.2. Counter Reuse . . . . .](#) [6](#)
- [7. Acknowledgements . . . . .](#) [6](#)
- [8. References . . . . .](#) [7](#)
  - [8.1. Normative References . . . . .](#) [7](#)
  - [8.2. Informative References . . . . .](#) [7](#)
- [Authors' Addresses . . . . .](#) [8](#)
- [Intellectual Property and Copyright Statements . . . . .](#) [9](#)

## 1. Introduction

This document describes the use of AES [[AES](#)] in Galois Counter Mode (GCM) [[GCM](#)] (AES-GCM) with RSA based key exchange as a ciphersuite for TLS. This mechanism is not only efficient and secure, hardware implementations can achieve high speeds with low cost and low latency, because the mode can be pipelined. Applications like CAPWAP, which uses DTLS, can benefit from the high-speed implementations when wireless termination points (WTPs) and controllers (ACs) have to meet requirements to support higher throughputs in the future. AES-GCM has been specified as a mode that can be used with IPsec ESP [[RFC4106](#)] and 802.1AE MAC Security [[IEEE8021AE](#)]. It also is part of the NSA suite B ciphersuites for TLS [[I-D.rescorla-tls-suiteb](#)]; however in order to meet Suite B requirements these ciphersuites require ECC base key exchange and TLS 1.2. The ciphersuites defined in this document are based on RSA which allows the use of AES-GCM in environments that have not deployed ECC algorithms and do not need to meet NSA Suite B requirements. AES-GCM is an authenticated encryption with associated data (AEAD) cipher, as defined in TLS 1.2 [[I-D.ietf-tls-rfc4346-bis](#)]. The ciphersuites defined in this draft may be used with Datagram TLS defined in [[RFC4347](#)]. This memo uses GCM in a way similar to [[I-D.ietf-tls-ecc-new-mac](#)].

## 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. RSA Based AES-GCM Cipher Suites

The following ciphersuites use the new authenticated encryption modes defined in TLS 1.2 with AES in Galois Counter Mode (GCM) [[GCM](#)]:

```
CipherSuite TLS_RSA_WITH_AES_128_GCM_SHA256 = {TBD1,TBD1}
CipherSuite TLS_RSA_WITH_AES_256_GCM_SHA384 = {TBD2,TBD2}
CipherSuite TLS_RSA_DHE_WITH_AES_128_GCM_SHA256 = {TBD3,TBD3}
CipherSuite TLS_RSA_DHE_WITH_AES_256_GCM_SHA384 = {TBD4,TBD4}
```

These ciphersuites use the AES-GCM authenticated encryption with associated data (AEAD) algorithms AEAD\_AES\_128\_GCM and AEAD\_AES\_256\_GCM described in [[I-D.mcgrew-auth-enc](#)]. Note that this specification uses a 128-bit authentication tag with GCM. The "nonce" SHALL be 12 bytes long and it is "partially implicit" (see section 3.2.1 in [[I-D.mcgrew-auth-enc](#)]). Part of the nonce is

generated as part of the handshake process and is static for the entire session and part is carried in each packet.

```
Struct{
    opaque salt[4];
    opaque explicit_nonce_part[8];
} GCMNonce
```

The salt is the "implicit" part of the nonce and is not sent in the packet. It is either the client\_write\_IV if the client is sending or the server\_write\_IV if the server is sending. These IVs SHALL be 4 bytes long.

The explicit\_nonce\_part is chosen by the sender and included in the packet. Each value of the explicit\_nonce\_part MUST be distinct for each distinct invocation of GCM encrypt function for any fixed key. Failure to meet this uniqueness requirement can significantly degrade security. The explicit\_nonce\_part is carried in the IV field of the GenericAEADCipher structure. Therefore, for all the algorithms defined in this section, SecurityParameters.iv\_length=8.

In the case of TLS the explicit\_nonce\_part MAY be the 64-bit sequence number. In the case of Datagram TLS [[RFC4347](#)] the explicit\_nonce\_part MAY be formed from the concatenation of the 16-bit epoch with the 48-bit DTLS seq\_num.

The RSA and RSA-DHE key exchange is performed as defined in [[I-D.ietf-tls-rfc4346-bis](#)].

The PRF algorithms SHALL be as follows:

For TLS\_RSA\_WITH\_AES\_128\_GCM\_SHA256 and  
TLS\_RSA\_DHE\_WITH\_AES\_128\_GCM\_SHA256 the hash function is SHA256.

For TLS\_RSA\_WITH\_AES\_256\_GCM\_SHA384 and  
TLS\_RSA\_DHE\_WITH\_AES\_256\_GCM\_SHA384 the hash function is SHA384.

### [3.1.](#) Recommendations for Multiple Cryptographic Processors

If multiple cryptographic processors are in use by the sender, then the sender MUST ensure that each value of the `explicit_nonce_part` that is used by each processor is distinct. In this case each encryption processor SHOULD include in the `explicit_nonce_part` a fixed value that is distinct for each processor. The recommended format is

```
explicit_nonce_part = FixedDistinct || Variable
```

where the `FixedDistinct` field is distinct for each encryption processor, but is fixed for a given processor, and the `Variable` field is distinct for each distinct nonce used by a particular encryption processor. When this method is used, the `FixedDistinct` fields used by the different processors MUST have the same length.

In the terms of Figure 2 in [[I-D.mcgrew-auth-enc](#)], the `Salt` is the `Fixed-Common` part of the nonce (it is fixed, and it is common across all encryption processors), the `FixedDistinct` field exactly corresponds to the `Fixed-Distinct` field, and the `Variable` field corresponds to the `Counter` field, and the `explicit` part exactly corresponds to the `explicit_nonce_part`.

For clarity, we provide an example for TLS in which there are two distinct encryption processors, each of which uses a one-byte `FixedDistinct` field:

```
Salt           = eedc68dc
FixedDistinct = 01           (for the first encryption processor)
FixedDistinct = 02           (for the second encryption processor)
```

The GCMnonces generated by the first encryption processor, and their

corresponding explicit\_nonce\_parts, are:

GCMNonce	explicit_nonce_part
-----	-----
eedc68dc0100000000000000	0100000000000000
eedc68dc0100000000000001	0100000000000001
eedc68dc0100000000000002	0100000000000002
...	

The GCMnonces generated by the second encryption processor, and their corresponding explicit\_nonce\_parts, are

GCMNonce	explicit_nonce_part
-----	-----
eedc68dc0200000000000000	0200000000000000
eedc68dc0200000000000001	0200000000000001
eedc68dc0200000000000002	0200000000000002
...	

#### 4. TLS Versions

These ciphersuites make use of the authenticated encryption with additional data defined in TLS 1.2 [[I-D.ietf-tls-rfc4346-bis](#)]. They MUST NOT be negotiated in older versions of TLS. Clients MUST NOT

offer these cipher suites if they do not offer TLS 1.2 or later. Servers which select an earlier version of TLS MUST NOT select one of these cipher suites. Because TLS has no way for the client to indicate that it supports TLS 1.2 but not earlier, a non-compliant server might potentially negotiate TLS 1.1 or earlier and select one of the cipher suites in this document. Clients MUST check the TLS version and generate a fatal "illegal\_parameter" alert if they detect an incorrect version.

#### 5. IANA Considerations

IANA has assigned the following values for the ciphersuites defined in this draft:

CipherSuite TLS\_RSA\_WITH\_AES\_128\_GCM\_SHA256 = {TBD1,TBD1}  
CipherSuite TLS\_RSA\_WITH\_AES\_256\_GCM\_SHA384 = {TBD2,TBD2}  
CipherSuite TLS\_RSA\_DHE\_WITH\_AES\_128\_GCM\_SHA256 = {TBD3,TBD3}  
CipherSuite TLS\_RSA\_DHE\_WITH\_AES\_256\_GCM\_SHA384 = {TBD4,TBD4}

## [6.](#) Security Considerations

The security considerations in [[I-D.ietf-tls-rfc4346-bis](#)] apply to this document as well. The remainder of this section describes security considerations specific to the cipher suites described in this document.

### [6.1.](#) Perfect Forward Secrecy

The perfect forward secrecy properties of RSA based TLS ciphersuites are discussed in the security analysis of [[I-D.ietf-tls-rfc4346-bis](#)]. It should be noted that only the ephemeral Diffie-Hellman based ciphersuites (RSA\_DHE) are capable of providing perfect forward secrecy.

### [6.2.](#) Counter Reuse

AES-GCM security requires that the counter is never reused. The IV construction in [Section 3](#) is designed to prevent counter reuse.

## [7.](#) Acknowledgements

This draft borrows heavily from [[I-D.ietf-tls-ecc-new-mac](#)].

## [8.](#) References

Salowey, et al.

Expires July 16, 2008

[Page 6]

---

Internet-Draft

RSA AES-GCM Ciphersuites

January 2008

### [8.1.](#) Normative References

[AES] National Institute of Standards and Technology,  
"Specification for the Advanced Encryption Standard  
(AES)", FIPS 197, November 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, April 2006.

[I-D.ietf-tls-rfc4346-bis]

Dierks, T. and E. Rescorla, "The Transport Layer Security (TLS) Protocol Version 1.2", [draft-ietf-tls-rfc4346-bis-07](#) (work in progress), November 2007.

[I-D.mcgregw-auth-enc]

McGrew, D., "An Interface and Algorithms for Authenticated Encryption", [draft-mcgregw-auth-enc-05](#) (work in progress), November 2007.

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

[RFC4346] Dierks, T. and E. Rescorla, "The Transport Layer Security (TLS) Protocol Version 1.1", [RFC 4346](#), April 2006.

[RFC4347] Rescorla, E. and N. Modadugu, "Datagram Transport Layer Security", [RFC 4347](#), April 2006.

## [8.2](#). Informative References

[I-D.ietf-tls-ecc-new-mac]

Rescorla, E., "TLS Elliptic Curve Cipher Suites with SHA-256/384 and AES Galois Counter Mode", [draft-ietf-tls-ecc-new-mac-02](#) (work in progress), December 2007.

[I-D.rescorla-tls-suiteb]

Salter, M. and E. Rescorla, "Suite B Cipher Suites for TLS", [draft-rescorla-tls-suiteb-01](#) (work in progress), June 2007.

[IEEE8021AE]

Institute of Electrical and Electronics Engineers, "Media Access Control Security", IEEE Standard 802.1AE, August 2006.

[RFC4106] Viega, J. and D. McGrew, "The Use of Galois/Counter Mode



(GCM) in IPsec Encapsulating Security Payload (ESP)",  
[RFC 4106](#), June 2005.

#### Authors' Addresses

Joseph Salowey  
Cisco Systems, Inc.  
2901 3rd. Ave  
Seattle, WA 98121  
USA

Email: [jsalowey@cisco.com](mailto:jsalowey@cisco.com)

Abhijit Choudhury  
Cisco Systems, Inc.  
3625 Cisco Way  
San Jose, CA 95134  
USA

Email: [abhijitc@cisco.com](mailto:abhijitc@cisco.com)

David McGrew  
Cisco Systems, Inc.  
170 W Tasman Drive  
San Jose, CA 95134  
USA

Email: [mcgrew@cisco.com](mailto:mcgrew@cisco.com)

## Full Copyright Statement

Copyright (C) The IETF Trust (2008).

This document is subject to the rights, licenses and restrictions contained in [BCP 78](#), and except as set forth therein, the authors retain all their rights.

This document and the information contained herein are provided on an "AS IS" basis and THE CONTRIBUTOR, THE ORGANIZATION HE/SHE REPRESENTS OR IS SPONSORED BY (IF ANY), THE INTERNET SOCIETY, THE IETF TRUST AND THE INTERNET ENGINEERING TASK FORCE DISCLAIM ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

## Intellectual Property

The IETF takes no position regarding the validity or scope of any Intellectual Property Rights or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; nor does it represent that it has made any independent effort to identify any such rights. Information on the procedures with respect to rights in RFC documents can be found in [BCP 78](#) and [BCP 79](#).

Copies of IPR disclosures made to the IETF Secretariat and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this specification can be obtained from the IETF on-line IPR repository at <http://www.ietf.org/ipr>.

The IETF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary rights that may cover technology that may be required to implement this standard. Please address the information to the IETF at [ietf-ipr@ietf.org](mailto:ietf-ipr@ietf.org).

## Acknowledgment

Funding for the RFC Editor function is provided by the IETF Administrative Support Activity (IASA).

