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The Secure Neighbor Discovery (SEND) Hash Threat Analysis

Abstract

This document analyzes the use of hashes in Secure Neighbor Discovery (SEND), the possible threats to these hashes and the impact of recent attacks on hash functions used by SEND. The SEND specification currently uses the SHA-1 hash algorithm and PKIX certificates and does not provide support for hash algorithm agility. This document provides an analysis of possible threats to the hash algorithms used in SEND.

Status of This Memo

This document is not an Internet Standards Track specification; it is published for informational purposes.

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1. Introduction

SEND [RFC3971] uses the SHA-1 hash algorithm [SHA1] to generate the contents of the Key Hash field and the Digital Signature field of the RSA Signature option. It also indirectly uses a hash algorithm (SHA-1, MD5, etc.) in the PKIX certificates [RFC5280] used for router authorization in the Authorization Delegation Discovery (ADD) process. Recently there have been demonstrated attacks against the collision free property of such hash functions [SHA1-COLL] and attacks on the PKIX X.509 certificates that use the MD5 hash algorithm [X509-COLL]. The document analyzes the impacts of these attacks on SEND and it recommends mechanisms to make SEND resistant to such attacks.

2. Impact of Collision Attacks on SEND

[RFC4270] summarizes a study that assesses the threat of the aforementioned attacks on the use of cryptographic hashes in Internet protocols. This document analyzes the hash usage in SEND following the approach recommended by [RFC4270] and [NEW-HASHES].

The following sections discuss the various aspects of hash usage in SEND and determine whether they are affected by the attacks on the underlying hash functions.

2.1. Attacks against CGAs Used in SEND

Cryptographically Generated Addresses (CGAs) are defined in [RFC3972] and are used to securely associate a cryptographic public key with an IPv6 address in the SEND protocol. Impacts of collision attacks on current uses of CGAs are analyzed in [RFC4982]. The basic idea behind collision attacks, as described in Section 4 of [RFC4270], is on the non-repudiation feature of hash algorithms. However, CGAs do not provide non-repudiation features. Therefore, as [RFC4982] points out CGA-based protocols, including SEND, are not affected by collision attacks on hash functions. If pre-image attacks were to become feasible, an attacker can find new CGA Parameters that can generate the same CGA as the victim. This class of attacks could be potentially dangerous since the security of SEND messages relies on the strength of the CGA.

2.2. Attacks against PKIX Certificates in Authorization Delegation Discovery Process

To protect Router Discovery, SEND requires that routers be authorized to act as routers. Routers are authorized by provisioning them with certificates from a trust anchor, and the hosts are configured with the trust anchor(s) used to authorize routers. Researchers demonstrated attacks against PKIX certificates with MD5 signatures in 2005 [NEW-HASHES], in 2007 [X509-COLL] [STEV2007] [SLdeW2007], and in 2009 [SSALMOdeW2009] [SLdeW2009]. An attacker can take advantage of these vulnerabilities to obtain a certificate with a different identity and use the certificate to impersonate a router. For this attack to succeed, the attacker needs to predict the content of all fields (some of them are human-readable) appearing before the public key, including the serial number and validity periods. Even though a relying party cannot verify the content of these fields, the CA can identify the forged certificate, if necessary.

2.3. Attacks against the Digital Signature in the SEND RSA Signature Option

The digital signature in the RSA Signature option is produced by signing, with the sender's private key, the SHA-1 hash over certain fields in the Neighbor Discovery message as described in Section 5.2 of [RFC3971]. It is possible for an attacker to come up with two different Neighbor Discovery messages m and m' that result in the same value in the Digital Signature field. Since the structure of the Neighbor Discovery messages is well defined, it is not practical to use this vulnerability in real world attacks.

2.4. Attacks against the Key Hash Field of the SEND RSA Signature Option

The SEND RSA signature option described in Section 5.2 of [RFC3971] defines a Key Hash field. This field contains a SHA-1 hash of the public key that was used to generate the CGA. To use a collision attack on this field, the attacker needs to come up with another public key (k') that produces the same hash as the real key (k). But the real key (k) is already authorized through a parallel mechanism (either CGAs or router certificates). Hence, collision attacks are not possible on the Key Hash field. Pre-image attacks on the Key Hash field are not useful for the same reason (any other key that hashes into the same Key Hash value will be detected due to a mismatch with the CGA or the router certificate).

3. Conclusion

Current attacks on hash functions do not constitute any practical threat to the digital signatures used in SEND (both in the RSA signature option and in the X.509 certificates). Attacks on CGAs, as described in [RFC4982], will compromise the security of SEND and they need to be addressed by encoding the hash algorithm information into the CGA as specified in [RFC4982].

4. Security Considerations

This document analyzes the impact that the attacks against hash functions have on SEND. It concludes that the only practical attack on SEND stems from a successful attack on an underlying CGA. It does not add any new vulnerabilities to SEND.

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