OSPF MD5 Authentication

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1. Introduction

Growth in the Internet has made us aware of the need for improved authentication of routing information. OSPF provides two authentication mechanisms for use in an area: "No Authentication" and "Simple Password". Both are vulnerable to passive attacks currently widespread in the Internet. Well-understood security issues exist in routing protocols [4]. Clear text passwords, currently specified for use with OSPF, are no longer considered sufficient [5].

If authentication is disabled, then only simple misconfigurations are detected. Simple passwords transmitted in the clear will further protect against the honest neighbor, but are useless in the general case. By simply capturing information on the wire - straightforward even in a remote environment - a hostile process can learn the password and overcome the network.

We propose that OSPF use an authentication algorithm, as in SNMP Version 2, augmented by a sequence number. MD5 is proposed as the standard authentication algorithm for OSPF, but the mechanism is intended to be algorithm-independent. While this mechanism is not unbreakable (no known mechanism is), it provides a greatly enhanced probability that a system being attacked will detect and ignore hostile messages. This is because we transmit the output of an authentication algorithm (e.g., MD5) rather than the secret OSPF Authentication Key. This output is a one-way function of a message and a secret OSPF Authentication Key. This OSPF Authentication Key is never sent over the network in the clear, thus providing protection against the passive attacks now commonplace in the Internet.

In this way, protection is afforded against forgery or message modification. It is possible to replay a message until the sequence number changes, but the sequence number makes replay in the long term less of an issue. The mechanism does not afford confidentiality, since messages stay in the clear; however, the mechanism is also exportable from most countries, which test a privacy algorithm would fail.

Other relevant rationales for the approach are that MD5 is used in SNMP Version 2, and is therefore present in routers already, as is some form of password management. A similar approach has been proposed for authentication in IP version 6 (IPv6).

2. Implementation Approach

Implementation requires three issues to be addressed:

(1) A changed packet format,

(2) Authentication procedures, and

(3) Management controls.

2.1. OSPF PDU Format

The basic OSPF message format provides for a 24 byte header with an arbitrary data content. When MD5 is used, the same header and content are used, except that the eight byte "authentication key" field is reused to describe a "Keyed Message Digest" trailer. This consists in five fields:

(1) The "Authentication Type" is Keyed Message Digest Algorithm, indicated by the value 2.

(2) A 16 bit offset from the OSPF header to the MD5 digest (if no other trailer fields are ever defined, this value equals the OSPF Data Length).

(3) An unsigned 8-bit field that contains the Key Identifier or Key-ID. This identifies the key used to create the Authentication Data for this OSPF message. A key is associated with an interface.

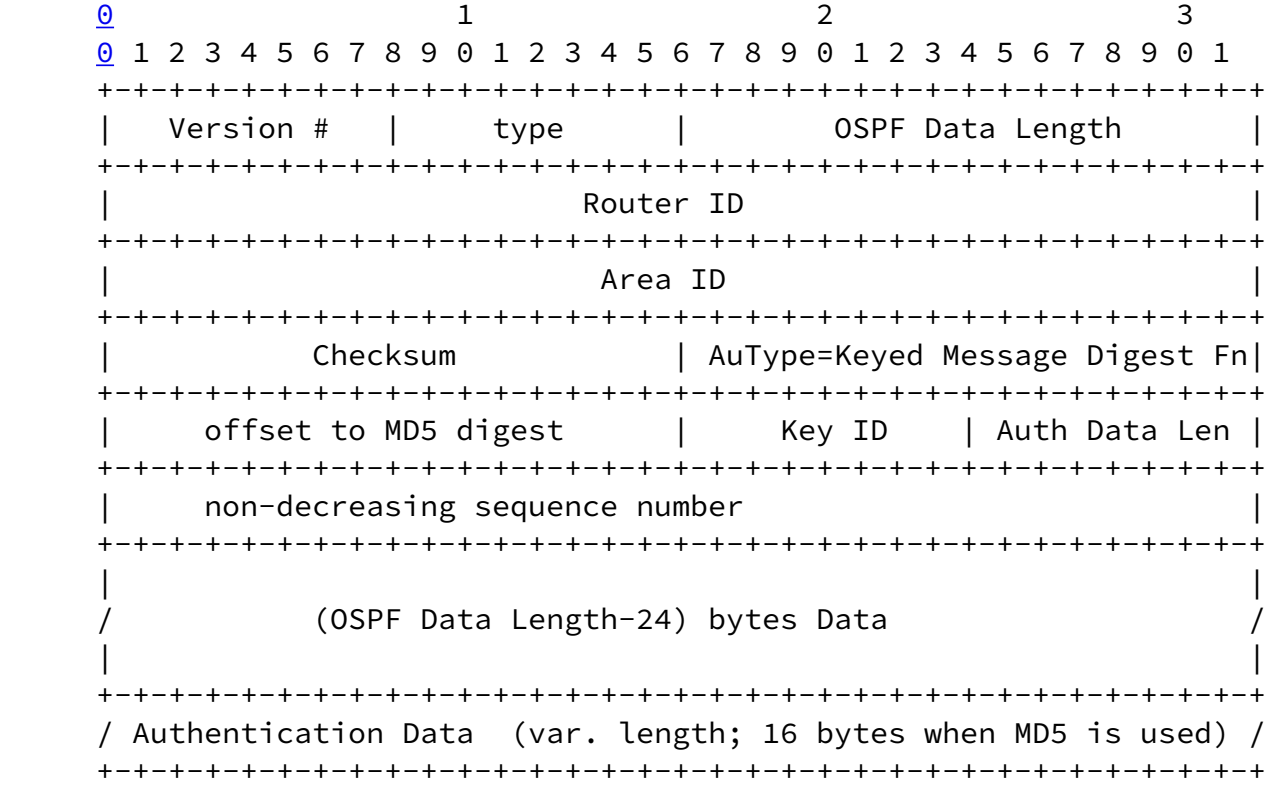
(4) An unsigned 8-bit field that contains the length in octets of the trailing Authentication Data field. The presence of this field permits other algorithms (e.g., SHA) to be substituted for MD5 if desired.

(5) An unsigned 32 bit non-decreasing sequence number.

The trailer consists of the Authentication Data, which is the output of the Keyed Message Digest Algorithm. When the Authentication Algorithm is MD5, the output data is 16 bytes; during digest calculation, this is effectively followed by a pad field and a length field as defined by RFC 1321.

2.2. Processing Algorithm

When the authentication type is "Keyed Message Digest", message processing is changed in message creation and reception.



In memory, the following trailer is appended by the MD5 algorithm and treated as though it were part of the message.

2.2.1. Message Generation

The OSPF Packet is created as usual, with these exceptions:

(1) The OSPF checksum is not calculated, but is set to zero.

(2) The authentication type field indicates the Keyed Message Digest Algorithm (2).

(3) The authentication "password" field is reused to store a packet offset to the Authentication Data, a Key Identifier, the Authentication Data Length, and a non-decreasing sequence number.

The value used in the sequence number is arbitrary, but two suggestions are the time of the message's creation or a simple message counter.

The OSPF Authentication Key is selected by the sender based on the outgoing interface. Each key has a lifetime associated with it. No key is ever used outside its lifetime. If more than one key is currently alive, then the youngest key (the key whose lifetime most recently started) SHOULD be used. Since the key's algorithm is an attribute of the key, stored in the sender and receiver along with it, the Key ID effectively indicates which authentication algorithm is in use if the

implementation supports more than one authentication algorithm.

(1) The OSPF header's packet length field indicates the standard OSPF portion of the packet.

(2) The Authentication Data Offset, Key Identifier, and Authentication Data size fields are filled in appropriately.

(3) The OSPF Authentication Key, which is 16 bytes long when the MD5 algorithm is used, is now appended to the data. For all algorithms, the OSPF Authentication Key is never longer than the output of the algorithm in use.

(4) Trailing pad and length fields are added and the digest calculated using the indicated algorithm. When MD5 is the algorithm in use, these are calculated per RFC 1321.

(5) The digest is written over the OSPF Authentication Key. When MD5 is used, this digest will be 16 bytes long.

The trailing pad is not actually transmitted, as it is entirely predictable from the message length and algorithm in use.

2.2.2. Message Reception

When the message is received, the process is reversed:

(1) The OSPF Checksum is not calculated,

(2) The digest is set aside,

(3) The appropriate algorithm and key are determined from the value of the Key Identifier field,

(4) The OSPF Authentication Key is written into the appropriate number (16 when MD5 is used) of bytes starting at the offset indicated,

(5) Appropriate padding is added as needed, and

(6) A new digest calculated using the indicated algorithm.

If the calculated digest does not match the received digest, the message is discarded unprocessed. If the neighbor is in a state other than DOWN or ATTEMPT and the received sequence number is less than the last one received, the message likewise is discarded unprocessed. The received sequence number must, of course, be stored by neighbor and zeroed upon a "neighbor down" event. Acceptable messages are now truncated to "OSPF Data Length" and treated normally.

3. Management Procedures

3.1. Use of SNMP in Key Management

It is strongly desirable that a hypothetical security breach in one Internet protocol not automatically compromise other Internet protocols. Also, the default method for changing SNMP Version 2 encryption keys does not provide the property of perfect forward secrecy. Therefore, the OSPF Authentication key of this specification SHOULD NOT be stored using SNMP.

3.2. Key Management Requirements

Implementations MUST support the storage of more than one key at the same time. They MUST associate a specific lifetime (i.e., data/time first valid and data/time no longer valid) with each key, the key identifier, and MUST support manual key distribution (e.g., the privileged user manually typing in the key, key lifetime, and key

identifier on the router console). If more than one algorithm is supported, then the implementation MUST require that the algorithm be specified for each key at the time the other key information is entered. Keys that are out of date MAY be deleted at will by the implementation without requiring human intervention.

It is likely that the IETF will define a standard key management protocol. It is strongly desirable to use that key management protocol to distribute OSPF Authentication Keys among communicating OSPF implementations. Such a protocol would provide scalability and significantly reduce the human administrative burden. The Key ID can be

used as a hook between OSPF and such a future protocol. Key management protocols have a long history of subtle flaws that are often discovered long after the protocol was first described in public. To avoid having to change all OSPF implementations should such a flaw be discovered, integrated key management protocol techniques were deliberately omitted from this specification.

3.3. Key Management Procedures

As with all security methods using keys, it is necessary to change the OSPF Authentication Key on a regular basis. To maintain routing stability during such changes, implementations are required to store and support the use of more than one OSPF Authentication Key on a given interface at the same time.

Each key will have its own Key Identifier, which is stored locally. The combination of the Key Identifier and the interface associated with the message uniquely identifies the Authentication Algorithm and OSPF Authentication Key in use.

As noted above in Section 2.2.1, the party creating the OSPF message will select a valid key from the set of valid keys for that interface. The receiver will use the Key Identifier and interface to determine which key to use for authentication of the received message. More than one key may be associated with an interface at the same time.

Hence it is possible to have fairly smooth OSPF Authentication Key rollovers without losing legitimate OSPF messages because the stored key is incorrect and without requiring people to change all the keys at once. To ensure a smooth rollover, each communicating OSPF system must be updated with the new key several minutes before they current key will expire and several minutes before the new key lifetime begins. The new key should have a lifetime that starts several minutes before the old key expires. This gives time for each system to learn of the new OSPF

Authentication Key before that key will be used. It also ensures that the new key will begin being used and the current key will go out of use before the current key's lifetime expires. For the duration of the overlap in key lifetimes, a system may receive messages using either key and authenticate the message.

4. Conformance Requirements

To conform to this specification, an implementation MUST support all of its aspects. The MD5 authentication algorithm defined in RFC-1321 MUST be implemented by all conforming implementations. A conforming implementation MAY also support other authentication algorithms such as NIST's Secure Hash Algorithm (SHA). Manual key distribution as described above MUST be supported by all conforming implementations. All implementations MUST support the smooth key rollover described under "Key Change Procedures.S

The user documentation provided with the implementation MUST contain clear instructions on how to ensure that smooth key rollover occurs.

Implementations SHOULD support a standard key management protocol for secure distribution of OSPF Authentication Keys once such a key management protocol is standardized by the IETF.

5. Acknowledgments

This work was done by the OSPF Working Group, of which John Moy is the Chair. This suggestion was originally made by Christian Huitema on behalf of the IAB. Jeff Honig (Cornell) and Dennis Ferguson (ANS) built the first operational prototype, proving out the algorithms. The authors gladly acknowledge significant inputs from each of these sources.

6. References

[1] Moy, John, "OSPF Version 2", RFC 1583, March 1994.

[2] Rivest, R., "The MD5 Message-Digest Algorithm", RFC 1321, April 1992.

[3] F. Baker, R. Coltun, "OSPF Version 2 Management Information Base", RFC 1253, August 1991

[4] S. Bellovin, "Security Problems in the TCP/IP Protocol Suite", ACM Computer Communications Review, Volume 19, Number 2, pp.32-48, April 1989.

[5] N. Haller, R. Atkinson, "Internet Authentication Guidelines", RFC-XXXX (already submitted to RFC Editor), September 1994.

7. Security Considerations

This entire memo describes and specifies an authentication mechanism for the OSPF routing protocol that is believed to be secure against active and passive attacks. Passive attacks are clearly widespread in the Internet at present. Protection against active attacks is also needed even though such attacks are not currently widespread.

Users need to understand that the quality of the security provided by this mechanism depends completely on the strength of the implemented authentication algorithms, the strength of the key being used, and the correct implementation of the security mechanism in all communicating OSPF implementations. This mechanism also depends on the OSPF Authentication Key being kept confidential by all parties. If any of these incorrect or insufficiently secure, then no real security will be provided to the users of this mechanism.

Confidentiality is not provided by this mechanism. Work is underway within the IETF to specify a standard mechanism for IP-layer encryption. That mechanism might be used to provide confidentiality for OSPF in the future. Protection against traffic analysis is also not provided. Mechanisms such as bulk link encryption might be used when protection against traffic analysis is required.

The memo is written to address a security consideration in OSPF Version 2 that was raised during the IAB's recent security review [cite RFC here].

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