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EAP Early Authentication Problem Statement
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Abstract

EAP (Extensible Authentication Protocol) early authentication may be defined as the use of EAP to establish authenticated keying material on a target authenticator prior to arrival of the peer at the access network managed by that authenticator. This draft discusses the EAP early authentication problem in detail.

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1. Introduction

When a mobile device, during an active communication session, moves from one access network to another and changes its point of attachment, the session may be subjected to disruption in the continuity of service due to the delay associated with the handover operation. The performance requirements of a real-time application will vary based on the type of application and its characteristics such as delay and packet loss tolerance. For VoIP applications, ITU-T G.114 [ITU] recommends a steady-state end-to-end delay of 150 ms as the upper limit and rates 400 ms as generally unacceptable delay. Similarly, a streaming application has a tolerable packet (SDU) error rates ranging from 0.1 to 0.00001 with a transfer delay of less than 300 ms. Any help that an optimized handoff mechanism can provide toward meeting these objectives is useful. The ultimate objective is to achieve seamless handover with low latency, even when handover is between different link technologies or between different AAA domains.

As a mobile device goes through a handover process, it is subjected to delay because of the rebinding of its association at or across several layers of the protocol stack and because of the additional round trips needed for a new EAP exchange. Delays incurred within each protocol layer affect the ongoing multimedia application and data traffic within the client [WCM].

The handover process often requires authentication and authorization for acquisition or modification of resources assigned to the mobile device. In most cases, this authentication and authorization needs interaction with a central authority in a domain. In some cases the central authority may be placed far away from the mobile device. The delay introduced due to such an authentication and authorization procedure adds to the handover latency and consequently affects ongoing application sessions[MQ7]. The discussion in this document is focused on mitigating delay due to network access authentication and authorization.

2. Terminology

AAA Authentication, Authorization, and Accounting. AAA protocols RADIUS [RFC2865] and Diameter [RFC3588].

AAA domain
The set of access networks within the scope of a specific AAA server. Thus, if a peer changes from one point of attachment to another within the same AAA domain, it continues to be served by the same AAA server.

Access Point (AP)
A network point of attachment in a IEEE 802.11 wireless LAN [IEEE.802-11.2007].

Authenticator
See [RFC3748].

Basic Service Set (BSS)
The basic building block of an IEEE 802.11 wireless LAN [IEEE.802-11.2007]. A BSS consists of a group of any number of 802.11 stations.

Candidate Access Network
An access network that can potentially become the target access network for a peer. There can be multiple candidate access networks for the peer.

Candidate Authenticator (CA)
An authenticator that can potentially become the target authenticator for a peer. There can be multiple candidate authenticators for the peer.

EAP Server
See [RFC3748].

EAP Early Authentication (EEA)
The utilization of EAP to pre-establish EAP keying material on an EAP authenticator prior to arrival on a link served by that authenticator of the mobile device that acts as an EAP peer.

Extended Service Set (ESS)
A set of infrastructure BSSs in IEEE 802.11 wireless LAN [IEEE.802-11.2007], where the access points communicate amongst themselves to forward traffic from one BSS to another to facilitate movement of stations between BSSs.

Inter-AAA-Domain Handover (Inter-Domain Handover)
A handover across multiple AAA domains.

Inter-Authenticator Handover
A handover across multiple authenticators. An inter-access-domain handover, an inter-ESS handover, an inter-AAA-domain handover, an inter-technology handover can be view as examples of inter-authenticator handover.

Inter-ESS Handover
An 802.11 handover across multiple ESSs.

Inter-Technology Handover
A handover across different link layer technologies.

Intra-AAA-Domain Handover (Intra-Domain Handover)
A handover within the same AAA domain. Intra-AAA-domain handover include a handover across different authenticators within the same AAA domain.

Intra-Technology Handover
A handover within the same link layer technology.

Master Session Key (MSK)
See [RFC3748].

Peer
The entity that responds to the authenticator (below); for details, see [RFC3748].

Serving Access Network

An access network that is currently serving the peer.

Serving Authenticator (SA)
An authenticator that is currently serving the peer.

Target Access Network
An access network that has been chosen to be the new serving access network for a peer.

Target Authenticator (TA)
An authenticator that has been chosen to be the new serving authenticator for a peer.

3. Problem Statement

The basic mechanism of handover is a two-step procedure involving

- handover preparation iand
- handover execution

Handover preparation includes the discovery of candidate network points of attachment and selection of an appropriate target attachment point from the candidate set. Handover execution consists of setting up L2 and L3 connectivity with the target. Currently, as

part of the second step, network access authentication and authorization is performed directly with the target network. Following a successful EAP authentication, a secure association procedure is performed between the peer and the target authenticator to derive a new set of link-layer ciphering keys from EAP keying material such as the MSK. The second step may require full EAP authentication in the absence of any particular optimization for handover key management. The handover latency introduced by full EAP authentication has proven to be larger than what is acceptable for real-time application scenarios as described in [MQ7]. Hence, improvement in the handover latency performance due to EAP is a necessary objective for such scenarios.

As an example of the second step, in IEEE 802.11 wireless LANs [IEEE.802-11.2007]the network access authentication and authorization

involves performing a new IEEE 802.1X message exchange with the authenticator in the target AP to initiate an EAP exchange to the authentication server[WPA].

As another example, in 3GPP Technical Specification TS 33.402 [TS33.402]], network access authentication and authorization happens after L2 connection is established between the mobile device and a non-3GPP target access network, and involves EAP exchange between the mobile device and 3GPP AAA server through the non-3GPP target access network.

There has been relevant optimization work undertaken by various standards organizations, but these efforts have generally been scoped to specific link layer technologies. The work done in the IEEE 802.11f ([IEEE.802-11F.2003] and 802.11r [IEEE.802-11R.2008]) Task Groups applies only to transfers within one 802.11 ESS or AAA domain. [TS33.402] defines the authentication and key management procedures performed during interworking between non-3GPP access networks and the Evolved Packet System (EPS). These procedures are not really independent of link technology, since they assume either that the authenticator lies in the EPS network or that separate authentications are performed in the access network and then in the EPS network. Therefore, a solution is still needed to enable EAP early authentication for inter-AAA-domain handovers and inter-technology handovers. A search for solutions at the IP level may offer the necessary technology independence.

Optimized solutions for secure inter-authenticator handovers can be seen either as security context transfer (e.g., using the EAP Extensions for EAP Re-authentication Protocol (ERP)) [RFC5296], or as EAP early authentication. Security context transfer involves transfer of reusable key context to the new point of attachment. Horizontal context transfer of reusable key context is not

recommended [RFC4962] because of the possibility that the compromise of one authenticator might lead to the compromise of another authenticator. ERP uses existing EAP keying material obtained from the AAA server in the home realm to derive a cryptologically independent re-authentication key to be distributed to an ERP server in a visited domain. This reduces handover delay by eliminating the need to run full EAP authentication with the EAP server in the home domain for intra-domain handovers.

However, there are certain cases where ERP is not applicable or an additional optimization mechanism is needed to establish a key for the candidate authenticator:

- One case is an inter-domain handover. A trust relationship is required between the home and visited AAA domains. Given that trust relationship and assuming the visited AAA domain supports ERP, full EAP authentication with the EAP server in the home AAA domain is still needed to distribute the existing keying materials to the ERP server when the mobile device first enters the visited AAA domain.

- Another case is an inter-technology handover where the candidate and serving authenticator are different entities belonging to two different visited AAA domains and the AAA is same in the home AAA domain.

Applicability of EAP early authentication is limited to the scenarios where candidate authenticators can be discovered and an accurate prediction of movement can be easily made; also, the effectiveness of EAP early authentication may be less significant for particular inter-technology handover scenarios where simultaneous use of multiple technologies is not a major concern.

In EAP early authentication, AAA-based authentication and authorization for a candidate authenticator is performed while ongoing data communication is in progress via the serving network. The goal of EAP early authentication is to complete AAA signaling for EAP before the peer moves. There are several AAA issues related to EAP early authentication. These issues are described in Section 6.

Figure 1 shows the functional elements that are related to EAP early authentication. These functional elements include a peer, a serving authenticator, a candidate authenticator and an AAA/EAP server (or AAA/EAP servers, if this is an inter-AAA-domain handover). When the serving and candidate authenticators belong to different AAA domains, the candidate authenticator may use a different AAA server and user credentials than those were used by the serving authenticator to authenticate the peer. Alternatively, the candidate authenticator

and the serving authenticator may rely on the same AAA server, which

is located in the home domain of the mobile device.

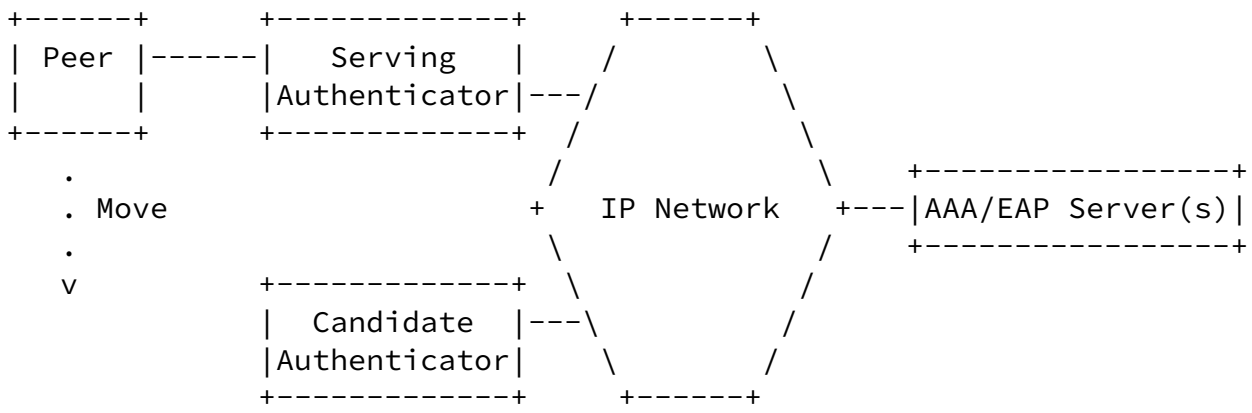


Figure 1: EAP Pre-authentication Functional Elements

A peer is attached to the serving access network. Before the peer performs handover from the serving access network to a candidate access network, it performs EAP early authentication with a candidate authenticator via the serving access network. The peer may perform EAP early authentication with one or more candidate authenticators. It is assumed that each authenticator has an IP address. It is assumed that there is at least one candidate authenticator in each candidate access network while the serving access network may or may not have a serving authenticator. The serving and candidate access networks may use different link layer technologies.

Each authenticator is either a standalone authenticator or pass-through authenticator [RFC3748]. When an authenticator acts as a standalone authenticator, it also has the functionality of an EAP server. When an authenticator acts as a pass-through authenticator, it communicates with the EAP server typically implemented on a AAA server using a AAA transport protocol such as RADIUS [RFC2865] and Diameter [RFC3588].

If the candidate authenticator uses an MSK [RFC5247] for generating lower-layer ciphering keys, EAP early authentication is used for proactively generating an MSK for the candidate authenticator.

3.1. Topological Classification of Handover Scenarios

The complexity of the authentication and authorization portion of handover depends on whether the handover involves a change of authenticator, and whether it involves a change in EAP Server. Consider first the case where the authenticators operate in pass-through mode, so that the EAP Server is a AAA server. Then there is

a strict hierarchy of complexity, as follows:

1. intra-authenticator handover: the candidate and serving authenticator are identical. The authenticator can continue to use the same keying material. The early authentication problem is simply how to recognize this situation.

2. inter-authenticator handover with common AAA server: the candidate and serving authenticator are different entities, but the AAA server is the same. There are two sub-cases here:

   (a) the AAA server is common because both authenticators lie within the same network, or

   (b) the AAA server is common because AAA entities in the serving and candidate networks proxy to a AAA server in the home domain.

3. inter-AAA-domain handover: the candidate and serving authenticator are different entities, and the respective AAA servers also differ. As a result, authentication in the candidate network requires a second set of user credentials.

A fourth case is where one or both authenticators is collocated with an EAP Server. This has some of the characteristics of an inter-AAA-domain handover, but offers less flexibility for resolution of the early authentication problem.

Orthogonally to this classification, one can distinguish intra-technology handover from inter-technology handover, thinking of the link technologies involved. In the inter-technology case, it is highly probable that the authenticators will differ. The most likely cases are 2(b) or 3 in the above list.

4. Early Authentication Usage Models

As noted in Section 3, there are cases where early authentication is applicable while ERP does not work. This section concentrates on providing some usage models around which we can build our analysis of the EAP early authentication problem. Different usage models can be defined depending on whether

- the serving authenticator is not involved in early authentication (direct pre-authentication usage model),

- the serving authenticator interacts only with the candidate authenticator (indirect pre-authentication usage model), or

- the serving authenticator interacts with the AAA server (the authenticated anticipatory keying usage model).

It is assumed that the serving and candidate authenticators are different entities (case 1 of Section 3.1 excluded). It is further assumed in describing these models that there is no direct L2 connectivity between the peer and a candidate authenticator.

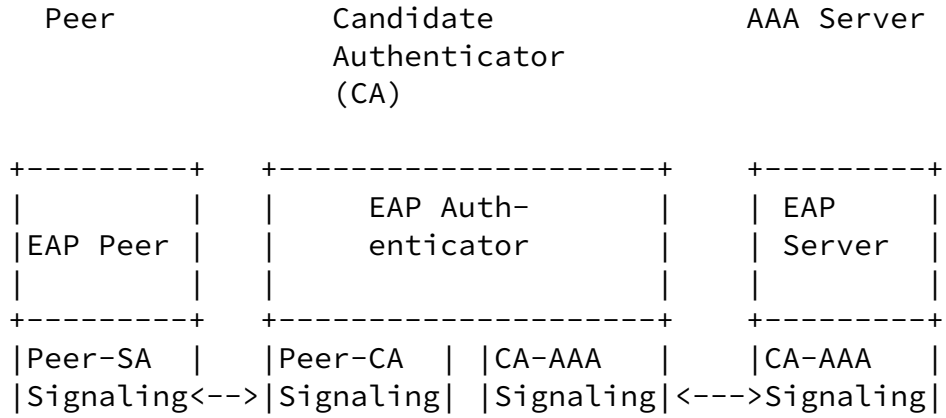
4.1. EAP Pre-authentication Usage Models

In the EAP Pre-authentication usage model, the serving authenticator does not interact with the AAA server directly. Depending on how the serving authenticator is involved in the pre-authentication signaling, the EAP pre-authentication usage model can be further categorized into the following two submodels.

4.1.1. The Direct Pre-authentication Model

In this model, the serving authenticator is not involved in the EAP exchange and only forwards the EAP pre-authentication traffic as it would any other data traffic, or there may be no serving authenticator at all in the serving access network. This model is applicable to any of the cases described in Section 3.1 except case 1.

The direct pre-authentication signaling for the usage model is shown in Figure 3.



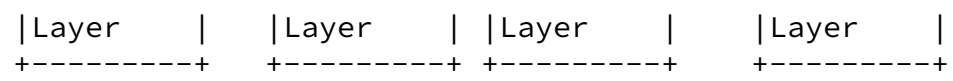


Figure 2: Direct Pre-authentication Usage Model

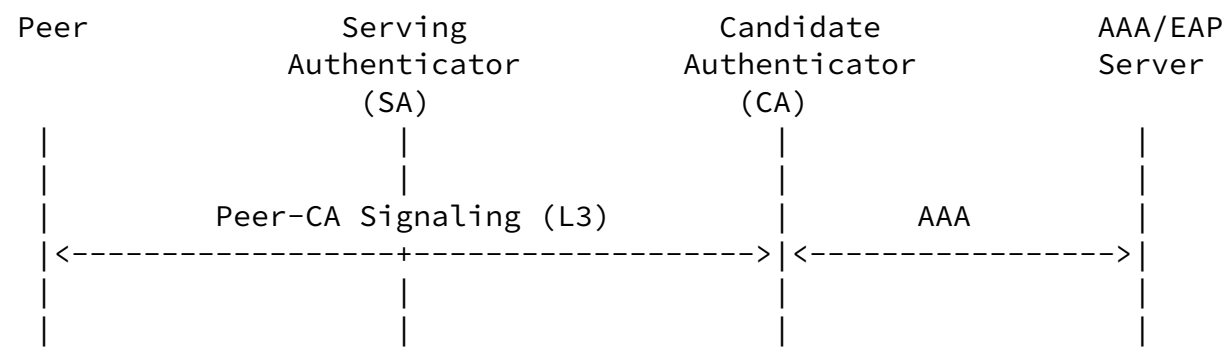


Figure 3: Direct Pre-authentication Signaling for the Usage Model

4.1.2. The Indirect Pre-authentication Usage Model

The indirect pre-authentication usage model is illustrated in Figure 4

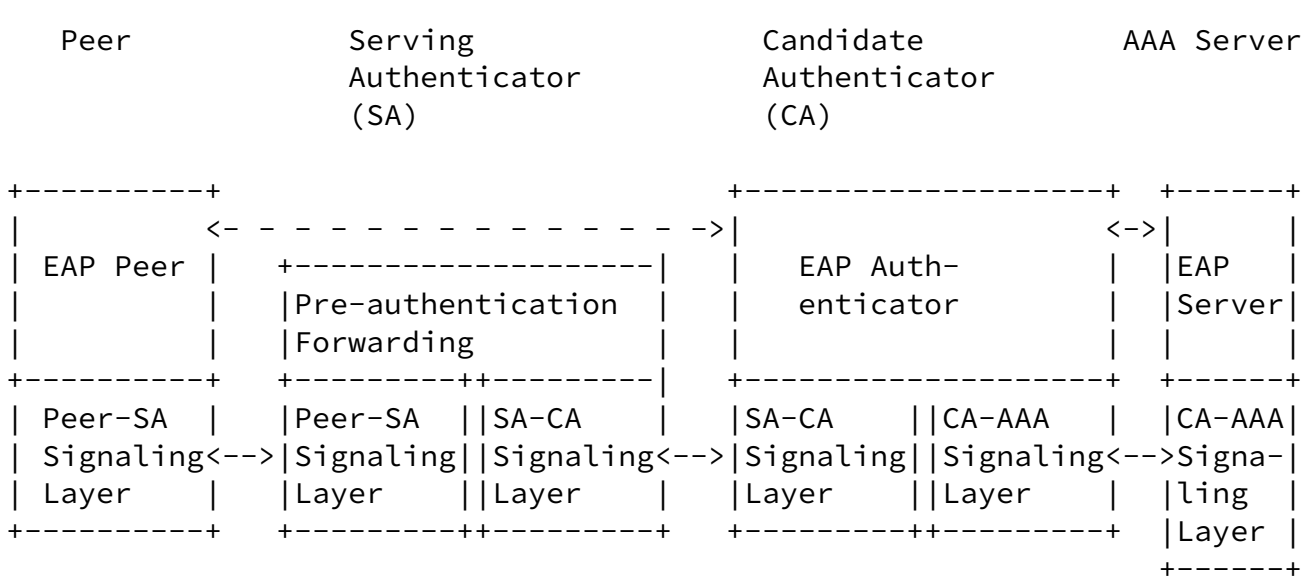


Figure 4: Indirect Pre-authentication Usage Model

In this indirect pre-authentication model, it is assumed that a trust relationship exists between the serving network (or serving AAA domain) and candidate network (or candidate AAA domain). The serving authenticator is involved in EAP pre-authentication signaling. This pre-authentication model is needed if the peer cannot discover the candidate authenticator's Identity or if IP communication is not available due to security or network topology reasons.

The role of the serving authenticator in this pre-authentication model is to forward EAP pre-authentication signaling between the peer and candidate authenticator and not to act as an authenticator for the candidate point of access. It continues to act as an authenticator for the serving point of access. The role of the

candidate authenticator is to forward EAP pre-authentication signaling between the peer (via the serving authenticator) and EAP server and receive the transported keying materials from the EAP server as an authenticator.

The pre-authentication signaling for this model is shown in Figure 5.

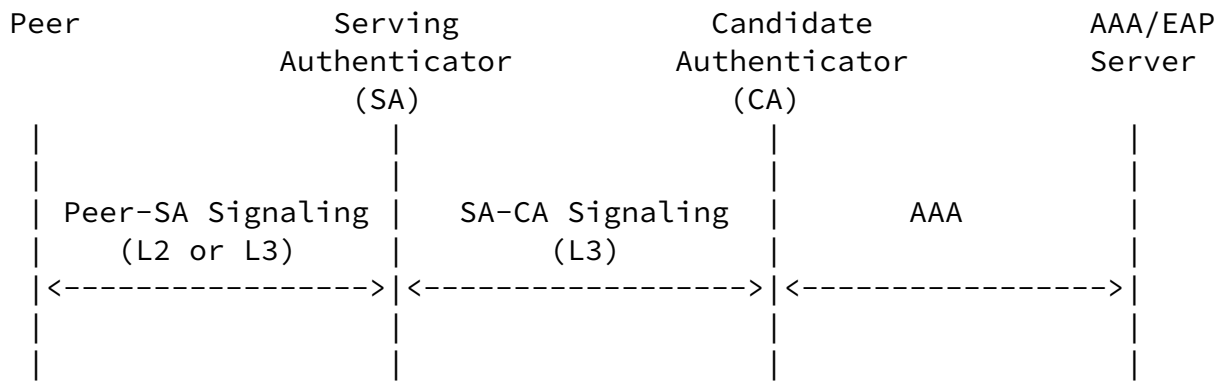


Figure 5: Indirect Pre-authentication Signaling for the Usage Model

In this model, the pre-authentication signaling path between a peer and a candidate authenticator consists of two segments: peer to serving authenticator signaling (Peer-SA signaling) and serving authenticator to candidate authenticator signaling (SA-CA signaling).

Peer-SA signaling is performed over L2 or L3.

SA-CA signaling is performed over L3.

4.2. The Authenticated Anticipatory Keying Usage Model

In the anticipated authentication keying usage model, the serving authenticator is required to interact with the AAA server directly. The authenticated anticipatory keying usage model is illustrated in Figure 6.

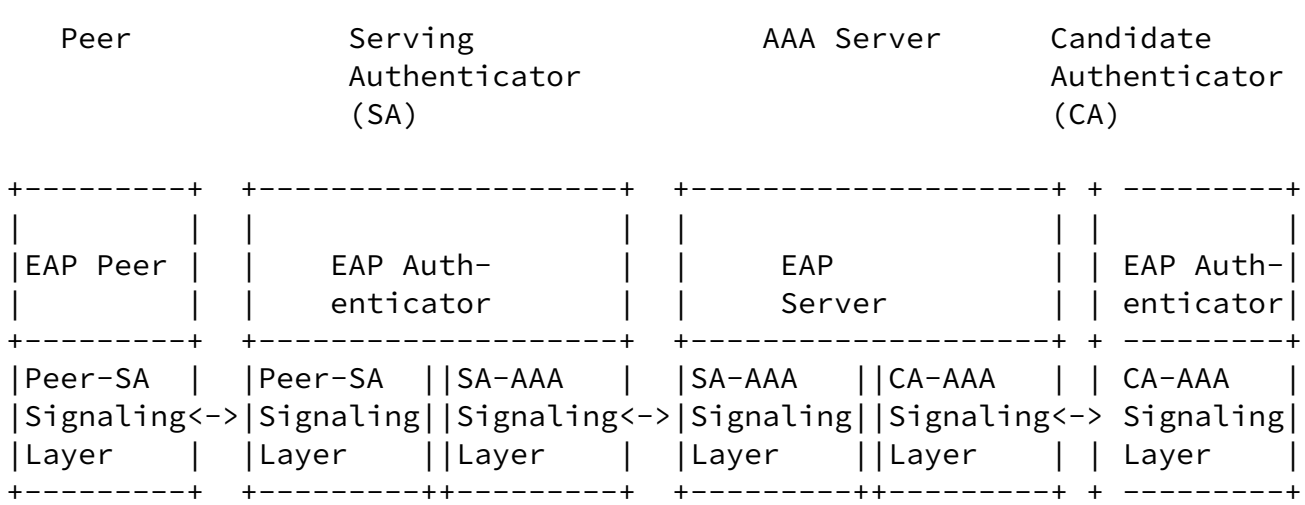


Figure 6: Authenticated Anticipatory Keying Usage Model

In this usage model, it is assumed that there is no trust relationship between the serving authenticator and the candidate

authenticator. The serving authenticator is involved in EAP authenticated anticipatory keying signaling.

The role of the serving authenticator in this usage model is to communicate with the peer on one side and exchange authenticated anticipatory keying signaling with the EAP server on the other side. This is not the simple mediation function of an authenticator, because the SA-AAA signaling in this case must identify the candidate authenticator to which keying material must be pushed. The role of the candidate authenticator is to receive the transported keying materials from the EAP server and to act as an authenticator after handover occurs. The Peer-SA signaling is performed over L2 or L3. The SA-AAA and AAA-CA segments operate over L3.

5. Architectural Considerations

There are two architectural issues relating to early authentication: authenticator discovery and context binding.

5.1. Authenticator Discovery

In general, early authentication requires the identity of a candidate authenticator to be discovered by a peer, by a serving authenticator, or by some other entity prior to handover. An authenticator discovery protocol is typically defined as a separate protocol from an early authentication protocol. For example, the IEEE 802.21 Information Service (IS) [IEEE.802-21] provides a link-layer-independent mechanism for obtaining neighboring network information by defining a set of Information Elements (IEs), where one of the IEs

is defined to contain an IP address of a point of attachment. IEEE 802.21 IS queries for such an IE may be used as a method for authenticator discovery.

If IEEE 802.21 IS or a similar mechanism is used, authenticator discovery requires a database of information regarding the target network; the provisioning of a server with such a database is another issue.

5.2. Context Binding

When a candidate authenticator uses different EAP transport protocols for normal authentication and early authentication, a mechanism is needed to bind link-layer-independent context carried over early authentication signaling to the link-layer-specific context of the link to be established between the peer and the candidate authenticator. The link-layer-independent context includes the identities of the peer and authenticator as well as the MSK. The link-layer-specific context includes link layer addresses of the peer and the candidate authenticator. Such context binding can happen before or after the peer changes its point of attachment.

There are at least two possible approaches to address the context binding issue. The first approach is based on communicating the link layer context as opaque data via early authentication signaling. The second approach is based on running EAP over the link layer of the candidate authenticator after the peer arrives at the authenticator, using short-term credentials generated via early authentication. In this case, the short-term credentials are shared between the peer and the candidate authenticator. In both approaches, context binding needs to be securely made between the peer and the candidate authenticator. Also, the peer is not fully authorized by the candidate authenticator until the peer completes the link-layer-specific secure association procedure with the authenticator using link layer signaling.

6. AAA Issues

Most of the AAA documents today do not distinguish between a normal authentication and a early authentication and this creates a set of open issues:

Early authentication authorization
: Users may not be allowed to have more than one logon session at the time. This means that while such users actively engage in a session (as a result of a previously valid authentication), they will not be able to perform early authentication. The AAA server currently has no way of distinguishing between a normal authentication request and an early authentication request.

Early authentication lifetime

Currently, AAA protocols define attributes carrying lifetime information for a normal authentication session. Even when a user profile and the AAA server support early authentication, the lifetime for a early authentication session is typically valid only for a short amount of time because the peer has not completed its authentication at the target link layer. It is currently not possible for a AAA server to indicate to the AAA client or a peer the lifetime of the early authenticated session unless AAA protocols are extended to carry early authentication session lifetime information. In other words, it is not clear to the peer or the authenticator when the early authentication session will expire.

Early authentication retries

It is typically expected that shortly following the early authentication process, the peer moves to the new point of attachment and converts the early authentication state to a normal authentication state (the procedure for which is not the topic of this particular subsection). However, if the peer has not yet moved to the new location and realizes that the early authentication is expiring, it may perform another early authentication. Some limiting mechanism is needed to avoid an unlimited number of early-authentication attempts.

Completion of network attachment

Once the peer has successfully attached to the new point of attachment, it needs to convert its authentication state from early authenticated to fully attached and authorized. If the AAA server needs to differentiate between early authentication and normal authentication, there may need to be a mechanism within the AAA protocol to provide this indication to the AAA server. This may be important from a billing perspective if the billing policy does not charge for a early authenticated peer until the peer is fully attached to the target authenticator.

Session resumption

In the case where the peer cycles between a network N1 with which it has a normal authentication state to another network N2 and then back to N1, it should be possible to simply convert the full authentication state to an early authenticated state. The problems around handling session lifetime and keying material caching need to be dealt with.

Multiple candidate authenticators
: There may be situations where the peer needs from among from among number of candidate authenticators. In such cases, it is desirable for the peer to perform early authentication with multiple candidate authenticators. This amplifies the difficulties noted under the point "Early authentication authorization"

Inter-domain handover support
: There may be situations where the peer moves out of the home domain or across different visited domains, in such cases, the early authentication should be performed through the visited AAA domain with the AAA server in the home AAA domain. It also requires the peer or the authenticator in the visited domain to acquire the identity information of the visited domain or the home domain for routing the EAP early authentication traffic. Knowledge of domain identities is required by both the peer and the authenticator to generate the early authentication key for mutual authentication between the peer and the visited AAA server.

Inter-technology support
: Current specifications on early authentication mostly deal with homogeneous 802.11 networks. AAA attributes such as Calling-Station-ID [I-D.aboba-radext-wlan] may need to be expanded to cover other access technologies. Furthermore, inter-technology handovers may require a change of the peer identifier as part of the handover. Investigation on the best type of identifiers for peers that support multiple access technologies is required.

7. Security Considerations

This section specifically covers threats introduced to the EAP model by early authentication. Security issues on general EAP and handover are described in other documents such as [RFC3748], [RFC4962], [RFC5169] and [RFC5247].

Since early authentication described in this document needs to work across multiple authenticators, any solution needs to consider the following security threats.

First, a resource consumption denial of service attack is possible, where an attacker that is not on the same IP link as the legitimate peer or the candidate authenticator may send unprotected early authentication messages to the legitimate peer or the candidate authenticator. As a result, the latter may spend computational and bandwidth resources on processing early authentication messages sent

by the attacker. This attack is possible for both direct and

indirect pre-authentication scenarios. To mitigate this attack, the candidate network or authenticator may apply non-cryptographic packet filtering so that early authentication messages received from only a specific set of serving networks or authenticators are processed. In addition, a simple solution for the peer side would be to let the peer always initiate EAP early authentication and not allow EAP early authentication initiation from an authenticator.

Second, consideration for the channel binding problem described in [RFC5247] is needed as lack of channel binding may enable an authenticator to impersonate another authenticator or communicate incorrect information via out-of-band mechanisms (such as via a AAA or lower layer protocol) [RFC3748]. It should be noted that it is relatively easier to launch such an impersonation attack for early authentication than normal authentication because an attacker does not need to be physically on the same link as the legitimate peer to send a early authentication trigger to the peer.

8. IANA Considerations

This document makes no requests for IANA action.

9. Acknowledgments

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11. References

11.1. Normative References

[RFC3748] Aboba, B., Blunk, L., Vollbrecht, J., Carlson, J., and H. Levkowetz, "Extensible Authentication Protocol (EAP)", RFC 3748, June 2004.

[RFC4962] Housley, R. and B. Aboba, "Guidance for Authentication,

Authorization, and Accounting (AAA) Key Management", BCP 132, RFC 4962, July 2007.

[RFC5247] Aboba, B., Simon, D., and P. Eronen, "Extensible Authentication Protocol (EAP) Key Management Framework", RFC 5247, August 2008.

11.2. Informative References

[RFC2865] Rigney, C., Willens, S., Rubens, A., and W. Simpson, "Remote Authentication Dial In User Service (RADIUS)", RFC 2865, June 2000.

[RFC3588] Calhoun, P., Loughney, J., Guttman, E., Zorn, G., and J. Arkko, "Diameter Base Protocol", RFC 3588, September 2003.

[RFC5169] Clancy, T., Nakhjiri, M., Narayanan, V., and L. Dondeti, "Handover Key Management and Re-Authentication Problem Statement", RFC 5169, March 2008.

[RFC5296] Narayanan, V. and L. Dondeti, "EAP Extensions for EAP Re-authentication Protocol (ERP)", RFC 5296, August 2008.

[I-D.aboba-radext-wlan]
Aboba, B., Malinen, J., Congdon, P., and J. Salowey, "RADIUS Attributes for IEEE 802 Networks", draft-aboba-radext-wlan-11 (work in progress), April 2009.

[IEEE.802-21]
"Draft Standard for Local and Metropolitan Area Networks: Media Independent Handover Services", IEEE , 2008.

[IEEE.802-11.2007]

"Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications", IEEE Standard 802.11, 2007, <http://standards.ieee.org/getieee802/download/802.11-2007.pdf>.

[IEEE.802-11R.2008]
"Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications - Amendment 2: Fast BSS Transition", IEEE Standard 802.11R, 2008, <http://

standards.ieee.org/getieee802/download/802.11r-2008.pdf>.

[IEEE.802-11F.2003]
"IEEE Trial-Use Recommended Practice for Multi-Vendor Access Point Interoperability via an Inter-Access Point Protocol Across Distribution Systems Supporting IEEE 802.11 Operation", IEEE Recommendation 802.11F, 2003, <http://standards.ieee.org/getieee802/download/802.11F-2003.pdf>.

[TS33.402]
3GPP, "System Architecture Evolution (SAE):Security aspects of non-3GPP accesses (Release 8)", 3GPP TS33.402, V8.3.1 , 2009.

[ITU] ITU-T, "General Characteristics of International Telephone Connections and International Telephone Circuits: One-Way Transmission Time", ITU-T Recommendation G.114 , 1998.

[WPA] The Wi-Fi Alliance, "WPA (Wi-Fi Protected Access)", Wi-Fi WPA v3.1, 2004.

[MQ7] Lopez, R., Dutta, A., Ohba, Y., Schulzrinne, H., and A. Skarmeta, "Network-layer Assisted Mechanism to Optimize Authentication Delay During Handoff in 802.11 Networks", The 4th Annual International Conference on Mobile and

Ubiquitous Systems: Computing, Networking and Services (MOBIQUITOUS 2007) , 2007.

[WCM] Dutta, A., Famorali, D., Das, S., Ohba, Y., and R. Lopez, "Media-independent pre-authentication supporting secure interdomain handover optimization", IEEE Wireless Communications Volume 15, Issue 2, April 2008.

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