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Security of Messages Exchanged Between Servers and Relay Agents
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Abstract

The Dynamic Host Configuration Protocol for IPv4 (DHCPv4) has no guidance for how to secure messages exchanged between servers and relay agents. The Dynamic Host Configuration Protocol for IPv6 (DHCPv6) states that IPsec should be used to secure messages exchanged between servers and relay agents, but does not require encryption. And, with recent concerns about pervasive monitoring and other attacks, it is appropriate to require securing relay to relay and relay to server communication for DHCPv6 and relay to server communication for DHCPv4.

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1. Introduction

The Dynamic Host Configuration Protocol for IPv4 (DHCPv4) [RFC2131] and [RFC1542] has no guidance for how to secure messages exchanged between servers and relay agents. The Dynamic Host Configuration Protocol for IPv6 (DHCPv6) [RFC3315] states that IPsec should be used to secure messages exchanged between servers and relay agents, but does not recommend encryption. And, with recent concerns about pervasive monitoring [RFC7258], it is appropriate to require use of IPsec with encryption for relay to server communication for DHCPv4 and require use of IPsec with encryption for relay to relay and relay

to server communication for DHCPv6.

2. Requirements Language and Terminology

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] when they appear in ALL CAPS. When these words are not in ALL CAPS (such as "should" or "Should"), they have their usual English meanings, and are not to be interpreted as [RFC2119] key words.

This document uses terminology from [RFC1542], [RFC2131], and [RFC3315].

3. Security of Messages Exchanged Between Servers and Relay Agents

For DHCPv6 [RFC3315], this specification REQUIRES IPsec encryption of relay to relay and relay to server communication and replaces the text in RFC3315 Section 21.1.

For DHCPv4 [RFC2131], this specification REQUIRES IPsec encryption of relay to server communication.

By using IPsec with encryption for this communication, the potentially sensitive client message and relay included information, such as the DHCPv4 relay-agent information option (82) [RFC3046], vendor-specific information (for example, [CableLabs-DHCP]), and Access-Network-Identifier Option(s) [RFC7839], are protected from pervasive monitoring and other attacks.

Relay agents and servers MUST exchange messages securely using the IPsec mechanisms described in [RFC4301]. If a client message is relayed through multiple relay agents (relay chain), each of the relay agents MUST have an established independent, pairwise trust relationships. That is, if messages from client C will be relayed by relay agent A to relay agent B and then to the server, relay agents A and B MUST be configured to use IPsec for the messages they exchange, and relay agent B and the server MUST be configured to use IPsec for

the messages they exchange.

Selectors
: Relay agents are manually configured with the addresses of the relay agent or server to which DHCP messages are to be forwarded. Each relay agent and server that will be using IPsec for securing DHCP messages MUST also be configured with a list of the relay agents to which messages will be returned. The selectors for the relay agents and servers will be the pairs of addresses defining relay agents and servers and the

direction of DHCP message exchange on DHCPv4 UDP port 67 or DHCPv6 UDP port 547.

Mode
: Relay agents and servers MUST use IPsec in transport mode and Encapsulating Security Payload (ESP).

Encryption and authentication algorithms
: This document REQUIRES combined mode algorithms for ESP authenticated encryption, ESP encryption algorithms, and ESP authentication algorithms as per Sections 2.1, 2.2, and 2.3 of [RFC7321] respectively. Encryption is required as relay agents may forward unencrypted client messages as well as include additional sensitive information, such as vendor-specific information (for example, [CableLabs-DHCP]) and [RFC7839].

Key management
: Because both relay agents and servers tend to be managed by a single organizational entity, public key schemes MAY be optional. Manually configured key management MAY suffice, but does not provide defense against replayed messages. Accordingly, IKEv2 [RFC7296] with pre-shared secrets SHOULD be supported. IKEv2 with public keys MAY be supported. Additional information on manual vs automated key management and when one should be used

over the other can be found in [RFC4107].

Security policy	DHCP messages between relay agents and servers MUST only be accepted from DHCP peers as identified in the local configuration.
Authentication	Shared keys, indexed to the source IP address of the received DHCP message, are adequate in this application.

Note: As using IPsec with multicast has additional complexities (see [RFC5374]), relay agents SHOULD be configured to forward DHCP messages to unicast addresses.

4. Security Considerations

The security model specified in this document is hop-by-hop. For DHCPv6, there could be multiple relay agents between a client and

server and each of these hops needs to be secured. For DHCPv4, there is no support for multiple relays.

As this document only mandates securing messages exchanged between relay agents and servers, the message exchanges between clients and the first hop relay agent or server are not secured. Clients may follow the recommendations in [RFC7844] to minimize what information they expose or make use of [I-D.ietf-dhc-sedhcpv6] to secure communication between the client and server.

As mentioned in [RFC4552] Section 14, the following are known limitations of the usage of manual keys:

- As the sequence numbers cannot be negotiated, replay protection cannot be provided. This leaves DHCP insecure against all the attacks that can be performed by replaying DHCP packets.
- Manual keys are usually long lived (changing them often is a tedious task). This gives an attacker enough time to discover the keys.

It should be noted if the requirements in this document are followed,

while the DHCP traffic on the wire between relays and servers is encrypted, the unencrypted data may still be available through other attacks on the DHCP servers, relays, and related systems. Securing these systems and the data in databases and logs also needs to be considered - on the systems themselves and if transferred over a network (i.e., to network attached storage, for backups, or to operational support systems).

Use of IPsec as described herein is also applicable to Lightweight DHCPv6 Relay Agents [RFC6221], as they have a link-local address which can be used to secure communication with their next hop relay(s).

5. IANA Considerations

This document has no requests of the fantastic IANA team.

6. Acknowledgments

The motivation for this document was several IESG discusses on recent DHCP relay agent options.

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