3GPP TSG SA WG3 Security ó SA3#35 **S3-040876**
October 5-8, 2004
St Paul's Bay, Malta

Title:	LS on EAP Authentication commands for WLAN interworking
Response to:	-
Release:	Rel-6
Work Item:	WLAN Security
Source:	SA3
To:	T2
Cc:	T3

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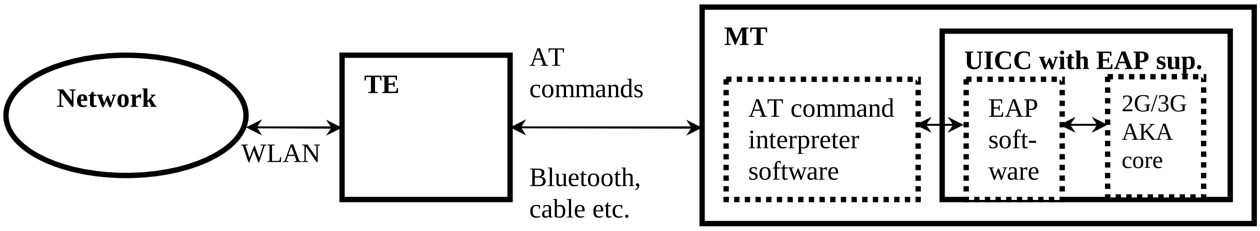
Attachments: S3-040875

1. Overall Description

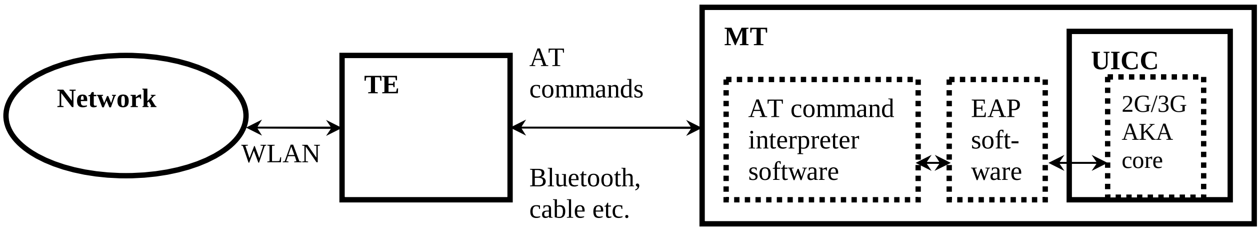
1.1 WLAN authentication

SA3 discussed solutions to achieve authentication for WLAN access with a functionally split WLAN-UE. In the configuration considered, the WLAN-UE is functionally split into two physical devices that securely communicate over a local interface, e.g. Bluetooth, or serial cable. One device may be a laptop computer with WLAN card (TE), the other one a mobile phone with a UICC or SIM (MT).
Authentication takes place using EAP-SIM or EAP-AKA. SA3 decided that EAP must terminate inside the MT, in order not to leak any 2G/3G keys out to the TE. Therefore, two different implementations exist, depending on the location of EAP support:

1. If the UICC supports EAP according to ETSI TS 102.310, and the MT supports the appropriate filter rules to prevent illegitimate commands to the card, EAP is run on the card:



2. If the UICC or SIM card does not support EAP, the MT must run EAP, and use standard 2G/3G authentication commands towards the card:



NOTE: The priority rules for selection of UICC or MT in case both the UICC and the MT support EAP are under study in SA3.

For implementation 1, the AT commands "Restricted UICC Logical Channel access +CRLA" and "Generic UICC Logical Channel access +CGLA" according to TS 27.007 can be used, as proposed in S3-040760 (related CR is attached). However, it was pointed out during the discussion at SA3#35 that the use of these commands may pose a security risk, as the security depends on the presence of appropriate filtering rules in the MT to prevent that the TE sends arbitrary commands to the card. For implementation 2, it is not yet defined which commands to use.

SA3 currently sees the following possibilities:

A) T2 could change TS 27.007 so that the existing AT commands mentioned above could be re-used for UICC and SIM cards without EAP support in implementation 2. This could be done by adding to the text of sections 8.18 and 8.44 of TS 27.007 that the AT commands may also be used to allow the TE to send commands to applications on the MT outside the UICC or SIM. In that case, the MT would only forward the EAP authentication commands to the card in case the card supports EAP and the filter rules are in place. Otherwise the applications on the MT would handle EAP.

B) T2 could define new AT command(s) dedicated to transferring EAP authentication messages only. The MT would then run the commands mentioned above towards the card, if the card supports EAP. Otherwise the applications on the MT would handle EAP.

Option A) has the advantage that not much specification work is needed. It has, however, the security disadvantage that it opens a direct channel from the TE to the smart card. Therefore, option A)'s security depends on the quality of filtering measures implemented in the MT to drop any command to the card which is not used for EAP authentication, whereas Option B) strictly limits the TE's possibilities to EAP authentication.

It was also pointed out at SA3#35 that it is highly desirable to have a unified procedure for both, cases 1 and 2. It shall not be required that the TE is aware of the particular function split in the MT. Therefore the TE shall use the same commands in both cases.

1.2 Risks of direct UICC access by the TE

Independent from the above topics, SA3 is concerned about the AT commands that give a TE full access to the smart card. SA3 considered the risks of 2G/3G authentication data leakage into an open platform like a PC-based TE, and decided that this leakage must be avoided. The open platform could be infected by Trojan Horse software that supports remote cloning attacks against the unsuspecting subscriber. Therefore, SA3 found it necessary to terminate EAP in the MT, so that only the EAP keys for WLAN authentication are given out to the TE.

These efforts are useless if they can be circumvented by a powerful command like "Generic access", which allows the TE to arbitrarily run Authenticate commands to the card in GSM or 3G context. Therefore, SA3 considers it necessary to prevent illegal or accidental use of the "Generic access" command by restricting access to it, e.g. by following measures:

C) In the default MT state after power-up, the "Generic access" command, if received via a TE-MT interface, shall be protected by a mandatory lock. TS 27.007 V6.6.0 currently defines the lock on the "Generic access" as optional.

D) If option A) is selected by T2, the "Generic access" command shall additionally support a "half-unlocked" state, where only the EAP commands are passed through to the UICC, but all other commands are blocked by a filter in the MT, which analyzes the "Generic access" command contents.

2. Actions

ACTION1: SA3 kindly asks T2 to consider options A) and B) above, and possibly other solutions, and implement the required functionality within Rel-6 time frame. It would also be appreciated if T2 could indicate that a unified solution was seen as possible, but not in the Rel-6 timeframe.

ACTION2: SA3 kindly asks T2 to address SA3's concerns pointed out in section 1.2, e.g. by mandating a secure lock mechanism on the "Generic access" command.

3. Date of Next TSG-SA3 Meetings

SA3#36	23 - 26 November 2004	Shenzhen, China
SA3#37	21 - 25 February 2005	Sophia Antipolis, France

3GPP TSG SA WG3 Meeting S3#35
St Paul's Bay, Malta, 5 ñ 8 October 2004

Tdoc ⌘S3-040875

CR-Form-v7.1

CHANGE REQUEST

⌘ **33.234 CR 027** ⌘**rev** **2** ⌘ Current version: **6.2.0** ⌘

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

Proposed change affects: UICC apps⌘ ☒ ME ☒ Radio Access Network □ Core Network □

Title:	⌘	Correction of WLAN UE function split			
Source:	⌘	SA WG3			
Work item code:	⌘	WLAN	***Date:***	⌘	07/10/2004
Category:	⌘	**F**	***Release:***	⌘	Rel-6

Use one of the following categories:
F *(correction)*
A *(corresponds to a correction in an earlier release)*
B *(addition of feature),*
C *(functional modification of feature)*
D *(editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

Use one of the following releases:

Ph2	*(GSM Phase 2)*
R96	*(Release 1996)*
R97	*(Release 1997)*
R98	*(Release 1998)*
R99	*(Release 1999)*
Rel-4	*(Release 4)*
Rel-5	*(Release 5)*
Rel-6	*(Release 6)*
Rel-7	*(Release 7)*

Reason for change:	⌘	In SA3#32 alternative 2 was chosen as the working assumption for WLAN UE functional split (see S3-040197). However, the required standardized API for local interface between the TE and the ME does not exist yet. Therefore, this CR proposes a technically feasible solution to implement WLAN UE functional split as described in alternative 2.
Summary of change:	⌘	Modify the WLAN UE functional split to include the termination of EAP in the UICC or in the MT by AT commands.
Consequences if not approved:	⌘	Functional split cannot be implemented in release 6 in a standardized manner.

Clauses affected:	⌘	2, 5.6, 6.1.3, (new) 6.1.3.1, (new) 6.1.3.2, 6.7, 6.7.1, 6.7.2, 6.7.3, 6.7.4				
		Y	**N**			
Other specs affected:	⌘	**X**		Other core specifications	⌘	27.007
			X	Test specifications		
			X	O&M Specifications		
Other comments:	⌘					

2 References

The following documents contain provisions, which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 22.934: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Feasibility study on 3GPP system to Wireless Local Area Network (WLAN) interworking".

[2] 3GPP TR 23.934: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3GPP system to Wireless Local Area Network (WLAN) Interworking; Functional and architectural definition".

[3] IETF RTC 3748: "Extensible Authentication Protocol (EAP)".

[4] draft-arkko-pppext-eap-aka-12, April 2004: "Extensible Authentication Protocol Method for UMTS Authentication and Key Agreement (EAP-AKA)". IETF Work in progress

[5] draft-haverinen-pppext-eap-sim-13, April 2004: "Extensible Authentication Protocol Method for GSM Subscriber Identity Modules (EAP-SIM)". IETF Work in progress

[6] IEEE Std 802.11i/D7.0, October 2003: "Draft Supplement to Standard for Telecommunications and Information Exchange Between Systems - LAN/MAN Specific Requirements - Part 11: Wireless Medium Access Control (MAC) and physical layer (PHY) specifications: Specification for Enhanced Security".

[7] RFC 2716, October 1999: "PPP EAP TLS Authentication Protocol".

[8] SHAMAN/SHA/DOC/TNO/WP1/D02/v050, 22-June-01: "Intermediate Report: Results of Review, Requirements and Reference Architecture".

[9] ETSI TS 101 761-1 v1.3.1B: "Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; Data Link Control (DLC) layer; Part 1: Basic Data Transport".

[10] ETSI TS 101 761-2 v1.2.1C: "Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; Data Link Control (DLC) layer; Part 2: Radio Link Control (RLC) sublayer".

[11] ETSI TS 101 761-4 v1.3.1B: "Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; Data Link Control (DLC) layer; Part 4 Extension for Home Environment".

[12] ETSI TR 101 683 v1.1.1: "Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; System Overview".

[13] 3GPP TS 23.234: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3GPP system to Wireless Local Area Network (WLAN) Interworking; System Description".

[14] RFC 2486, January 1999: "The Network Access Identifier".

[15] RFC 2865, June 2000: "Remote Authentication Dial In User Service (RADIUS)".

[16] RFC 1421, February 1993: "Privacy Enhancement for Internet Electronic Mail: Part I: Message Encryption and Authentication Procedures".

[17] Federal Information Processing Standard (FIPS) draft standard: "Advanced Encryption Standard (AES)", November 2001.

[18] 3GPP TS 23.003: "3rd Generation Partnership Project; Technical Specification Group Core Network; Numbering, addressing and identification".

[19] IEEE P802.1X/D11 June 2001: "Standards for Local Area and Metropolitan Area Networks: Standard for Port Based Network Access Control".

[20] 3GPP TR 21.905: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Vocabulary for 3GPP Specifications".

[21] 3GPP TS 33.102: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Security Architecture".

[22] CAR 020 SPEC/0.95cB: "SIM Access Profile, Interoperability Specification", version 0.95VD.

[23] draft-ietf-aaa-eap-08.txt, June 2004: "Diameter Extensible Authentication Protocol (EAP) Application". IETF Work in progress

[24] RFC 3588, September 2003: "Diameter base protocol".

[25] RFC 3576, July 2003: "Dynamic Authorization Extensions to Remote Authentication Dial In User Service (RADIUS)".

[26] RFC 3579, September 2003: "RADIUS (Remote Authentication Dial In User Service) Support for Extensible Authentication Protocol (EAP)".

[27] draft-ietf-eap-keying-02.txt, June 2004: "EAP Key Management Framework". IETF Work in progress

[28] E. Barkan, E. Biham, N. Keller: "Instant Ciphertext-Only Cryptoanalysis of GSM Encrypted Communication", Crypto 2003, August 2003.

[29] draft-ietf-ipsec-ikev2-14.txt, May 2004: "Internet Key Exchange (IKEv2) Protocol".

[30] RFC 2406, November 1998: "IP Encapsulating Security Payload (ESP)".

[31] draft-ietf-ipsec-ui-suites-06.txt, April 2004: "Cryptographic Suites for IPsec". IETF Work in progress

[32] draft-ietf-ipsec-udp-encaps-09.txt, May 2004: "UDP Encapsulation of IPsec Packets". IETF Work in progress

[33] draft-ietf-ipsec-ikev2-algorithms-05.txt, April 2004: "Cryptographic Algorithms for use in the Internet Key Exchange Version 2". IETF Work in progress

[34] RFC 2104, February 1997: "HMAC: Keyed-Hashing for Message Authentication".

[35] RFC 2404, November 1998: "The Use of HMAC-SHA-1-96 within ESP and AH".

[36] RFC 2548, March 1999: " Microsoft Vendor-specific RADIUS Attributes".

[37] draft-mariblanca-aaa-eap-lla-01.txt, June 2004: "EAP lower layer attributes for AAA protocols".

[xx] 3GPP TS 27.007: "Technical Specification Group Terminals; AT command set for User Equipment (UE)".

[yy] ETSI TS 102.310: "Smart Cards; Extensible Authentication Protocol support in the UICC".

5.6 WLAN UE functionality split

The WLAN UE may consist of several devices. When there is more than one, it will be typically a WLAN Terminal Equipment (e.g. a laptop) and a Mobile Terminal (e.g. a mobile phone) equipped with a UICC or SIM card.

The WLAN TE ~~will~~ provides WLAN access, while the MT or UICC or SIM card ~~will~~ implements the authentication as the EAP termination, which includes key derivation and identity handling. The termination point of EAP shall always be the MT or UICC. When any authentication process is finished (in the MT or UICC), the resulting keys ~~will~~ can be retrieved by ~~be sent to~~ the WLAN TE in order to be used for link layer security in the WLAN access.

~~NOTE: It shall be possible to have the termination of EAP in the UICC (or SIM card). Details are FFS.~~

6.1.3 EAP support in UICC~~Smart Cards~~

~~Editors note: LS (S3-030187/ S1-030546) from SA1 has stated, "There are requests from operators for a secure SIM based WLAN authentication solution". SA3 has SA1 in an LS (S3-030306) if this request is confirmed. The input paper to SA3 on this can be found at: http://www.3gpp.org/ftp/tsg_sa/WG3_Security/TSGS3_28_Berlin/Docs/ZIP/S3-030198.zip~~

6.1.3.1 EAP-AKA procedure

It shall be possible as an implementation option to have the termination of EAP in the UICC. For this purpose, all steps of the EAP-AKA authentication mechanism described in 6.1.1.1 apply with the exception of step 15 that shall be replaced with the following:

The WLAN-UE runs EAP authentication method (see TS 102.310 [yy]) on the UICC. The USIM verifies that AUTN is correct and hereby authenticates the network. If AUTN is incorrect, the UICC rejects the authentication (not shown in this example). If the sequence number is out of synch, UICC initiates a synchronization procedure, c.f. [4]. If AUTN is correct, the UICC computes the Master Session Key and Extended Master Session Key and 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.

6.1.3.2 EAP-SIM procedure

It shall be possible as an implementation option to have the termination of EAP in the UICC. To handle EAP-SIM the UICC uses GSM AKA by applying conversion functions c2 and c3 (as defined in 33.102 [21]). For this purpose, all steps of the EAP-SIM authentication mechanism described in 6.1.2.1 apply with the exception of step 14 that shall be replaced with the following:

The WLAN-UE runs EAP authentication method (see TS 102.310 [yy]) on the UICC. The WLAN-UE continues the authentication exchange only if the MAC is correct.

If a protected pseudonym was received, then the UICC stores the pseudonym for future authentications.

6.7 WLAN-UE split interworking

EAP-AKA/SIM procedures terminate in the UICC or MT, so the TE shall contact the MT via protected local interface (e.g. Bluetooth, IrDa, RS232, USB, Ö) at any authentication or re-authentication process, using AT commands as defined in TS 27.007 [xx]. The ~~Bluetooth~~ local interface (e.g. Bluetooth, IrDa, RS232, USB, Ö) acts as a transparent carrier of the EAP methods; the TE just forwards messages from the MT or UICC to the network (or in the opposite direction) and does not take active part in the authentication process. The TE is not able to handle any key except the MSK and/or the EMSK when it receives them at the end of the authentication process. The MT shall forbid the transfer of RUN GSM ALGO command, and the AUTHENTICATE command in GSM/UMTS security context, from any TE involved in WLAN-UE split interworking. The EAP peer at the network side is any node in the WLAN AN, the VPLMN or the home network. Since the interworking to be described here is at the WLAN-UE side, it is not relevant which node is sending/receiving any message in the network side.

Editorís ~~NOTE~~note 1: ~~It shall be possible to have the termination of EAP in the UICC (or SIM card). Details are FFS~~.AT command set for the termination of EAP in the MT does not currently exist. SA3 has requested T2 (S3-040840) to investigate the suitability to define a new AT command set for this purpose or to utilize existing commands used for the UICC termination (i.e. +CGLA AT, +CRLA AT). In this latter case, a specific behaviour in the MT may be defined in order to handle EAP packets whenever the UICC is not capable of doing so (i.e. SIM or USIM not EAP capable).

Editorís note 2: it is highly desirable to have a unified procedure for both, cases 1 and 2. It should not be required that the TE is aware of the particular function split in the MT. Therefore the TE should use the same commands in both cases.

NOTE: The SIM Acces Profile may be used to access the UICC EAP capabilities. In this case, the usage of AT commands may be substituted by the usage of the Transfer APDU command (see CAR 020 SPEC/0.95cB [22]) all over this section. However, specific SAP requirements defined in the present document shall be fulfilled.

6.7.1 Full authentication with EAP AKA

6.7.1.1 Termination in the UICC

The process is shown in figure 11.

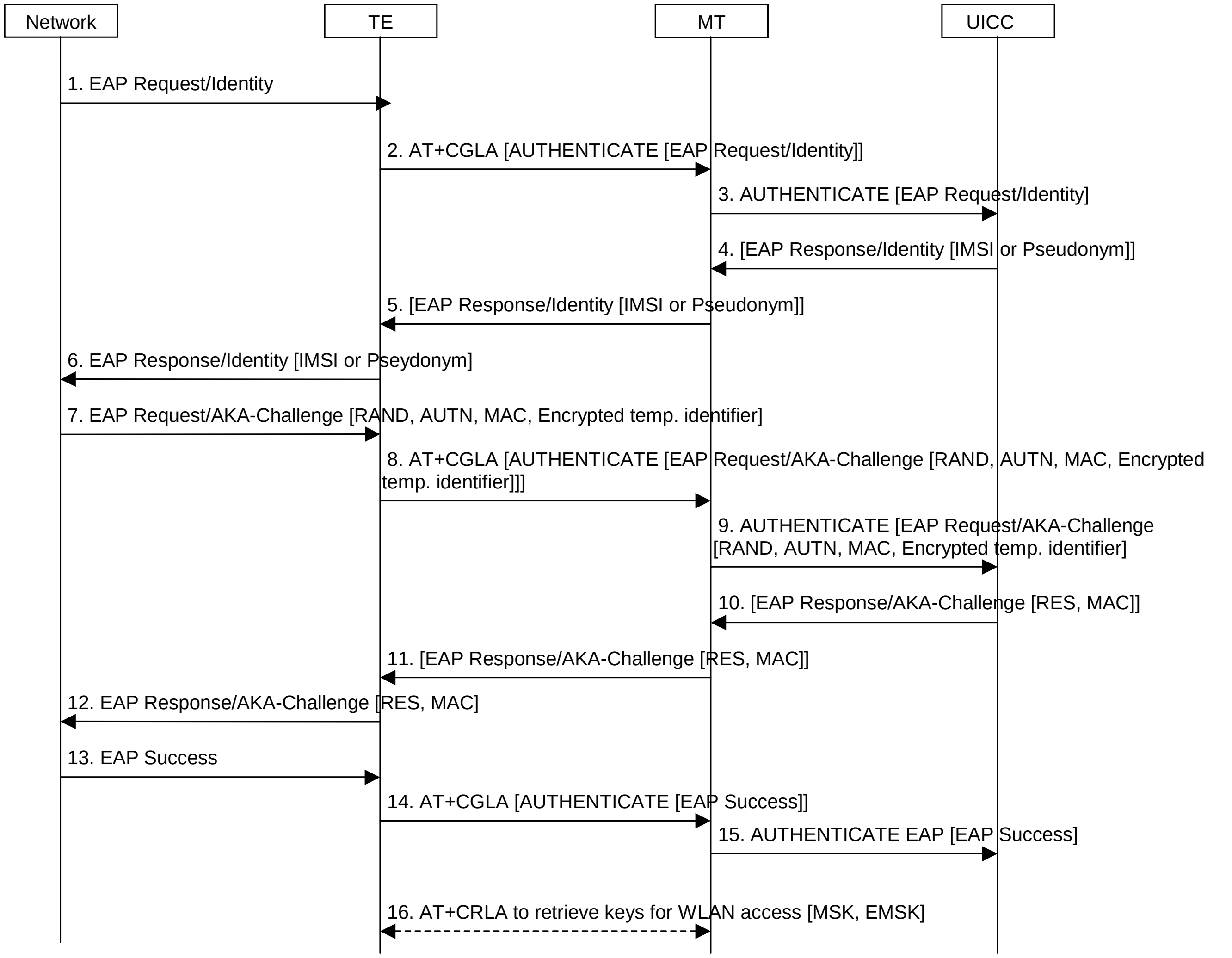

Network
TE
MT
UICC
1. EAP Request/Identity
2. AT+CGLA [AUTHENTICATE [EAP Request/Identity]]
3. AUTHENTICATE [EAP Request/Identity]
4. [EAP Response/Identity [IMSI or Pseudonym]]
5. [EAP Response/Identity [IMSI or Pseudonym]]
6. EAP Response/Identity [IMSI or Pseydonym]
7. EAP Request/AKA-Challenge [RAND, AUTN, MAC, Encrypted temp. identifier]
8. AT+CGLA [AUTHENTICATE [EAP Request/AKA-Challenge [RAND, AUTN, MAC, Encrypted temp. identifier]]]
9. AUTHENTICATE [EAP Request/AKA-Challenge [RAND, AUTN, MAC, Encrypted temp. identifier]
10. [EAP Response/AKA-Challenge [RES, MAC]]
11. [EAP Response/AKA-Challenge [RES, MAC]]
12. EAP Response/AKA-Challenge [RES, MAC]
13. EAP Success
14. AT+CGLA [AUTHENTICATE [EAP Success]]
15. AUTHENTICATE EAP [EAP Success]
16. AT+CRLA to retrieve keys for WLAN access [MSK, EMSK]

Figure 11: Full authentication with EAP-AKA

1. The network sends an EAP request identity (either a IMSI or a pseudonym) message to the TE (the device providing WLAN access) in order to initiate the procedure.

2. The TE builds an EAP Authenticate command using the EAP packet received in message 1 then sends this command to the USIM using +CGLA AT command. The EAP request identity message is forwarded via the MT to the USIM. Prior to step 2, the TE shall open a communication session with the USIM, as indicated in TS 27.007 [xx], and then shall select the appropriate DF, as indicated in TS 102.310 [yy].

3. The MT performs the received +CGLA AT command i.e. the MT sends the Authenticate command, as received in the AT command, to the USIM (see TS 27.007 [xx]).

4. The USIM returns the EAP Response/Identity packet to the MT, in the Authenticate command response data.

5. The MT returns the EAP Response/Identity packet to the TE, in the +CGLA AT command response data.

6. The TE sends the EAP Response/Identity packet to the network.

7. The network initiates the EAP AKA authentication process.

8. The TE builds an EAP Authenticate command using the EAP packet received in message 7 then sends this command to the USIM via the ME using +CGLA AT command.

9. The MT performs the received +CGLA AT command i.e. the MT sends the Authenticate command, as received in the AT command, to the USIM (see TS 27.007 [xx]).

10. The USIM returns the EAP Response/AKA-Challenge packet to the MT, in the Authenticate command response data.

11. The MT returns the EAP Response/AKA-Challenge packet to the TE, in the +CGLA AT command response data.

12. The TE sends the EAP Response/AKA-Challenge packet to the network, which checks the validity of the RES and compute the MAC of the entire message received, comparing it with the received MAC.

13. If both checks are correct, the network sends an EAP Success packet to the TE.

14. The TE builds an EAP Authenticate command using the EAP packet received in message 13 then sends this command to the USIM using +CGLA AT command.

15. The MT performs the received +CGLA AT command i.e. the MT sends the Authenticate command, as received in the AT command, to the USIM (see TS 27.007 [xx]).

16. After a successful EAP authentication, the TE shall retrieve the key material (i.e. MSK and EMSK) from EF$_{\text{EAPKEYS}}$ (for this purpose, the TE uses the +CRLA AT command). The TE uses MSK and EMSK for security purposes, for example for WLAN link layer security

6.7.1.2 Termination in the MT

The process is shown in figure 12~~1~~.

Editorís Note: AT command set for EAP termination in the MT is not yet defined.

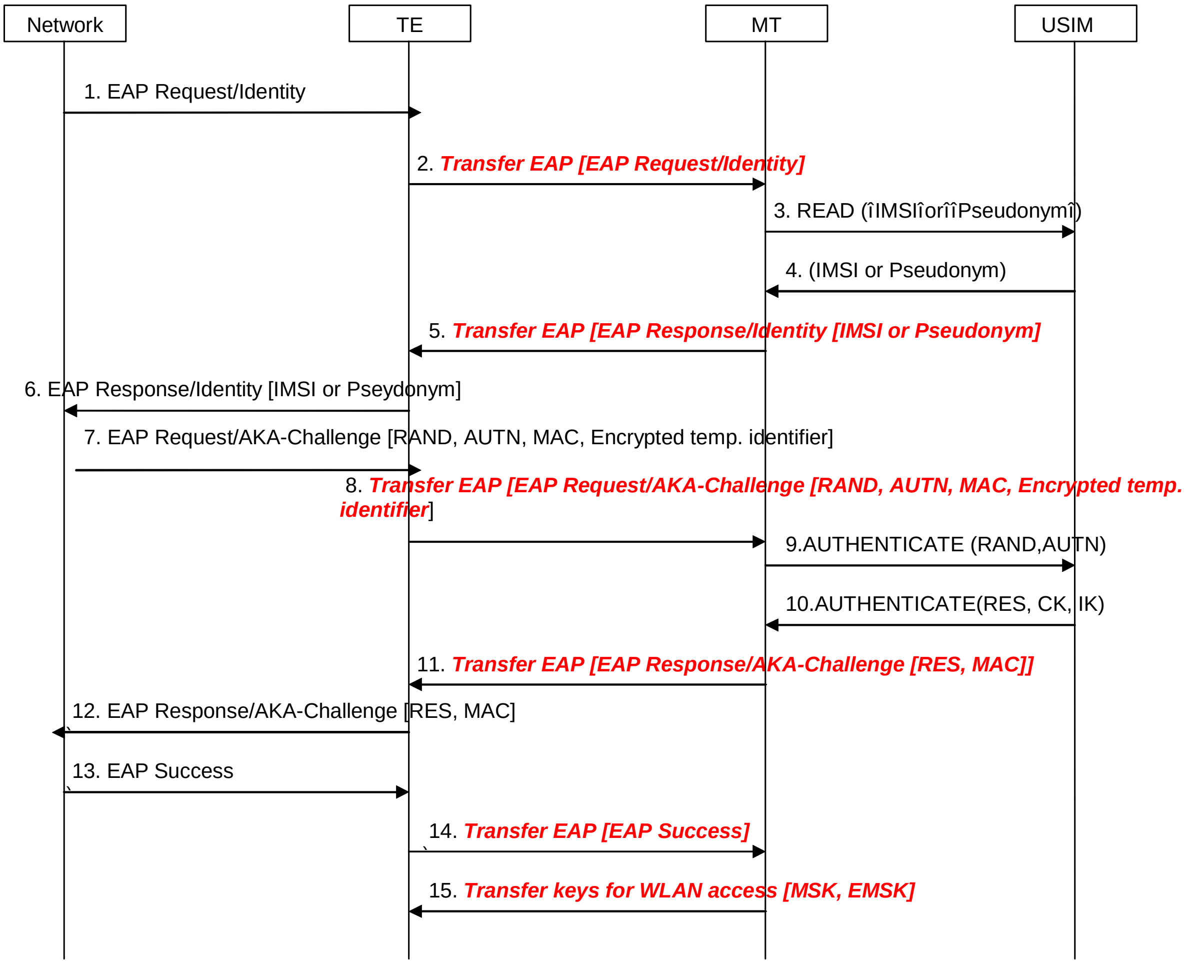

Network
TE
MT
USIM
1. EAP Request/Identity
2. Transfer EAP [EAP Request/Identity]
3. READ (îIMSIîorîîPseudonymî)
4. (IMSI or Pseudonym)
5. Transfer EAP [EAP Response/Identity [IMSI or Pseudonym]
6. EAP Response/Identity [IMSI or Pseydonym]
7. EAP Request/AKA-Challenge [RAND, AUTN, MAC, Encrypted temp. identifier]
8. Transfer EAP [EAP Request/AKA-Challenge [RAND, AUTN, MAC, Encrypted temp. identifier]
9.AUTHENTICATE (RAND,AUTN)
10.AUTHENTICATE(RES, CK, IK)
11. Transfer EAP [EAP Response/AKA-Challenge [RES, MAC]]
12. EAP Response/AKA-Challenge [RES, MAC]
13. EAP Success
14. Transfer EAP [EAP Success]
15. Transfer keys for WLAN access [MSK, EMSK]

Figure 12~~1~~: Full authentication with EAP AKA

1. The network sends a EAP request identity (either a IMSI or a pseudonym) message to the TE (the device providing WLAN access) in order to initiate the procedure.
2. The EAP request identity message is forwarded via the Bluetooth interface to the MT.
3. If the MT does not have the identity available, it requests the identity from the USIM.
4. The USIM returns the identity to the MT.
5. The MT inserts the identity in the EAP response identity message and sends it to the network via the TE.
6. The TE sends the EAP response identity message to the network.
7. The network initiates the EAP AKA authentication process.
8. The TE forwards the EAP request to the MT with all the parameters.
9. The MT requests authentication vectors from the USIM.
10. The USIM replies with the calculated keys CK and IK, which will be used by the MT to derive the Master Key (MK) according to ref. [4]. The USIM also returns RES. The MK is then used as input to generate the keys needed to calculate the MAC of message 8 (which will be checked against the received one) and the new MAC for the next message.
11. The EAP response message includes the RES and the calculated MAC.
12. The TE forwards the response message to the network, which will check the validity of the RES and compute the MAC of the of the entire message received, comparing it with the received MAC.
13. If both checks are correct, the network will send an EAP success message to the TE.
14. The TE forwards the EAP success to the MT as a success indication.
15. After receiving the success indication, the MT will derive according to ref. [4] the Master Session Key and Extended Master Session Key (MSK and EMSK) and send them to the TE. The TE uses them for security purposes, for example for WLAN link layer security

6.7.2 Full authentication with EAP SIM

6.7.2.1 Termination in the UICC

The process is shown in figure 13, and itís very similar to EAP AKA (from MT-TE interface point of view).

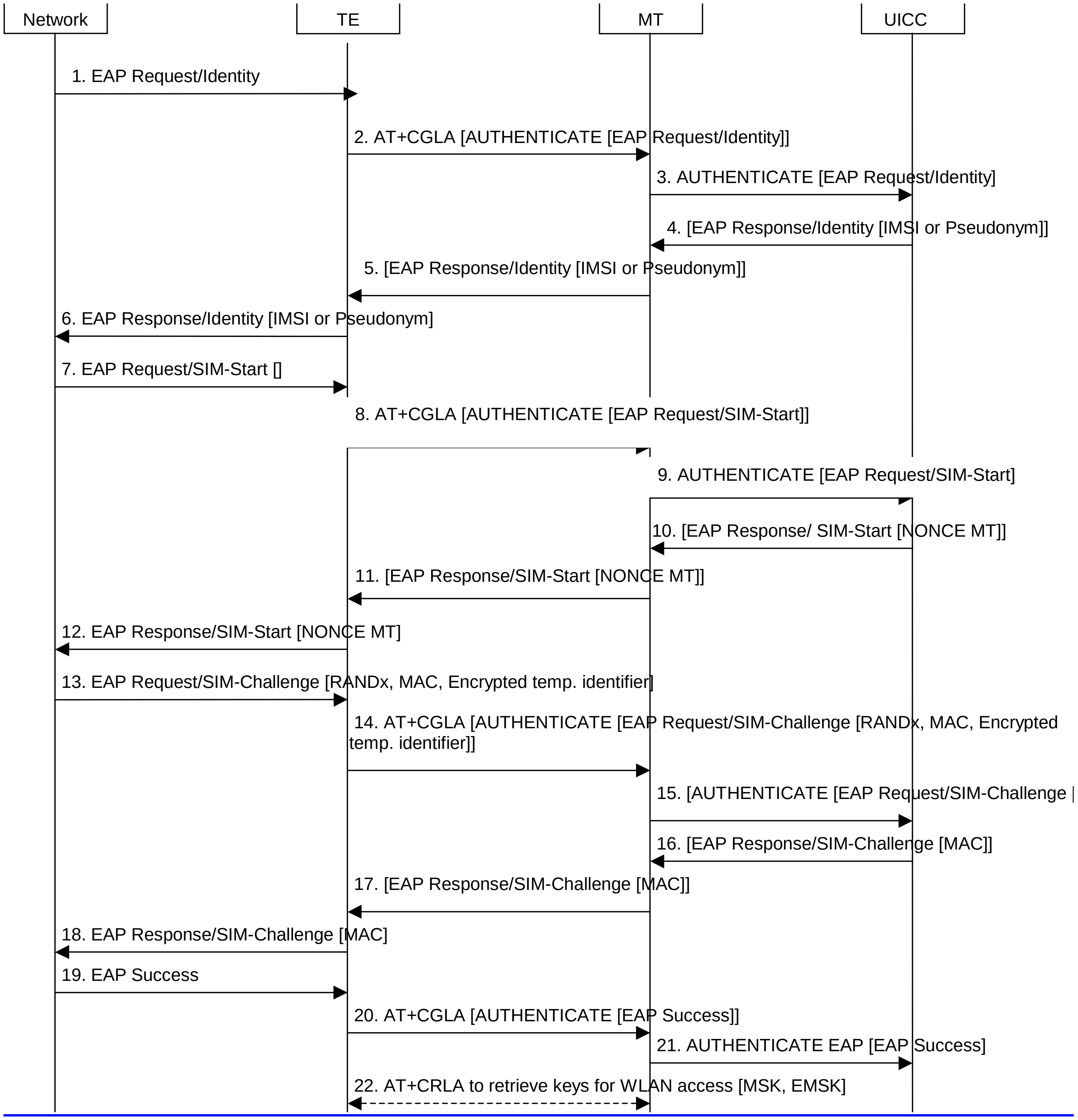

Network
TE
MT
UICC
1. EAP Request/Identity
2. AT+CGLA [AUTHENTICATE [EAP Request/Identity]]
3. AUTHENTICATE [EAP Request/Identity]
4. [EAP Response/Identity [IMSI or Pseudonym]]
5. [EAP Response/Identity [IMSI or Pseudonym]]
6. EAP Response/Identity [IMSI or Pseudonym]
7. EAP Request/SIM-Start []
8. AT+CGLA [AUTHENTICATE [EAP Request/SIM-Start]]
9. AUTHENTICATE [EAP Request/SIM-Start]
10. [EAP Response/ SIM-Start [NONCE MT]]
11. [EAP Response/SIM-Start [NONCE MT]]
12. EAP Response/SIM-Start [NONCE MT]
13. EAP Request/SIM-Challenge [RANDx, MAC, Encrypted temp. identifier]
14. AT+CGLA [AUTHENTICATE [EAP Request/SIM-Challenge [RANDx, MAC, Encrypted temp. identifier]]
15. [AUTHENTICATE [EAP Request/SIM-Challenge |
16. [EAP Response/SIM-Challenge [MAC]]
17. [EAP Response/SIM-Challenge [MAC]]
18. EAP Response/SIM-Challenge [MAC]
19. EAP Success
20. AT+CGLA [AUTHENTICATE [EAP Success]]
21. AUTHENTICATE EAP [EAP Success]
22. AT+CRLA to retrieve keys for WLAN access [MSK, EMSK]

Figure 13: Full authentication with EAP-SIM

1. The network sends an EAP request identity (either a IMSI or a pseudonym) message to the TE (the device providing WLAN access) in order to inititiate the procedure.

2. The TE builds an EAP Authenticate command using the EAP packet received in message 1 then sends this command to the USIM using +CGLA AT command. The EAP request identity message is forwarded via the MT to the USIM. Prior to step 2, the TE shall open a communication session with the USIM, as indicated in TS 27.007 [xx], and shall select the appropriate DF, as indicated in TS 102.310 [yy].

3. The MT performs the received +CGLA AT command i.e. the MT sends the Authenticate command, as received in the AT command, to the USIM (see TS 27.007 [xx])

4. The USIM returns the EAP Response/Identity packet to the MT, in the Authenticate command response data.

5. The MT returns the EAP Response/Identity packet to the TE, in the +CGLA AT command response data.

6. The TE sends the EAP Response/Identity packet to the network.

7. The network initiates the EAP SIM authentication process.

8. The TE builds an EAP Authenticate command using the EAP packet received in message 7 then sends this command to the USIM via the ME using +CGLA AT command.

9. The MT performs the received +CGLA AT command i.e. the MT sends the Authenticate command, as received in the AT command, to the USIM (see TS 27.007 [xx]).

10. The USIM returns the EAP Response/SIM-Start packet to the MT, in the Authenticate command response data.

11. The MT returns the EAP Response/SIM-Start packet to the TE, in the +CGLA AT command response data.

12. The TE sends the EAP Response/SIM-Start packet to the network, which uses the NONCE to calculate the MAC.

13. The network sends an EAP SIM challenge request with the calculated MAC (over the whole EAP message and the NONCE) and the rest of parameters.

14. The TE builds an EAP Authenticate command using the EAP packet received in message 13 then sends this command to the USIM via the ME using +CGLA AT command.

15. The MT performs the received +CGLA AT command i.e. the MT sends the Authenticate command, as received in the AT command, to the USIM (see TS 27.007 [xx]).

16. The USIM returns the EAP Response/SIM-Challenge packet to the MT, in the Authenticate command response data.

17. The MT returns the EAP Response/SIM-Challenge packet to the TE, in the +CGLA AT command response data.

18. The TE sends the EAP Response/SIM-Challenge packet to the network, which computes the MAC and compares it with the received MAC.

19. If checks are correct, the network sends an EAP Success packet to the TE.

20. The TE builds an EAP Authenticate command using the EAP packet received in message 19 then sends this command to the USIM using +CGLA AT command.

21. The MT performs the received +CGLA AT command i.e. the MT sends the Authenticate command, as received in the AT command, to the USIM (see TS 27.007 [xx]).

22. After a successful EAP authentication, the TE shall retrieve the key material (i.e. MSK and EMSK) from EF$_{EAPKEYS}$ (for this purpose, the TE uses the +CRLA AT command). The TE uses MSK and EMSK for security purposes, for example for WLAN link layer security

6.7.2.2 Termination in the MT

The process is shown in figure 14~~2~~, and itís very similar to EAP AKA (from MT-TE interface point of view).

Editorís Note: AT command set for EAP termination in the MT is not yet defined.

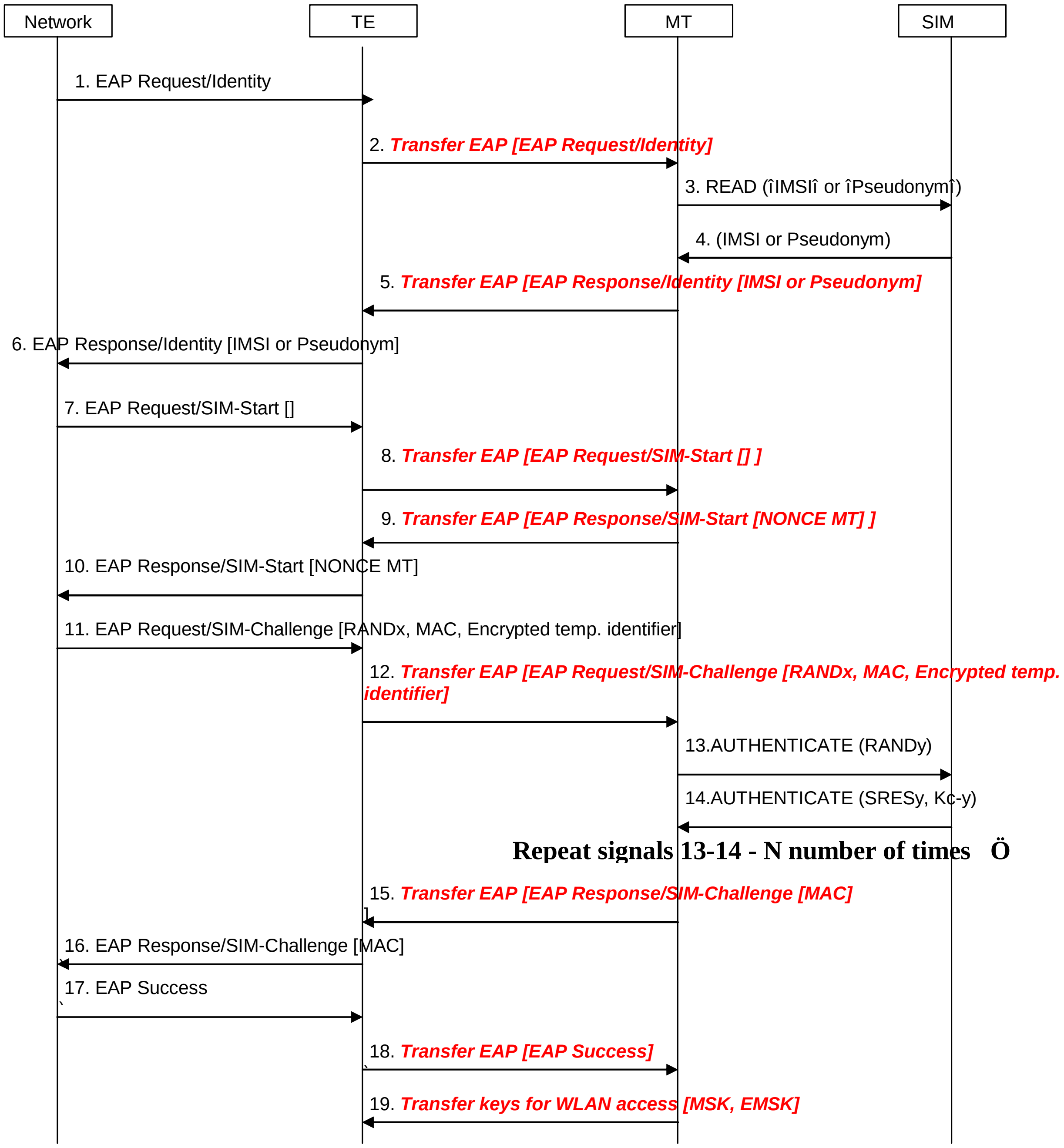

Network
TE
MT
SIM
1. EAP Request/Identity
2. Transfer EAP [EAP Request/Identity]
3. READ (îIMSIî or îPseudonymî)
4. (IMSI or Pseudonym)
5. Transfer EAP [EAP Response/Identity [IMSI or Pseudonym]
6. EAP Response/Identity [IMSI or Pseudonym]
7. EAP Request/SIM-Start []
8. Transfer EAP [EAP Request/SIM-Start []]
9. Transfer EAP [EAP Response/SIM-Start [NONCE MT]]
10. EAP Response/SIM-Start [NONCE MT]
11. EAP Request/SIM-Challenge [RANDx, MAC, Encrypted temp. identifier]
12. Transfer EAP [EAP Request/SIM-Challenge [RANDx, MAC, Encrypted temp. identifier]
13.AUTHENTICATE (RANDy)
14.AUTHENTICATE (SRESy, Kc-y)
Repeat signals 13-14 - N number of times Ö
15. Transfer EAP [EAP Response/SIM-Challenge [MAC]]
16. EAP Response/SIM-Challenge [MAC]
17. EAP Success
18. Transfer EAP [EAP Success]
19. Transfer keys for WLAN access [MSK, EMSK]

Figure 14~~2~~: Full authentication with EAP SIM

1. The network sends a EAP request identity (either a IMSI or a pseudonym) message to the TE (the device providing WLAN access) in order to inititiate the procedure.
2. The EAP request identity message is forwarded via the Bluetooth interface to the MT.
3. If the MT does not have the identity available, it requests the identity from the USIM.
4. The USIM returns the identity to the MT.
5. The MT inserts the identity in the EAP response identity message and sends it to the network via the TE.
6. The TE sends the EAP response identity message to the network.
7. The network initiates the EAP SIM authentication process.
8. The TE forwards the EAP SIMstart request to the MT.
9. The MT generates a NONCE and sends it to the TE.

10. The TE forwards the NONCE to the network, which uses the NONCE to calculate the MAC.

11. The network sends an EAP SIM challenge request with the calculated MAC (over the whole EAP message and the NONCE) and the rest of parameters.

12. The TE forwards the message to the MT.

13. The MT extracts the RAND and sends it to the SIM for key calculation.

14. The SIM responds with the calculated SRES and Kc (the two latter messages will be repeated two or three times). The MT will use the received Kcs (among other inputs) to derive the Master Key (MK) according to ref. [5]. The MK is then used as input to generate the keys needed to calculate the MAC of message 11 (which will be checked against the received one) and the new MAC for the next message.

15. The MT sends the EAP SIM challenge response with the MAC, calculated over the whole EAP message and the SRES (the SRES is the concatenated values of the individual SRESy received from the SIM).

16. The TE forwards the message to the network.

17. The network calculates its own copy of the MAC and if it matches the received one, it sends an EAP success message.

18. The TE forwards the EAP success to the MT as a success indication

19. After receiving the success indication, the MT will derive according to ref. [5] the Master Session Key and Extended Master Session Key (MSK and EMSK) and send them to the TE, which will use them for other security purposes, for example WLAN link layer security.

6.7.3 Fast re-authentication with EAP AKA

6.7.3.1 Termination in the UICC

The keys needed to protect the EAP packets are re-used from the previous full authentication process. The MSK and EMSK are calculated again using the original MK, as specified in ref. [4]. For this reason, the new MSK and EMSK are transferred from the USIM to the TE when the fast re-authentication process is finished. The process is shown in figure 15.

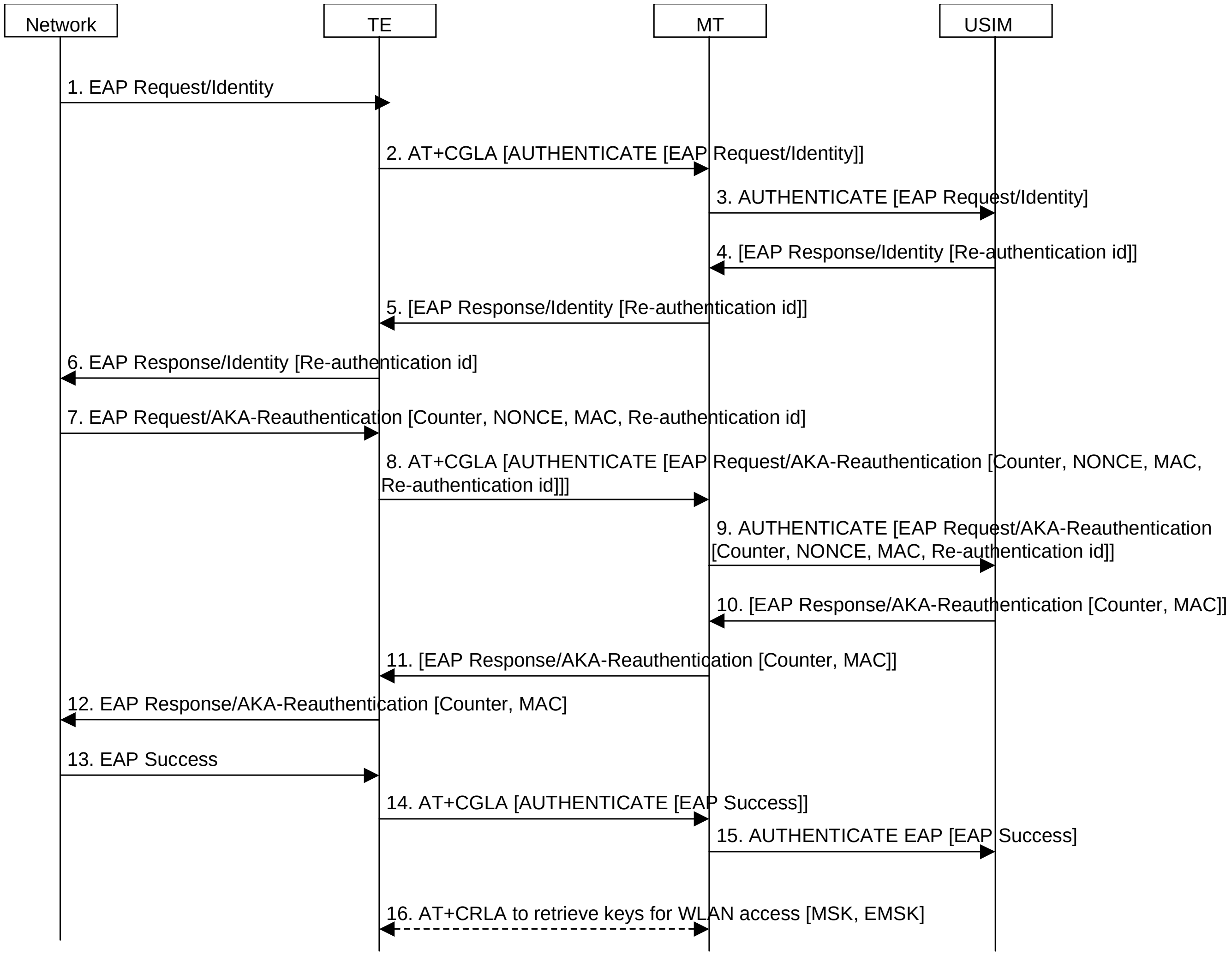

Network
TE
MT
USIM
1. EAP Request/Identity
2. AT+CGLA [AUTHENTICATE [EAP Request/Identity]]
3. AUTHENTICATE [EAP Request/Identity]
4. [EAP Response/Identity [Re-authentication id]]
5. [EAP Response/Identity [Re-authentication id]]
6. EAP Response/Identity [Re-authentication id]
7. EAP Request/AKA-Reauthentication [Counter, NONCE, MAC, Re-authentication id]
8. AT+CGLA [AUTHENTICATE [EAP Request/AKA-Reauthentication [Counter, NONCE, MAC, Re-authentication id]]]
9. AUTHENTICATE [EAP Request/AKA-Reauthentication [Counter, NONCE, MAC, Re-authentication id]]
10. [EAP Response/AKA-Reauthentication [Counter, MAC]]
11. [EAP Response/AKA-Reauthentication [Counter, MAC]]
12. EAP Response/AKA-Reauthentication [Counter, MAC]
13. EAP Success
14. AT+CGLA [AUTHENTICATE [EAP Success]]
15. AUTHENTICATE EAP [EAP Success]
16. AT+CRLA to retrieve keys for WLAN access [MSK, EMSK]

Figure 15: Fast re-authentication with EAP AKA

1. The network sends an EAP request identity message.

2. The TE builds an EAP Authenticate command using the EAP packet received in message 1 then sends this command to the USIM using +CGLA AT command.

3. The MT performs the received +CGLA AT command i.e. the MT sends the Authenticate command, as received in the AT command, to the USIM (see TS 27.007 [xx]).

4. If the USIM received a fast re-authentication identity in the last authentication process (either full or fast), it shall reply with this fast re-authentication identity in the EAP response identity message. Consequently, the USIM returns the EAP Response/Identity packet to the MT, in the Authenticate command response data.

5. The MT returns the EAP Response/Identity packet to the TE, in the +CGLA AT command response data.

6. The TE sends the EAP Response/Identity packet to the network.

7. The network initiates the EAP AKA reauthentication process.

8. The TE builds an EAP Reauthenticate command using the EAP packet received in message 7 then sends this command to the USIM via the ME using +CGLA AT command.

9. The MT performs the received +CGLA AT command i.e. the MT sends the Authenticate command, as received in the AT command, to the USIM (see TS 27.007 [xx]).

10. The USIM returns the EAP Response/AKA-Reauthentication packet to the MT, in the Authenticate command response data.

11. The MT returns the EAP Response/AKA-Reauthentication packet to the TE, in the +CGLA AT command response data.

12. The TE sends the EAP Response/AKA-Reauthentication packet to the network, which computes the MAC of the entire received message, and comapres it with the received MAC.

13. If checks are correct, the network sends an EAP Success packet to the TE.

14. The TE builds an EAP Authenticate command using the EAP packet received in message 13 then sends this command to the USIM using +CGLA AT command.

15. The MT performs the received +CGLA AT command i.e. the MT sends the Authenticate command, as received in the AT command, to the USIM (see TS 27.007 [xx]).

16. After a successful EAP reauthentication, the TE shall retrieve the key material (i.e. MSK and EMSK) from $EF_{EAPKEYS}$ (for this purpose, the TE uses the +CRLA AT command). The TE uses MSK and EMSK for security purposes, for example for WLAN link layer security

6.7.3.2 Termination in the MT

Editorís Note: AT command set for EAP termination in the MT is not yet defined.

The keys needed to protect the EAP packets are re-used from the previous full authentication process. The MSK and EMSK are calculated again using the original MK, as specified in ref. [4]. For this reason, the new MSK and EMSK are transferred from the MT to the TE when the fast re-authentication process is finished. The process is shown in figure 16~~3~~.

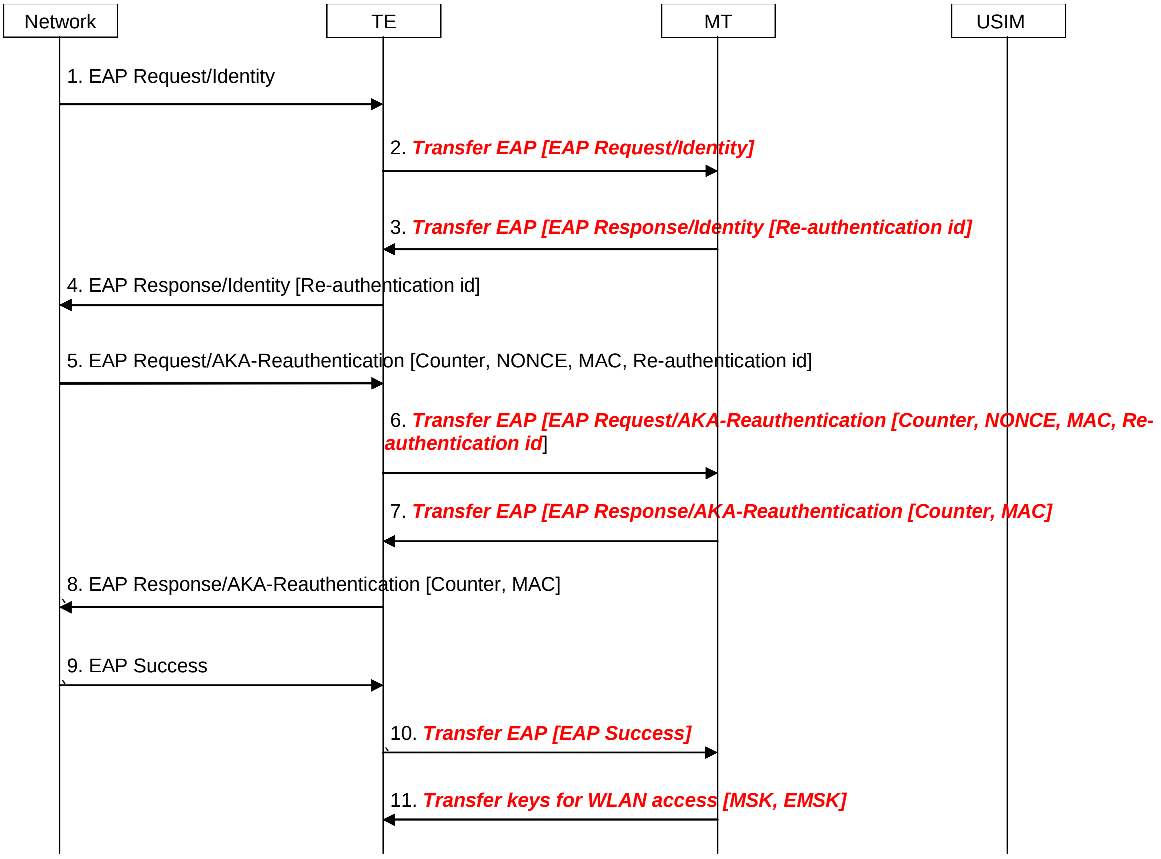

Network
TE
MT
USIM
1. EAP Request/Identity
2. Transfer EAP [EAP Request/Identity]
3. Transfer EAP [EAP Response/Identity [Re-authentication id]
4. EAP Response/Identity [Re-authentication id]
5. EAP Request/AKA-Reauthentication [Counter, NONCE, MAC, Re-authentication id]
6. Transfer EAP [EAP Request/AKA-Reauthentication [Counter, NONCE, MAC, Re-authentication id]
7. Transfer EAP [EAP Response/AKA-Reauthentication [Counter, MAC]
8. EAP Response/AKA-Reauthentication [Counter, MAC]
9. EAP Success
10. Transfer EAP [EAP Success]
11. Transfer keys for WLAN access [MSK, EMSK]

Figure 16~~3~~: Fast re-authentication with EAP AKA

1. The network sends a EAP request identity message.

2. The TE forwards the message to the MT via the Bluetooth interface.

3. If the MT received a fast re-authentication identity in the last authentication process (either full or fast), it replies with this fast re-authentication identity in the EAP response identity message.

NOTE: The MT may need to access the USIM to check if there is a re-authentication id available. However, it is still to be decided whether the USIM will store the re-authentication identities.

4. The MT forwards the message to the network.

5. The network sends the EAP AKA challenge with the needed parameters.

6. The TE transfers the message to the MT with the parameters.

7. The MT uses the same keys as in the previous authentication process to calculate the MAC, and checks if it matches the received one. If it is correct, it calculates a new MAC and sends it in the response message with the Counter received from the network.

8. The TE forwards the response message to the network.

9. The network calculates its own copy of the MAC over the received message and checks it with the received one. If it is correct, it sends a EAP success message.

10. The TE forwards the EAP success to the MT as a success indication.

11. After receiving the success indication, the MT sends the new calculated MSK and EMSK and sends them to the TE.

6.7.4 Fast re-authentication with EAP SIM

6.7.4.1 Termination in the UICC

The keys needed to protect the EAP packets are re-used from the previous full authentication process, as in EAP AKA fast re-authentication. The MSK and EMSK are calculated again using the original MK, as specified in ref. [5]. The new MSK and EMSK are transferred from the USIM to the TE when the fast re-authentication process is finished. The process is shown in figure 17.

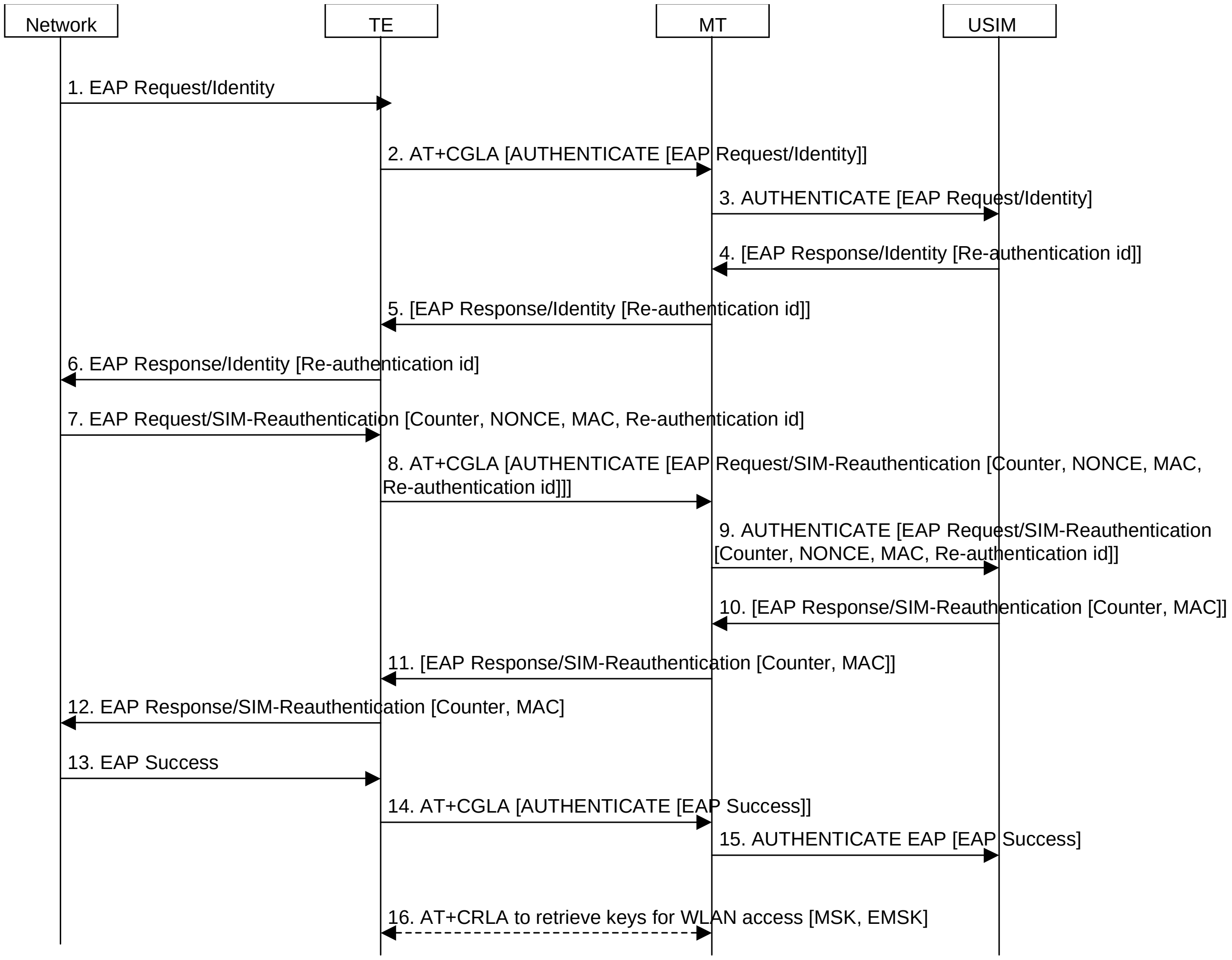

Network
TE
MT
USIM
1. EAP Request/Identity
2. AT+CGLA [AUTHENTICATE [EAP Request/Identity]]
3. AUTHENTICATE [EAP Request/Identity]
4. [EAP Response/Identity [Re-authentication id]]
5. [EAP Response/Identity [Re-authentication id]]
6. EAP Response/Identity [Re-authentication id]
7. EAP Request/SIM-Reauthentication [Counter, NONCE, MAC, Re-authentication id]
8. AT+CGLA [AUTHENTICATE [EAP Request/SIM-Reauthentication [Counter, NONCE, MAC, Re-authentication id]]]
9. AUTHENTICATE [EAP Request/SIM-Reauthentication [Counter, NONCE, MAC, Re-authentication id]]
10. [EAP Response/SIM-Reauthentication [Counter, MAC]]
11. [EAP Response/SIM-Reauthentication [Counter, MAC]]
12. EAP Response/SIM-Reauthentication [Counter, MAC]
13. EAP Success
14. AT+CGLA [AUTHENTICATE [EAP Success]]
15. AUTHENTICATE EAP [EAP Success]
16. AT+CRLA to retrieve keys for WLAN access [MSK, EMSK]

Figure 17: Fast re-authentication with EAP SIM

1. The network sends an EAP request identity message.
2. The TE builds an EAP Authenticate command using the EAP packet received in message 1 then sends this command to the USIM using +CGLA AT command.
3. The MT performs the received +CGLA AT command i.e. the MT sends the Authenticate command, as received in the AT command, to the USIM (see TS 27.007 [xx]).
4. If the USIM received a fast re-authentication identity in the last authentication process (either full or fast), it shall reply with this fast re-authentication identity in the EAP response identity message. Consequently, the USIM returns the EAP Response/Identity packet to the MT, in the Authenticate command response data.
5. The MT returns the EAP Response/Identity packet to the TE, in the +CGLA AT command response data.
6. The TE sends the EAP Response/Identity packet to the network.
7. The network initiates the EAP SIM reauthentication process.
8. The TE builds an EAP Authenticate command using the EAP packet received in message 7 then sends this command to the USIM via the ME using +CGLA AT command.
9. The MT performs the received +CGLA AT command i.e. the MT sends the Authenticate command, as received in the AT command, to the USIM (see TS 27.007 [xx]).
10. The USIM returns the EAP Response/SIM-Reauthentication packet to the MT, in the Authenticate command response data.

11. The MT returns the EAP Response/SIM-Reauthentication packet to the TE, in the +CGLA AT command response data.

12. The TE sends the EAP Response/SIM-Reauthentication packet to the network, which computes the MAC of the entire received message, and compares it with the received MAC.

13. If checks are correct, the network sends an EAP Success packet to the TE.

14. The TE builds an EAP Authenticate command using the EAP packet received in message 13 then sends this command to the USIM using +CGLA AT command.

15. The MT performs the received +CGLA AT command i.e. the MT sends the Authenticate command as it is to the USIM (see TS 27.007 [xx]).

16. After a successful EAP reauthentication, the TE shall retrieve the key material (i.e. MSK and EMSK) from $EF_{EAPKEYS}$ (for this purpose, the TE uses the +CRLA AT command). The TE uses MSK and EMSK for security purposes, for example for WLAN link layer security

6.7.4.2 Termination in the MT

Editorís Note: AT command set for EAP termination in the MT is not yet defined.

The keys needed to protect the EAP packets are re-used from the previous full authentication process, as in EAP AKA fast re-authentication. The MSK and EMSK are calculated again using the original MK, as specified in ref. [5]. The new MSK and EMSK are transferred from the MT to the TE when the fast re-authentication process is finished. The process is shown in figure 184.

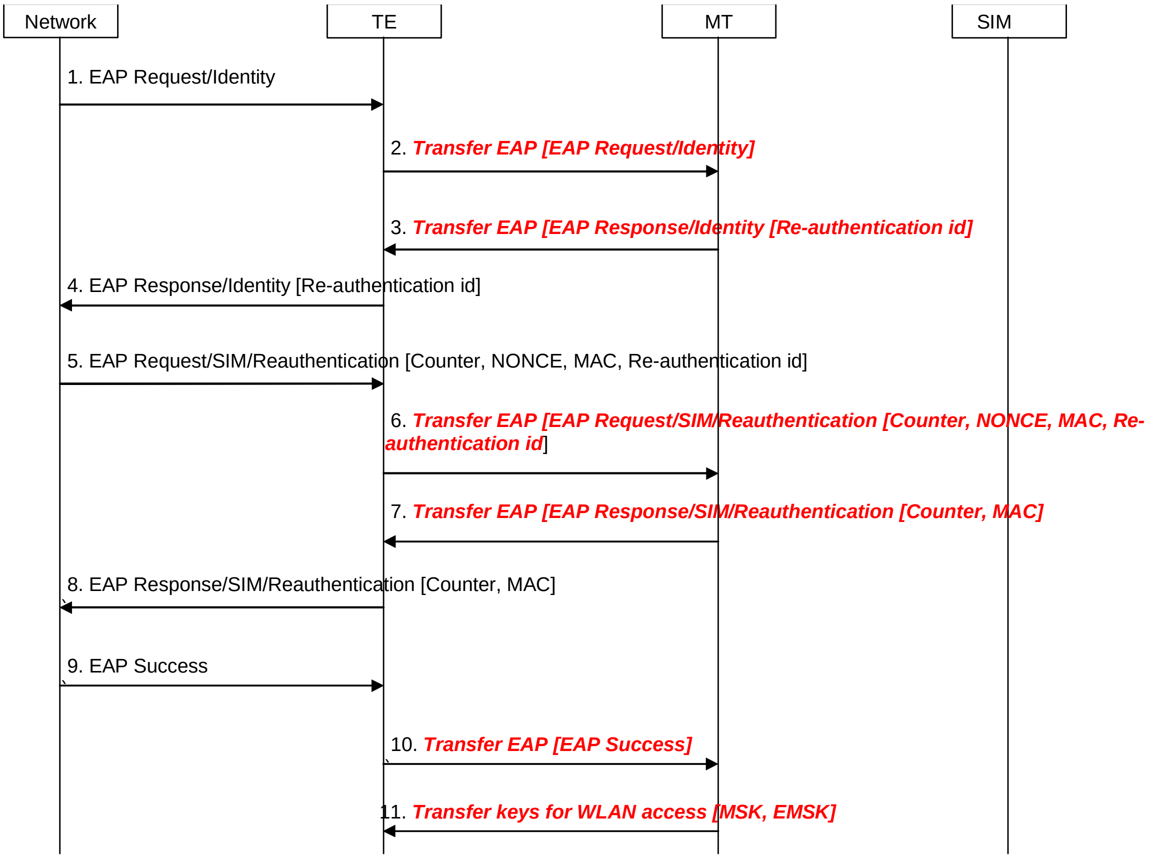

Network
TE
MT
SIM
1. EAP Request/Identity
2. Transfer EAP [EAP Request/Identity]
3. Transfer EAP [EAP Response/Identity [Re-authentication id]
4. EAP Response/Identity [Re-authentication id]
5. EAP Request/SIM/Reauthentication [Counter, NONCE, MAC, Re-authentication id]
6. Transfer EAP [EAP Request/SIM/Reauthentication [Counter, NONCE, MAC, Re-authentication id]
7. Transfer EAP [EAP Response/SIM/Reauthentication [Counter, MAC]
8. EAP Response/SIM/Reauthentication [Counter, MAC]
9. EAP Success
10. Transfer EAP [EAP Success]
11. Transfer keys for WLAN access [MSK, EMSK]

Figure 184: Fast re-authentication with EAP SIM

1. The network sends a EAP request identity message.
2. The TE forwards the message to the MT via the Bluetooth interface.

3. If the MT received a fast re-authentication identity in the last authentication process (either full or fast), it replies with this fast re-authentication identity in the EAP response identity message.

NOTE: the MT may need to access the USIM to check if there is a re-authentication id available. However, it is still to be decided whether the USIM will store the re-authentication identities.

4. The MT forwards the message to the network.

5. The network sends the EAP AKA challenge with the needed parameters.

6. The TE transfers the message to the MT with the parameters.

7. The MT uses the same keys as in the previous authentication process to calculate the MAC, and checks if it matches the received one. If it is correct, it calculates a new MAC and sends it in the response message with the Counter received from the network.

8. The TE forwards the response message to the network.

9. The network calculates its own copy of the MAC over the received message and checks it with the received one. If it is correct, it sends a EAP success message.

10. The TE forwards the EAP success to the MT as a success indication

11. After receiving the success indication, the MT sends the new calculated MSK and EMSK and sends them to the TE.