| **Source:** | **SA WG3 (Security)** |
|---|---|
| **Title:** | **CR to 33.234: Re-authentication failure notification to HSS (Rel-6)** |
| **Document for:** | **Approval** |
| **Agenda Item:** | **7.3.3** |

| SA Doc number | Spec | CR | Rev | Phase | Subject | Cat | Version-Current | SA WG3 Doc number | Workitem |
|---|---|---|---|---|---|---|---|---|---|
| SP-040389 | 33.234 | 006 | - | Rel-6 | Re-authentication failure notification to HSS | F | 6.0.0 | S3-040438 | WLAN |

CR-Form-v7

# CHANGE REQUEST

| ⌘ | **33.234** CR **006** | ⌘ **rev** | **-** | ⌘ | Current version: | **6.0.0** | ⌘ |

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

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**Proposed change affects:** UICC apps⌘ ☐   ME ☐   Radio Access Network ☐   Core Network **X**

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|---|---|---|
| ***Title:*** ⌘ | Re-authentication failure notification to HSS | |
| ***Source:*** ⌘ | SA WG3 | |
| ***Work item code:*** ⌘ | WLAN | ***Date:*** ⌘ 03/05/2004 |
| ***Category:*** ⌘ | **F** | ***Release:*** ⌘ Rel-6 |

| Use *one* of the following categories: | Use *one* of the following releases: |
|---|---|
| *F (correction)* | *2 (GSM Phase 2)* |
| *A (corresponds to a correction in an earlier release)* | *R96 (Release 1996)* |
| *B (addition of feature),* | *R97 (Release 1997)* |
| *C (functional modification of feature)* | *R98 (Release 1998)* |
| *D (editorial modification)* | *R99 (Release 1999)* |
| Detailed explanations of the above categories can | *Rel-4 (Release 4)* |
| be found in 3GPP TR 21.900. | *Rel-5 (Release 5)* |
| | *Rel-6 (Release 6)* |

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| | |
|---|---|
| ***Reason for change:*** ⌘ | It is already defined in TS 33.234 how to perform re-authentications (full or fast). These re-authentications can be used by the home operator to trace user's activity (whether he/she is still connected or not). On the other hand, in TS 23.234 it is described that HSS is informed when a certain user authenticates successfully and registers in a WLAN AN. Therefore, if a re-authentication procedure fails, the HSS shall be informed about it and change user's status. This notification is not yet defined in TS 33.234 |
| ***Summary of change:*** ⌘ | The HSS shall be informed by AAA server when a re-authentication procedure (full or fast) fails. The HSS will take proper action with this notification (log it for fraud detection, change user's status, etc.). Nevertheless, this action(s) taken by HSS are not defined in this CR. |
| ***Consequences if not approved:*** ⌘ | Registration status in HSS may not be correct in some situations |

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| | |
|---|---|
| ***Clauses affected:*** ⌘ | 5 Security features and 6 Security mechanisms |

| | Y | N | | |
|---|---|---|---|---|
| ***Other specs affected:*** ⌘ | X | | Other core specifications ⌘ | 29.234 |
| | | X | Test specifications | |
| | | X | O&M Specifications | |

| | |
|---|---|
| ***Other comments:*** ⌘ | |

## *** BEGIN SET OF CHANGES ***

## 5.1.7    Re-authentication in WLAN Access

A re-authentication maybe full or fast. Full re-authentication means that a new full authentication procedure shall take place as the initial authentication procedure where new keys are generated in the (U)SIM card and in the network. A fast re-authentication implies a new authentication in which some keys are not generated in (U)SIM and in the network, but reused from the previous authentication process.

NOTE:
The use of fast re-authentication implies the advantage of saving processing time in the WLAN UE and the AAA server and saving power consumption, mainly in the WLAN UE. However, it has the disadvantage that the continuous re-use of keys maybe risky if the user is accessing a low trusted WLAN AN. In this case the keys should be refreshed and hence full re-authentication should be used. The use of fast re-authentication should be left for situations in which the user is accessing a high trusted WLAN AN.

WLAN 802.1x/AAA re-authentication is performed between WLAN-UE and AAA server, through Wd and Wa interfaces.

NOTE 1:   The WLAN-AN may initiate the 802.1x/AAA re-authentication process periodically. The frequency of the 802.1x/AAA re-authentications is determined by a timer which normally is set by O&M procedures in the WLAN-AN but it may be sent to the WLAN-AN by the AAA server in a RADIUS or Diameter message (in the attribute RADIUS Session Timeout or Diameter AVP Authorization-Lifetime).

The WLAN UE may initiate the 802.1x/AAA re-authentication process for example upon moving to a new access point. The WLAN UE may also initiate the 802.1x/AAA re-authentication periodically; however it is out of the scope how the WLAN UE determines the frequency of periodic 802.1x/AAA re-authentications.

The 3GPP AAA server may initiate the 802.1x/AAA re-authentication process upon some event (for example the amount of data reported in accounting messages exceeds some limit), or periodically, alternatively to the usage of the Session Timeout/Authorization-Lifetime. The frequency of periodic 802.1x/AAA re-authentications is determined by a timer, which is normally set by O&M procedures in the 3GPP AAA server.

NOTE 2:   If several elements (UE, WLAN AN, 3GPP AAA server) maintain timers for periodic 802.1x/AAA re-authentications, then the element that has the shortest timer shall determine the frequency of periodic 802.1x/AAA re-authentications, because each element is able to initiate an 802.1x/AAA re-authentication.

At reception of the Session Timeout attribute, or the Authorization-Lifetime AVP, the WLAN-AN may substitute the previously set counter by the received one. Nevertheless, the 3GPP network does not have the certainty that the counter sent by the AAA server is enforced by the WLAN AN, since the latter may not support this feature (the reception and acceptance of this attribute or AVP). In this case, the WLAN AN shall discard it and trigger the re-authentications in the period set by O&M procedures as mentioned before.

The 802.1x/AAA re-authentication process shall be performed either with an EAP SIM/AKA full authentication process or with an EAP SIM/AKA fast re-authentication process. Both processes are described in this TS.

The EAP SIM/AKA re-authentication process shall be implemented together with the full authentication procedure in the network and the WLAN UE, although use of EAP/SIM/AKA for fast re-authentication is optional in the network and depends on operator's policies. The decision of using the fast re-authentication process is taken by the home network (i.e. the AAA server) and indicated to the WLAN UE by means of sending the re-authentication identity to the WLAN UE in any authentication process. When a re-authentication process is initiated by the network, the WLAN UE shall reply with the re-authentication identity if it is available (it was received in the previous successful authentication), and it shall be the home network (AAA server), when receiving this re-authentication identity the ultimate point of decision of whether to continue with a fast re-authentication or to defer to a full re-authentication. This decision of using fast re-authentication depends on operator's policies.

NOTE 3:   These policies depend on the level of trust of the 3GPP operator and the WLAN AN, and the possible threats detected by an operator, which may require a periodic refresh of keys. The full process description can be found in ref. [4] and [5].

Since HSS will maintain the registration status of the user in WLAN, any change to that status shall be communicated to HSS. When a re-authentication (full or fast) process fails, for any reason, the AAA server shall inform HSS about the event. The reason for this mechanism is that the home network may use re-authentication not only to authenticate the user periodically but also as a heartbeat mechanism (to track user's activity). The HSS will mark the user as registered when he/she first authenticates in WLAN. If for example the user removes the (U)SIM card, the next re-authentication will fail, and the HSS shall be informed.

# *** END SET OF CHANGES ***

# *** BEGIN SET OF CHANGES ***

## 6.1.1    USIM-based WLAN Access Authentication

USIM based authentication is a proven solution that satisfies the authentication requirements from section 4.2. This form of authentication shall be based on EAP-AKA (ref. [4]), as described in section 6.1.1.1.

Editor's note: also see section 4.2.4 on WLAN-UE Functional Split.

## 6.1.1.1    EAP/AKA Procedure

The EAP-AKA authentication mechanism is specified in ref. [4]. The present section describes how this mechanism is used in the WLAN-3GPP interworking scenario.
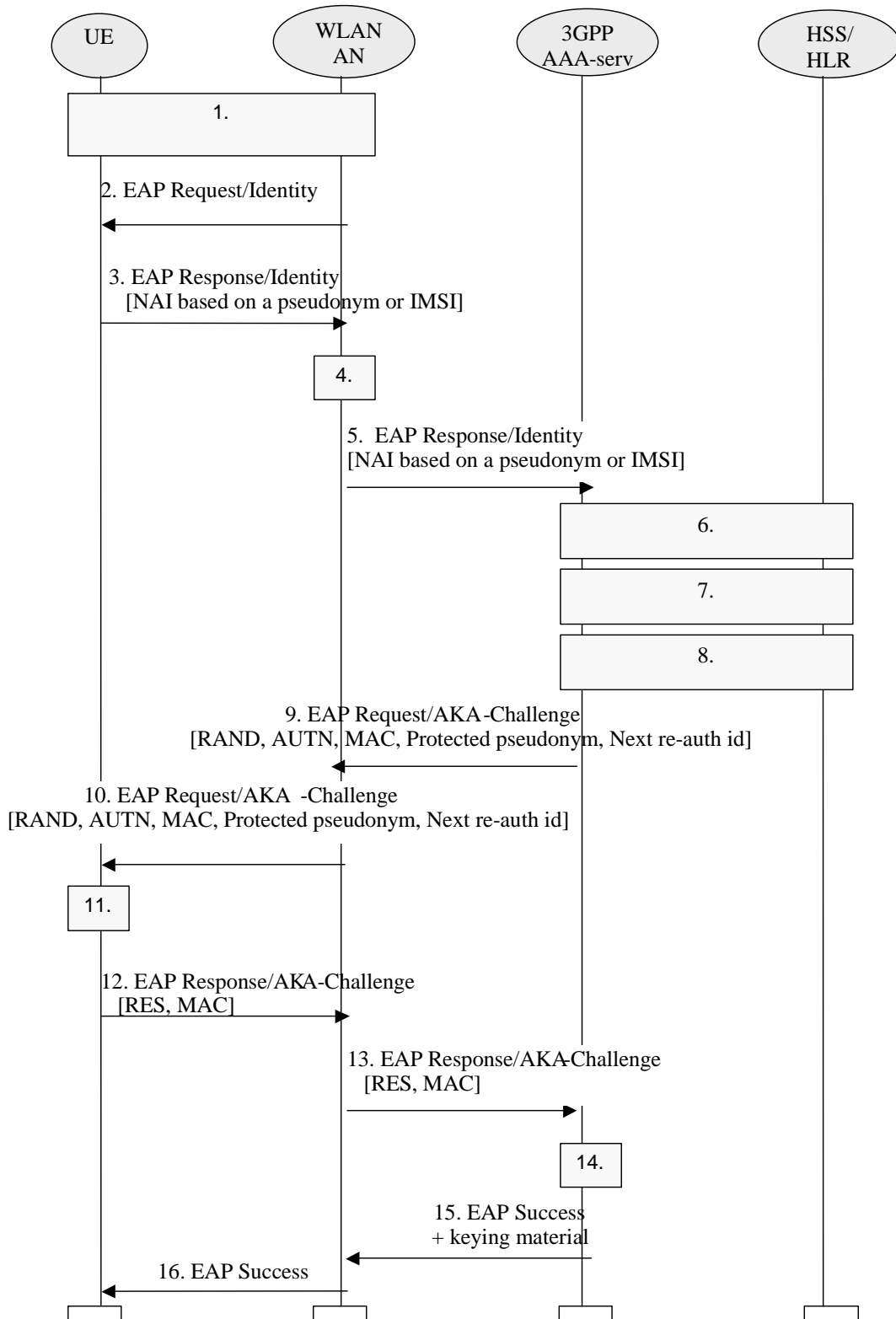


**Figure 4: Authentication based on EAP AKA scheme**

1.  A connection is established between the WLAN-UE and the WLAN-AN, using a Wireless LAN technology specific procedure (out of scope for this specification).

2.  The WLAN-AN sends an EAP Request/Identity to the WLAN-UE.

    EAP packets are transported over the Wireless LAN interface encapsulated within a Wireless LAN technology specific protocol.

3.  The WLAN-UE sends an EAP Response/Identity message. The WLAN-UE sends its identity complying with Network Access Identifier (NAI) format specified in RFC 2486. NAI contains either a temporary identifier (pseudonym) allocated to the WLAN-UE in previous authentication or, in the case of first authentication, the IMSI.

NOTE 1:  Generating an identity conforming to NAI format from IMSI is defined in EAP/AKA [4].

4.   The message is routed towards the proper 3GPP AAA Server based on the realm part of the NAI. The routing path may include one or several AAA proxies (not shown in the figure).

NOTE 2:  Diameter referral can also be applied to find the AAA server.

5.  The 3GPP AAA server receives the EAP Response/Identity packet that contains the subscriber identity.

6.  3GPP AAA Server identifies the subscriber as a candidate for authentication with EAP-AKA, based on the received identity. The 3GPP AAA Server then checks that it has an unused authentication vector available for that subscriber . If not, a set of new authentication vectors is retrieved from HSS/HLR. A mapping from the temporary identifier to the IMSI may be required.

NOTE 3:  It could also be the case that the 3GPP AAA Server first obtains an unused authentication vector for the subscriber and, based on the type of authenticator vector received (i.e. if a UMTS authentication vector is received), it regards the subscriber as a candidate for authentication with EAP-AKA.

7.  3GPP AAA server checks that it has the WLAN access profile of the subscriber available. If not, the profile is retrieved from HSS. 3GPP AAA Server verifies that the subscriber is authorized to use the WLAN service.

    Although this step is presented after step 6 in this example, it could be performed at some other point, however before step 14. (This will be specified as part of the Wx interface.)

8.  New keying material is derived from IK and CK., cf. [4]. This keying material is required by EAP-AKA, and some extra keying material may also be generated for WLAN technology specific confidentiality and/or integrity protection.

    A new pseudonym may be chosen and protected (i.e. encrypted and integrity protected) using EAP-AKA generated keying material.

9.  3GPP AAA Server sends RAND, AUTN, a message authentication code (MAC) and two user identities (if they are generated): protected pseudonym and/or re-authentication id to WLAN-AN in EAP Request/AKA-Challenge message. The sending of the re-authentication id depends on 3GPP operator's policies on whether to allow fast re-authentication processes or not. It implies that, at any time, the AAA server decides (based on policies set by the operator) to include the re-authentication id or not, thus allowing or disallowing the triggering of the fast re-authentication process.

10. The WLAN-AN sends the EAP Request/AKA-Challenge message to the WLAN-UE.

11. The WLAN-UE runs UMTS algorithm on the USIM. The USIM verifies that AUTN is correct and hereby authenticates the network. If AUTN is incorrect, the terminal rejects the authentication (not shown in this example). If the sequence number is out of synch, terminal initiates a synchronization procedure, c.f. [4]. If AUTN is correct, the USIM computes RES, IK and CK.

    The WLAN UE derives required additional new keying material from  the new computed IK and CK from the USIM, checks the received MAC with the new derived keying material.

    If a protected pseudonym was received, then the WLAN-UE stores the pseudonym for future authentications.

12. The WLAN UE calculates a new MAC value covering the EAP message with the new keying material. WLAN-UE sends EAP Response/AKA-Challenge containing calculated RES and  the new calculated MAC value to WLAN-AN.

13. WLAN-AN sends the EAP Response/AKA-Challenge packet to 3GPP AAA Server

14. 3GPP AAA Server checks the received MAC and compares XRES to the received RES.

15. If all checks in step 14 are successful, then 3GPP AAA Server sends the EAP Success message to WLAN-AN. If some extra keying material was generated for WLAN technology specific confidentiality and/or integrity protection then the 3GPP AAA Server includes this keying material in the underlying AAA protocol message (i.e. not at EAP level). The WLAN-AN stores the keying material to be used in communication with the authenticated WLAN-UE.

16. WLAN-AN informs the WLAN-UE about the successful authentication with the EAP Success message. Now the EAP AKA exchange has been successfully completed, and the WLAN-UE and the WLAN-AN share keying material derived during that exchange.

The authentication process may fail at any moment, for example because of unsuccessful checking of MACs or no response from the WLAN-UE after a network request. In that case, the EAP AKA process will be terminated as specified in ref. [4] and an indication shall be sent to HSS/HLR.

## 6.1.2     GSM SIM based WLAN Access authentication

SIM based authentication is useful for GSM subscribers that do not have a UICC with a USIM application. This form of authentication shall be based on EAP-SIM (ref. [5]), as described in section 6.1.2.1. This authentication method satisfies the authentication requirements from section 4.2, without the need for a UICC with a USIM application

Editor's note: Also see section 4.2.4 on WLAN UE split.

### 6.1.2.1       EAP SIM procedure

The EAP-SIM authentication mechanism is specified in ref. [5]. The present section describes how this mechanism is used in the WLAN-3GPP interworking scenario.
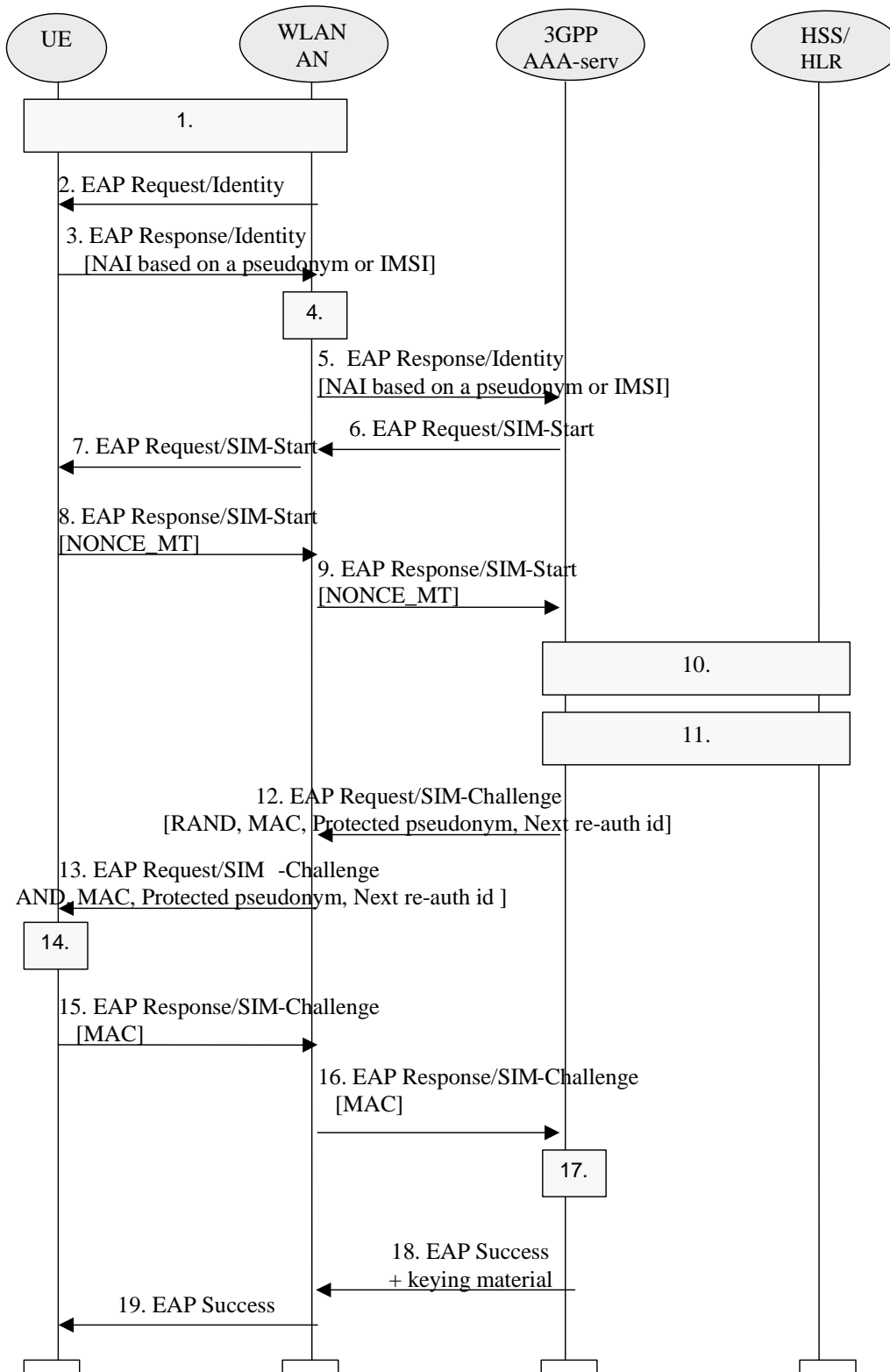
**Figure 5: Authentication based on EAP SIM scheme**

1. A connection is established between the WLAN-UE and the WLAN-AN, using a Wireless LAN technology specific procedure (out of scope for this specification).

2. The WLA-AN sends an EAP Request/Identity to the WLAN-UE.

   EAP packets are transported over the Wireless LAN interface encapsulated within a Wireless LAN technology specific protocol.

3. The WLAN-UE sends an EAP Response/Identity message. The WLAN-UE sends its identity complying with the Network Access Identifier (NAI) format specified in RFC 2486. NAI contains either a temporary identifier (pseudonym) allocated to WLAN-UE in previous authentication or, in the case of first authentication, the IMSI.

NOTE 1: Generating an identity conforming to NAI format from IMSI is defined in EAP/SIM.

4. The message is routed towards the proper 3GPP AAA Server based on the realm part of the NAI. The routing path may include one or several AAA proxies (not shown in the figure).

NOTE 2: Diameter referral can also be applied to find the AAA server.

5. The 3GPP AAA server receives the EAP Response/Identity packet that contains the subscriber identity.

6. The 3GPP AAA Server, identifies the subscriber as a candidate for authentication with EAP-SIM, based on the received identity, and then it sends the EAP Request/SIM-Start packet to WLAN-AN.

NOTE 3: It could also be the case that the 3GPP AAA Server first obtains an authentication vector for the subscriber and, based on the type of authenticator vector received (i.e. if a GSM authentication vector is received), it regards the subscriber as a candidate for authentication with EAP-SIM.

7. WLAN-AN sends the EAP Request/SIM-Start packet to WLAN-UE

8. The WLAN-UE chooses a fresh random number NONCE_MT. The random number is used in network authentication.

   The WLAN-UE sends the EAP Response/SIM-Start packet, containing NONCE_MT, to WLAN-AN.

9. WLAN-AN sends the EAP Response/SIM-Start packet to 3GPP AAA Server

10. The AAA server checks that it has available N unused authentication vectors for the subscriber. Several GSM authentication vectors are required in order to generate keying material with effective length equivalent to EAP-AKA. If N authentication vectors are not available, a set of authentication vectors is retrieved from HSS/HLR. A mapping from the temporary identifier to the IMSI may be required.

    Although this step is presented after step 9 in this examples, it could be performed at some other point, for example after step 5, however before step 12. (This will be specified as part of the Wx interface.)

11. The AAA server checks that it has the WLAN access profile of the subscriber available. If not, the profile is retrieved from HSS/HLR. 3GPP AAA Server verifies that the subscriber is authorized to use the WLAN service.

    Although this step is presented after step 10 in this example, it could performed at some other point, however before step 18. (This will be the specified as part of the Wx interface).

12. New keying material is derived from NONCE_MT and N Kc keys. This keying material is required by EAP-SIM, and some extra keying material may also be generated for WLAN technology specific confidentiality and/or integrity protection.

    A new pseudonym and/or a re-authentication identity may be chosen and protected (i.e. encrypted and integrity protected) using EAP-SIM generated keying material.

    A message authentication code (MAC) is calculated over the EAP message using an EAP-SIM derived key. This MAC is used as a network authentication value.

    3GPP AAA Server sends RAND, MAC, protected pseudonym and re-authentication identity (the two latter in case they were generated) to WLAN-AN in EAP Request/SIM-Challenge message. The sending of the re-authentication id depends on 3GPP operator's policies on whether to allow fast re-authentication processes or not. It implies that, at any time, the AAA server decides (based on policies set by the operator) to include the re-authentication id or not, thus allowing or disallowing the triggering of the fast re-authentication process.

13. The WLAN sends the EAP Request/SIM-Challenge message to the WLAN-UE.

14. WLAN-UE runs N times the GSM A3/A8 algorithms in the SIM, once for each received RAND.

   This computing gives N SRES and Kc values.

   The WLAN-UE derives additional keying material from N Kc keys and NONCE_MT.

   The WLAN-UE calculates its copy of the network authentication MAC with the newly derived keying material and checks that it is equal with the received MAC. If the MAC is incorrect, the network authentication has failed and the WLAN-UE cancels the authentication (not shown in this example). The WLAN-UE continues the authentication exchange only if the MAC is correct.

   The WLAN-UE calculates a new MAC with the new keying material covering the EAP message concatenated to the N SRES responses.

   If a protected pseudonym was received, then the WLAN-UE stores the pseudonym for future authentications.

15. WLAN-UE sends EAP Response/SIM-Challenge containing calculated MAC to WLAN-AN.

16. WLAN-AN sends the EAP Response/SIM-Challenge packet to 3GPP AAA Server.

17. 3GPP AAA Server compares its copy of the response MAC with the received MAC.

18. If the comparison in step 17 is successful, then 3GPP AAA Server sends the EAP Success message to WLAN-AN. If some extra keying material was generated for WLAN technology specific confidentiality and/or integrity protection, then the 3GPP AAA Server includes this derived keying material in the underlying AAA protocol message. (i.e. not at EAP level). The WLAN-AN stores the keying material to be used in communication with the authenticated WLAN-UE.

19. WLAN-AN informs the WLAN-UE about the successful authentication with the EAP Success message. Now the EAP SIM exchange has been successfully completed, and the WLAN-UE and the WLAN_AN may share keying material derived during that exchange.

NOTE 4:  The derivation of the value of N is for further study.

The authentication process may fail at any moment, for example because of unsuccessful checking of MACs or no response from the WLAN-UE after a network request. In that case, the EAP SIM process will be terminated as specified in ref. [5] and an indication shall be sent to HSS/HLR.

# *** END SET OF CHANGES ***

# *** BEGIN SET OF CHANGES ***

## 6.1.4 Fast re-authentication mechanisms in WLAN Access

When authentication processes have to be performed frequently, it can lead to a high network load especially when the number of connected users is high. Then it is more efficient to perform fast re-authentications. Thus the re-authentication process allows the WLAN-AN to authenticate a certain user in a lighter process than a full authentication, thanks to the re-use of the keys derived on the previous full authentication.

### 6.1.4.1 EAP/AKA procedure

The implementation of EAP/AKA must include the fast re-authentication mechanism described in this chapter, although its use is optional and depends on operator's policies, which shall be enforced by the AAA server by means of sending the re-authentication identity in any authentication process. The complete procedure is defined in ref [4]. In this section it is described how the process works for WLAN-3GPP interworking.
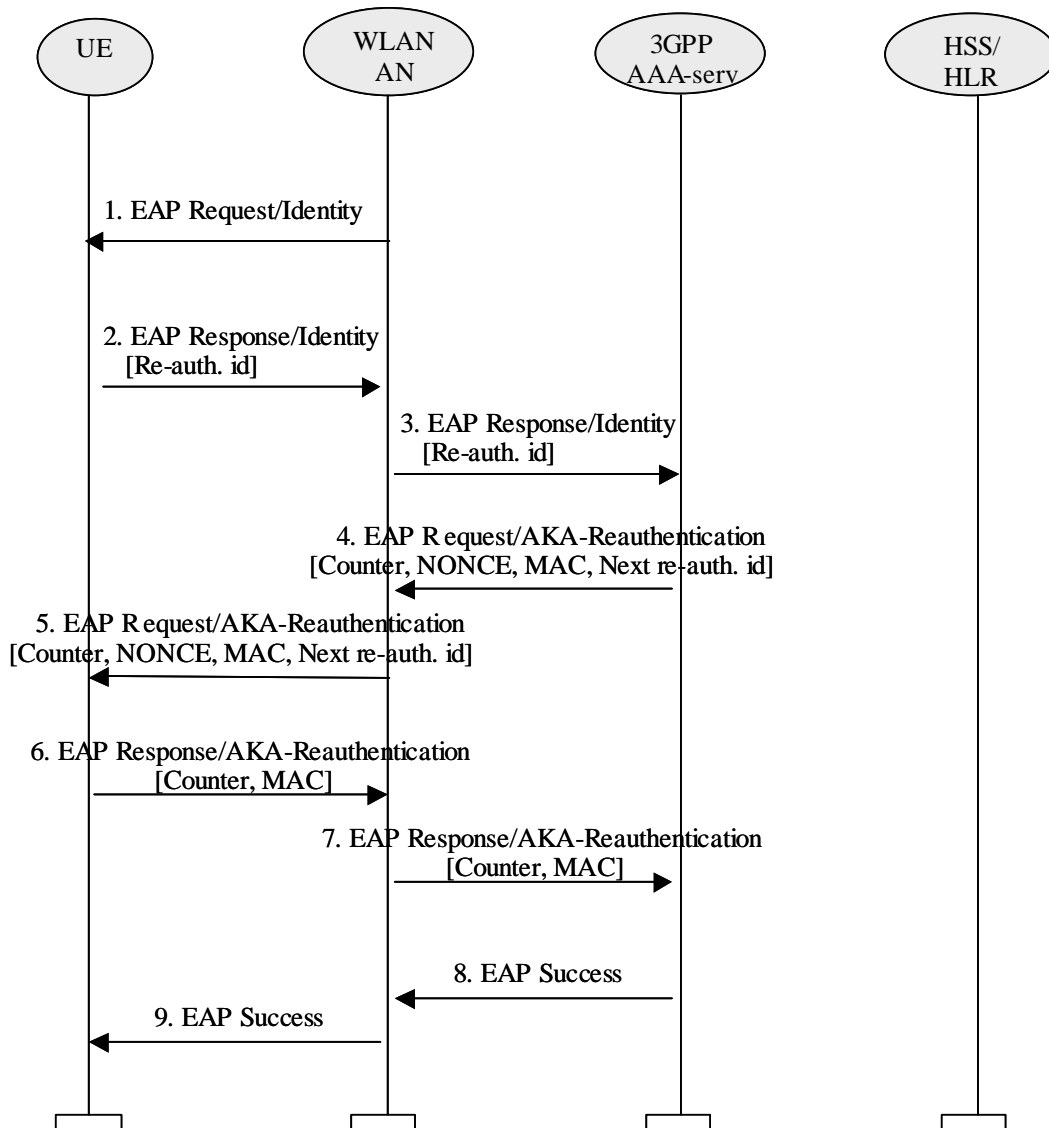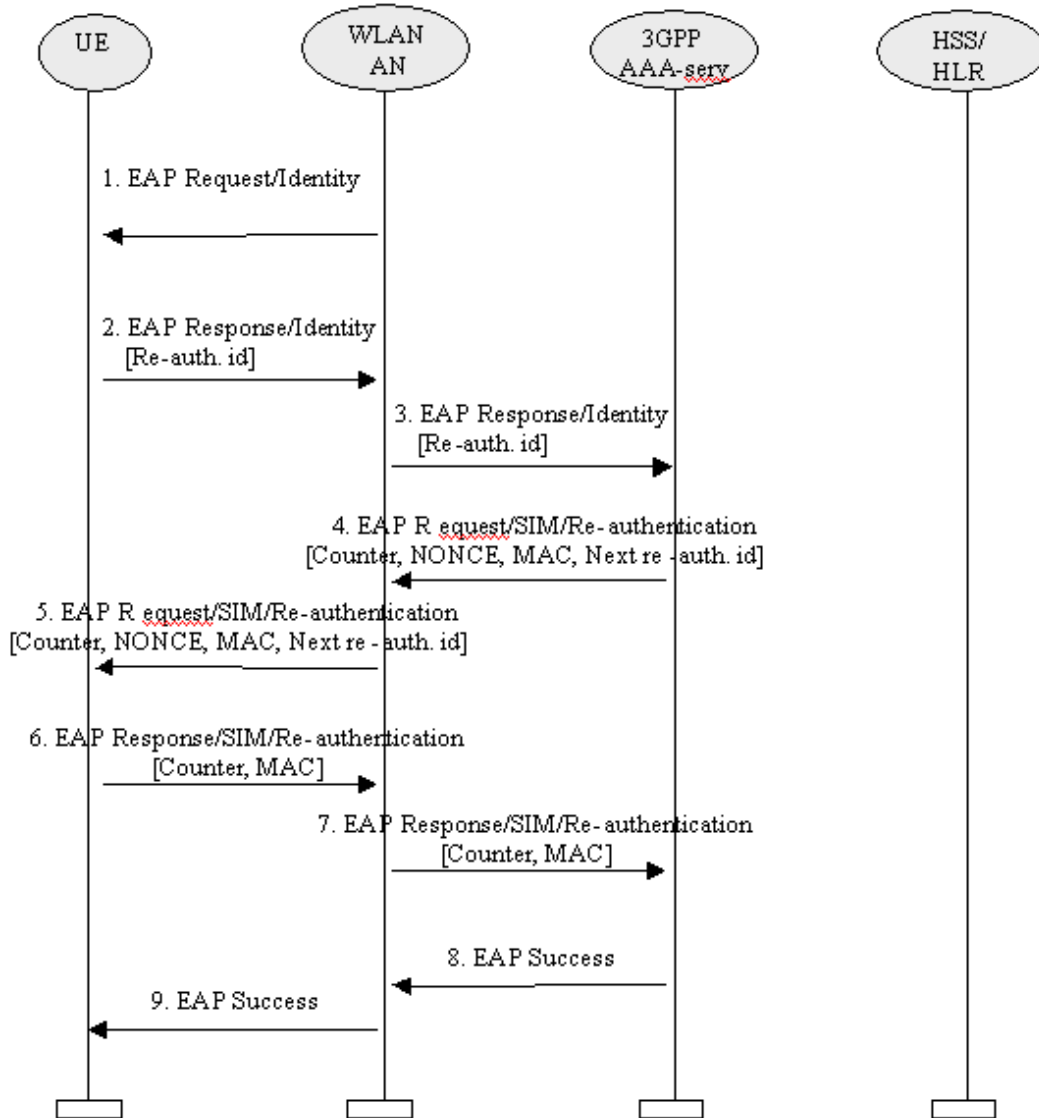


**Figure 6: EAP AKA fast re-authentication**

1. WLAN-AN sends an EAP Request/Identity to the WLAN-UE.

2. WLAN-UE replies with an EAP Response/Identity containing a re-authentication identity (this identity was previously delivered by AAA server in a full authentication procedure).

3. The WLAN-AN forwards the EAP Response/Identity to the AAA server.

4. The AAA server initiates the Counter (which was initialized to one in the full authentication process) and sends it in the EAP Request message, together with the NONCE, the MAC (calculated over the NONCE) and a re-authentication id for a next fast re-authentication. If the AAA server is not able to deliver a re-authentication identity, next time the WLAN-UE shall force a full-authentication (to avoid the use of the re-authentication identity more than once).

5. The WLAN-AN forwards the EAP Request message to the WLAN-UE.

6. The WLAN-UE verifies that the Counter value is fresh and the MAC is correct, and it sends the EAP Response message with the same Counter value (it is up to the AAA server to step it up) and a calculated MAC.

7. The WLAN-AN forwards the response to the AAA server.

8. The AAA server verifies that the Counter value is the same as it sent, and the MAC is correct, and sends an EAP Success message.

9. The EAP Success message is forwarded to the WLAN-UE.

The re-authentication process may fail at any moment, for example because of unsuccessful checking of MACs or no response from the WLAN-UE after a network request. In that case, the EAP AKA process will be terminated as specified in ref. [4] and an indication shall be sent to HSS/HLR.

## 6.1.4.2    EAP/SIM procedure

The implementation of EAP/SIM must include the fast re-authentication mechanism described in this chapter, although its use is optional and depends on operator's policies, which shall be enforced by the AAA server by means of sending the re-authentication identity in any authentication process. The complete procedure is defined in ref [4]. In this section it is described how the process works for WLAN-3GPP interworking.

**Figure 7: EAP SIM Fast re-authentication**

1.  WLAN-AN sends an EAP Request/Identity to the WLAN-UE.

2.  WLAN-UE replies with an EAP Response/Identity containing a re-authentication identity (this identity was previously delivered by AAA server in a full authentication procedure).

3.  The WLAN-AN forwards the EAP Response/Identity to the AAA server.

4.  The AAA server initiates the Counter (which was initialised to one in the full authentication process) and sends it in the EAP Request message, together with the NONCE, the MAC (calculated over the NONCE) and a re-authentication id for a next fast re-authentication. If the AAA server is not able to deliver a re-authentication identity, next time the WLAN-UE shall force a full-authentication (to avoid the use of the re-authentication identity more than once).

5.  The WLAN-AN forwards the EAP Request message to the WLAN-UE.

6.  The WLAN-UE verifies that the Counter value is fresh and the MAC is correct, and it sends the EAP Response message with the same Counter value (it is up to the AAA server to step it up) and a calculated MAC.

7.  The WLAN-AN forwards the response to the AAA server.

8.  The AAA server verifies that the Counter value is the same as it sent, and the MAC is correct, and sends an EAP Success message.

9.  The EAP Success message is forwarded to the WLAN-UE.

The re-authentication process may fail at any moment, for example because of unsuccessful checking of MACs or no response from the WLAN-UE after a network request. In that case, the EAP SIM process will be terminated as specified in ref. [5] and an indication shall be sent to HSS/HLR.

## *** END SET OF CHANGES ***