           The Network Endpoint Assessment (NEA) Asokan Attack Analysis

Abstract

   The Network Endpoint Assessment (NEA) protocols are subject to a
   subtle forwarding attack that has become known as the NEA Asokan
   Attack. This document describes the attack and countermeasures that
   may be mounted.

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1. Introduction

   The Network Endpoint Assessment (NEA) [2] protocols are subject to a
   subtle forwarding attack that has become known as the NEA Asokan
   Attack. This document describes the attack and countermeasures that
   may be mounted. The Posture Transport (PT) protocols developed by
   the NEA working group, PT-TLS [5] and PT-EAP [6], include mechanisms
   that can provide cryptographic-binding and identity-binding
   countermeasures.

2. NEA Asokan Attack Explained

   The NEA Asokan Attack is a variation on an attack described in a 2002
   paper written by Asokan, Niemi, and Nyberg [1]. Figure 1 depicts one
   version of the original Asokan attack. This attack involves tricking
   an authorized user into authenticating to a decoy Authentication,
   Authorization, and Accounting (AAA) server, which forwards the
   authentication protocol from one tunnel to another, tricking the real
   AAA server into believing these messages originated from the
   attacker-controlled machine. As a result, the real AAA server grants
   access to the attacker-controlled machine.

```
                   +-------------+ ========= +----------+
                   |   Attacker  |-AuthProto--|AAA Server|
                   +-------------+ ========= +----------+
                          |
                      AuthProto
                          |
 +--------------+ ========= +----------------+
 |AuthorizedUser|-AuthProto--|Decoy AAA Server|
 +--------------+ ========= +----------------+
```
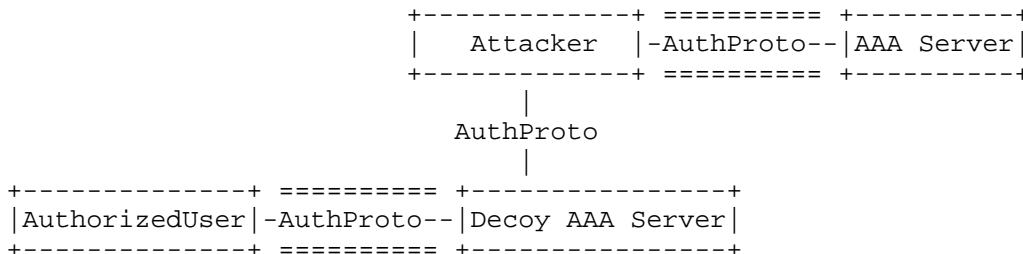
            Figure 1: One Example of Original Asokan Attack

As described in the NEA Overview [2], the NEA Reference Model is
composed of several nested protocols. The Posture Attribute (PA)
protocol is nested in the Posture Broker (PB) protocol, which is
nested in the PT protocol. When used together successfully, these
protocols allow an NEA Server to assess the security posture of an
endpoint. The NEA Server may use this information to decide whether
network access should be granted, or it may use this information for
other purposes.

Figure 2 illustrates an NEA Asokan Attack. The attacker wants to
trick GoodServer into believing that DirtyEndpoint has good security
posture. This might allow, for example, the attacker to bring an
infected machine onto a network and infect others. To accomplish
this goal, the attacker forwards PA messages from CleanEndpoint
through BadServer to DirtyEndpoint, which sends them on to
GoodServer. GoodServer is tricked into thinking that the PA messages
came from DirtyEndpoint and therefore considers DirtyEndpoint to be
clean.

```
                  +-------------+ ========= +----------+
                  |DirtyEndpoint|-----PA-----|GoodServer|
                  +-------------+ ========= +----------+
                         |
                        PA
                         |
 +-------------+ ========= +---------+
 |CleanEndpoint|-----PA-----|BadServer|
 +-------------+ ========= +---------+
```
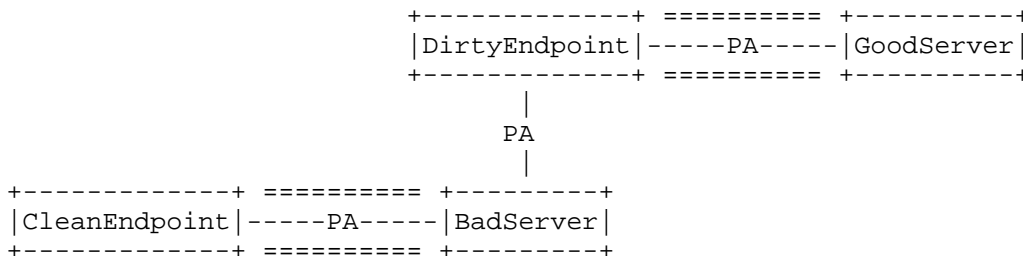
                    Figure 2: NEA Asokan Attack

Countermeasures against an NEA Asokan Attack are described in Section
4.

3. Lying Endpoints

   Some may argue that there are other attacks against NEA systems that
   are simpler than the Asokan attack, such as lying endpoint attacks.
   That is true. It's easy for an endpoint to simply lie about its
   posture. But, there are defenses against lying endpoint attacks,
   such as using an External Measurement Agent (EMA).

   An EMA is hardware, software, or firmware that is especially secure,
   hard to compromise, and designed to accurately report on endpoint
   configuration. The EMA observes and reports on critical aspects of
   endpoint posture, such as which security-relevant firmware and
   software have been loaded.

   When an EMA is used for NEA, the PA messages that reliably and
   securely establish endpoint posture are exchanged between the EMA
   itself and a Posture Validator on the NEA Server. The Posture
   Collector on the endpoint and any other intermediaries between the
   EMA and the Posture Validator on the NEA Server are not trusted.
   They just pass messages along as untrusted intermediaries.

   To ensure that the EMA's messages are accurately conveyed to the
   Posture Validator, even if the Posture Collector or other
   intermediaries have been compromised, these PA messages must provide
   integrity protection, replay protection, and source authentication
   between the EMA and the Posture Validator. Confidentiality
   protection is not needed, at least with respect to the software on
   the endpoint, but integrity protection should include protection
   against message deletion and session truncation. Organizations that
   have developed EMAs have typically developed remote attestation
   protocols that provide these properties (e.g., the Trusted Computing
   Group's (TCG's) Platform Trust Service (PTS) Protocol Binding to IF-M
   [7]). While the development of lying endpoint detection technologies
   is out of scope for NEA, these technologies must be supported by the
   NEA protocols. Therefore, the NEA protocols must support
   countermeasures against the NEA Asokan Attack.

4. Countermeasures against the NEA Asokan Attack

4.1. Identity Binding

   One way to mitigate the Asokan attack is to bind the identities used
   in tunnel establishment into a cryptographic exchange at the PA
   layer. While this can go a long way to preventing the attack, it
   does not bind the exchange to a specific TLS exchange, which is
   desirable. In addition, there is no standard way to extract an
   identity from a TLS session, which could make implementation
   difficult.

4.2. Cryptographic Binding

   Another way to thwart the NEA Asokan Attack is for the PA exchange to
   be cryptographically bound to the PT exchange and to any keying
   material or privileges granted as a result of these two exchanges.
   This allows the NEA Server to ensure that the PA messages pertain to
   the same endpoint as the party terminating the PT exchange and that
   no other party gains any access or advantage from this exchange.

4.2.1. Binding Options

   This section discusses binding protocol solution options and provides
   analysis. Since PT-TLS and PT-EAP involve TLS, this document focuses
   on TLS-based solutions that can work with either transport.

4.2.1.1. Information from the TLS Tunnel

   The TLS handshake establishes a cryptographic state between the TLS
   client and TLS server. There are several mechanisms that can be used
   to export information derived from this state. The client and server
   independently include this information in calculations to bind the
   instance of the tunnel into the PA protocol.

   Keying Material Export - RFC 5705 [8] defines Keying Material
   Exporters for TLS that allow additional secret key material to be
   extracted from the TLS master secret.

   tls-unique Channel Binding Data - RFC 5929 [9] defines several
   quantities that can be extracted from the TLS session to bind the TLS
   session to other protocols. The tls-unique binding consists of data
   extracted from the TLS handshake finished message.

4.2.1.2. TLS Cipher Suites

   In order to eliminate the possibility of a man-in-the-middle attack
   and thwart the Asokan attack when using the keying material export
   binding export mechanism, it is important that neither TLS endpoint
   be in sole control of the TLS pre-master secret. Cipher suites based
   on key transport, such as RSA cipher suites, do not meet this
   requirement; instead, Diffie-Hellman Cipher Suites, such as RSA-DHE,
   are required when this mechanism is employed.

4.2.1.3. Using Additional Key Material from TLS

   In some cases, key material is extracted from the TLS tunnel and used
   to derive ciphering keys used in another protocol. For example,
   EAP-TLS [10] uses key material extracted from TLS in lower-layer
   ciphering. In this case, the extracted keys must not be under the
   control of a single party, so the considerations in the previous
   section are important.

4.2.1.4. EMA Assumptions

   The EMA needs to obtain the binding data from the TLS exchange and
   prove knowledge of the binding data in an exchange that has integrity
   protection, source authentication, and replay protection.

5. Conclusions

   The recommendations for addressing the NEA Asokan Attack are as
   follows:

   1. Protocols should make use of cryptographic binding; in addition,
       binding identities of the tunnel endpoints in the EMA may be
       useful.

   2. In particular, L2 and L3 TLS-based PT transports (e.g., PT-TLS
       and PT-EAP) should use the same cryptographic binding mechanism.

   3. The preferred approach is to use the tls-unique channel binding
       data from [9]. The tls-unique value will be made available to
       the EMA that will use it. This approach can utilize any TLS
       cipher suite based on a strong cipher algorithm.

6. Security Considerations

   This document is primarily concerned with analyzing and proposing
   countermeasures for the NEA Asokan Attack. That does not mean that
   it covers all the possible attacks against the NEA protocols or
   against the NEA Reference Model. For a broader security analysis,
   see the Security Considerations section of the NEA Overview [2],
   PA-TNC [3], PB-TNC [4], PT-TLS [5], and PT-EAP [6].

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8. Acknowledgments

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