                 The Use of HMAC-MD5-96 within ESP and AH

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Abstract

   This memo describes the use of the HMAC algorithm [RFC-2104] in
   conjunction with the MD5 algorithm [RFC-1321] as an authentication
   mechanism within the revised IPSEC Encapsulating Security Payload
   [ESP] and the revised IPSEC Authentication Header [AH]. HMAC with MD5
   provides data origin authentication and integrity protection.

   Further information on the other components necessary for ESP and AH
   implementations is provided by [Thayer97a].

1.  Introduction

   This memo specifies the use of MD5 [RFC-1321] combined with HMAC
   [RFC-2104] as a keyed authentication mechanism within the context of
   the Encapsulating Security Payload and the Authentication Header.
   The goal of HMAC-MD5-96 is to ensure that the packet is authentic and
   cannot be modified in transit.

   HMAC is a secret key authentication algorithm. Data integrity and
   data origin authentication as provided by HMAC are dependent upon the
   scope of the distribution of the secret key. If only the source and
   destination know the HMAC key, this provides both data origin
   authentication and data integrity for packets sent between the two
   parties; if the HMAC is correct, this proves that it must have been
   added by the source.

In this memo, HMAC-MD5-96 is used within the context of ESP and AH.
For further information on how the various pieces of ESP - including
the confidentiality mechanism -- fit together to provide security
services, refer to [ESP] and [Thayer97a]. For further information on
AH, refer to [AH] and [Thayer97a].

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 [RFC-2119].

2. Algorithm and Mode

   [RFC-1321] describes the underlying MD5 algorithm, while [RFC-2104]
   describes the HMAC algorithm. The HMAC algorithm provides a framework
   for inserting various hashing algorithms such as MD5.

   HMAC-MD5-96 operates on 64-byte blocks of data.  Padding requirements
   are specified in [RFC-1321] and are part of the MD5 algorithm.  If
   MD5 is built according to [RFC-1321], there is no need to add any
   additional padding as far as HMAC-MD5-96 is concerned.  With regard
   to "implicit packet padding" as defined in [AH], no implicit packet
   padding is required.

   HMAC-MD5-96 produces a 128-bit authenticator value.  This 128-bit
   value can be truncated as described in RFC 2104.  For use with either
   ESP or AH, a truncated value using the first 96 bits MUST be
   supported.  Upon sending, the truncated value is stored within the
   authenticator field.  Upon receipt, the entire 128-bit value is
   computed and the first 96 bits are compared to the value stored in
   the authenticator field.  No other authenticator value lengths are
   supported by HMAC-MD5-96.

   The length of 96 bits was selected because it is the default
   authenticator length as specified in [AH] and meets the security
   requirements described in [RFC-2104].

2.1  Performance

   [Bellare96a] states that "(HMAC) performance is essentially that of
   the underlying hash function".  [RFC-1810] provides some performance
   analysis and recommendations of the use of MD5 with Internet
   protocols.  As of this writing no performance analysis has been done
   of HMAC or HMAC combined with MD5.

   [RFC-2104] outlines an implementation modification which can improve
   per-packet performance without affecting interoperability.

3. Keying Material

   HMAC-MD5-96 is a secret key algorithm. While no fixed key length is
   specified in [RFC-2104], for use with either ESP or AH a fixed key
   length of 128-bits MUST be supported.  Key lengths other than 128-
   bits MUST NOT be supported (i.e. only 128-bit keys are to be used by
   HMAC-MD5-96).  A key length of 128-bits was chosen based on the
   recommendations in [RFC-2104] (i.e. key lengths less than the
   authenticator length decrease security strength and keys longer than
   the authenticator length do not significantly increase security
   strength).

   [RFC-2104] discusses requirements for key material, which includes a
   discussion on requirements for strong randomness.  A strong pseudo-
   random function MUST be used to generate the required 128-bit key.

   At the time of this writing there are no specified weak keys for use
   with HMAC.  This does not mean to imply that weak keys do not exist.
   If, at some point, a set of weak keys for HMAC are identified, the
   use of these weak keys must be rejected followed by a request for
   replacement keys or a newly negotiated Security Association.

   [ARCH] describes the general mechanism for obtaining keying material
   when multiple keys are required for a single SA (e.g. when an ESP SA
   requires a key for confidentiality and a key for authentication).

   In order to provide data origin authentication, the key distribution
   mechanism must ensure that unique keys are allocated and that they
   are distributed only to the parties participating in the
   communication.

   [RFC-2104] makes the following recommendation with regard to
   rekeying.  Current attacks do not indicate a specific recommended
   frequency for key changes as these attacks are practically
   infeasible.  However, periodic key refreshment is a fundamental
   security practice that helps against potential weaknesses of the
   function and keys, reduces the information avaliable to a
   cryptanalyst, and limits the damage of an exposed key.

4.  Interaction with the ESP Cipher Mechanism

   As of this writing, there are no known issues which preclude the use
   of the HMAC-MD5-96 algorithm with any specific cipher algorithm.

5.  Security Considerations

   The security provided by HMAC-MD5-96 is based upon the strength of
   HMAC, and to a lesser degree, the strength of MD5. [RFC-2104] claims
   that HMAC does not depend upon the property of strong collision
   resistance, which is important to consider when evaluating the use of
   MD5, an algorithm which has, under recent scrutiny, been shown to be
   much less collision-resistant than was first thought. At the time of
   this writing there are no practical cryptographic attacks against
   HMAC-MD5-96.

   [RFC-2104] states that for "minimally reasonable hash functions" the
   "birthday attack", the strongest attack know against HMAC, is
   impractical. For a 64-byte block hash such as HMAC-MD5-96, an attack
   involving the successful processing of 2**64 blocks would be
   infeasible unless it were discovered that the underlying hash had
   collisions after processing 2**30 blocks. A hash with such weak
   collision-resistance characteristics would generally be considered to
   be unusable.

   It is also important to consider that while MD5 was never developed
   to be used as a keyed hash algorithm, HMAC had that criteria from the
   onset. While the use of MD5 in the context of data security is
   undergoing reevaluation, the combined HMAC with MD5 algorithm has
   held up to cryptographic scrutiny.

   [RFC-2104] also discusses the potential additional security which is
   provided by the truncation of the resulting hash. Specifications
   which include HMAC are strongly encouraged to perform this hash
   truncation.

   As [RFC-2104] provides a framework for incorporating various hash
   algorithms with HMAC, it is possible to replace MD5 with other
   algorithms such as SHA-1. [RFC-2104] contains a detailed discussion
   on the strengths and weaknesses of HMAC algorithms.

   As is true with any cryptographic algorithm, part of its strength
   lies in the correctness of the algorithm implementation, the security
   of the key management mechanism and its implementation, the strength
   of the associated secret key, and upon the correctness of the
   implementation in all of the participating systems.  [RFC-2202]
   contains test vectors and example code to assist in verifying the
   correctness of HMAC-MD5-96 code.

6.  Acknowledgments

   This document is derived in part from previous works by Jim Hughes,
   those people that worked with Jim on the combined DES/CBC+HMAC-MD5
   ESP transforms, the ANX bakeoff participants, and the members of the
   IPsec working group.

   We would also like to thank Hugo Krawczyk for his comments and
   recommendations regarding some of the cryptographic specific text in
   this document.

7.  References

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