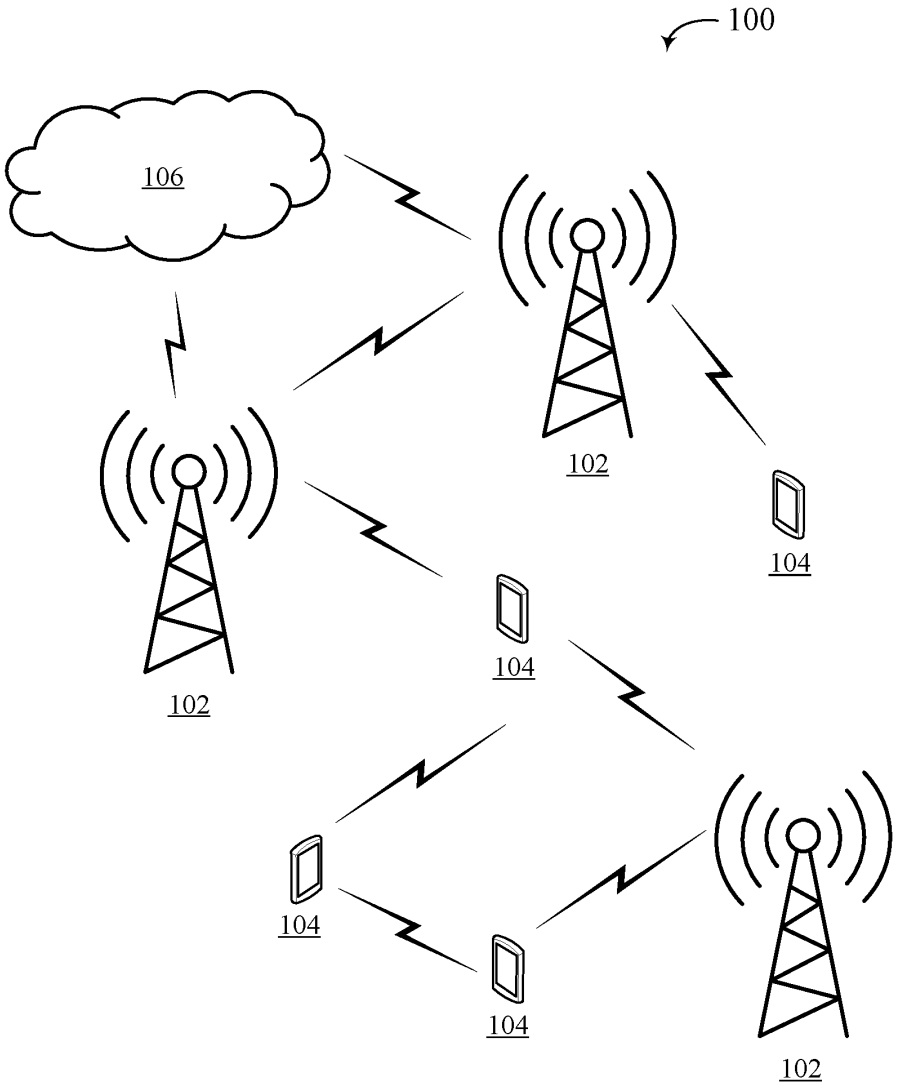



Figure 1

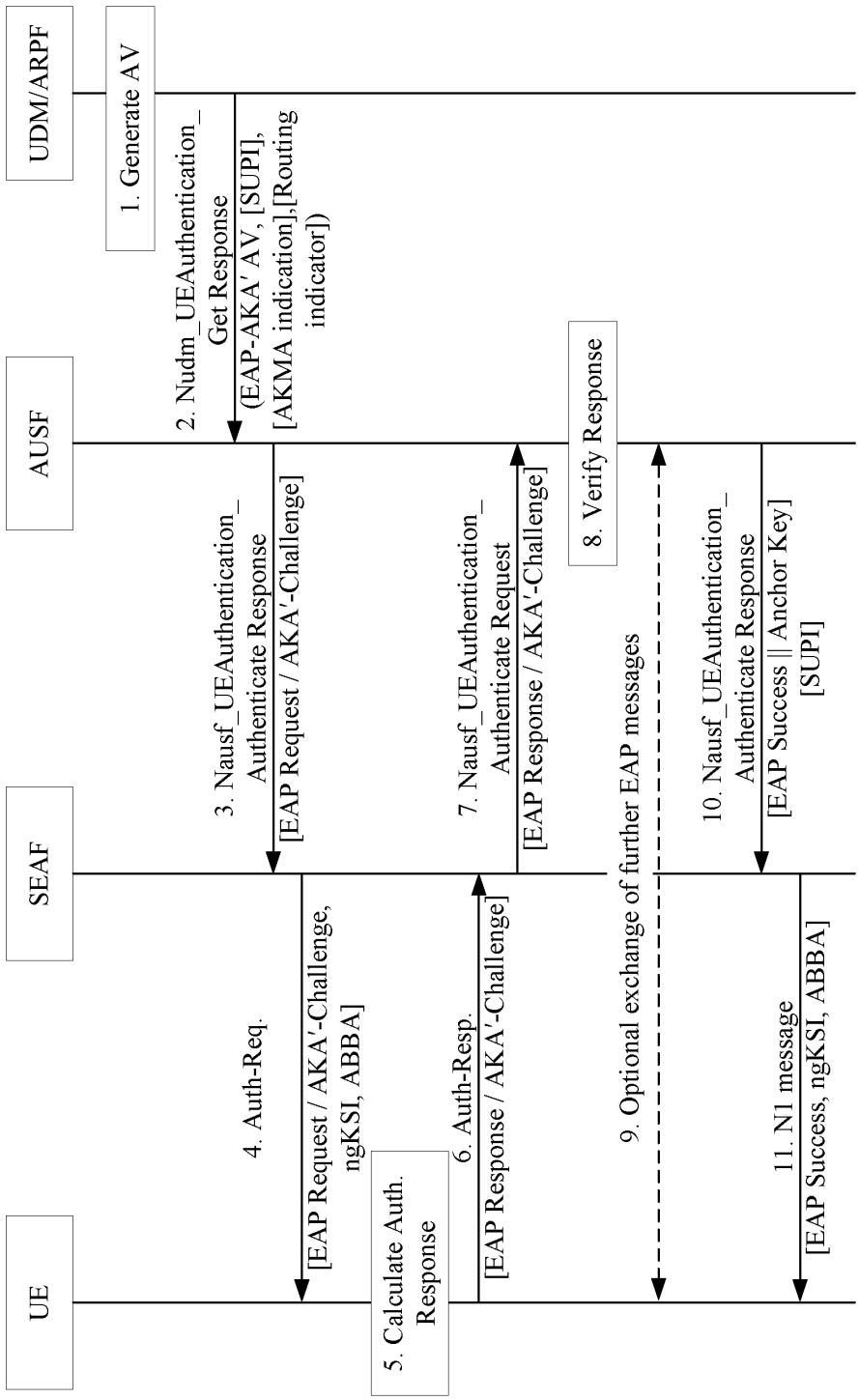

UE
SEAF
AUSF
UDM/ARPF
1. Generate AV
2. Nudm_UEAuthentication_ Get Response (EAP-AKA' AV, [SUPI], [AKMA indication],[Routing indicator])
3. Nausf_UEAuthentication_ Authenticate Response [EAP Request / AKA'-Challenge]
4. Auth-Req. [EAP Request / AKA'-Challenge, ngKSI, ABBA]
5. Calculate Auth. Response
6. Auth-Resp. [EAP Response / AKA'-Challenge]
7. Nausf_UEAuthentication_ Authenticate Request [EAP Response / AKA'-Challenge]
8. Verify Response
9. Optional exchange of further EAP messages
10. Nausf_UEAuthentication_ Authenticate Response [EAP Success || Anchor Key] [SUPI]
11. N1 message [EAP Success, ngKSI, ABBA]
200

Figure 2

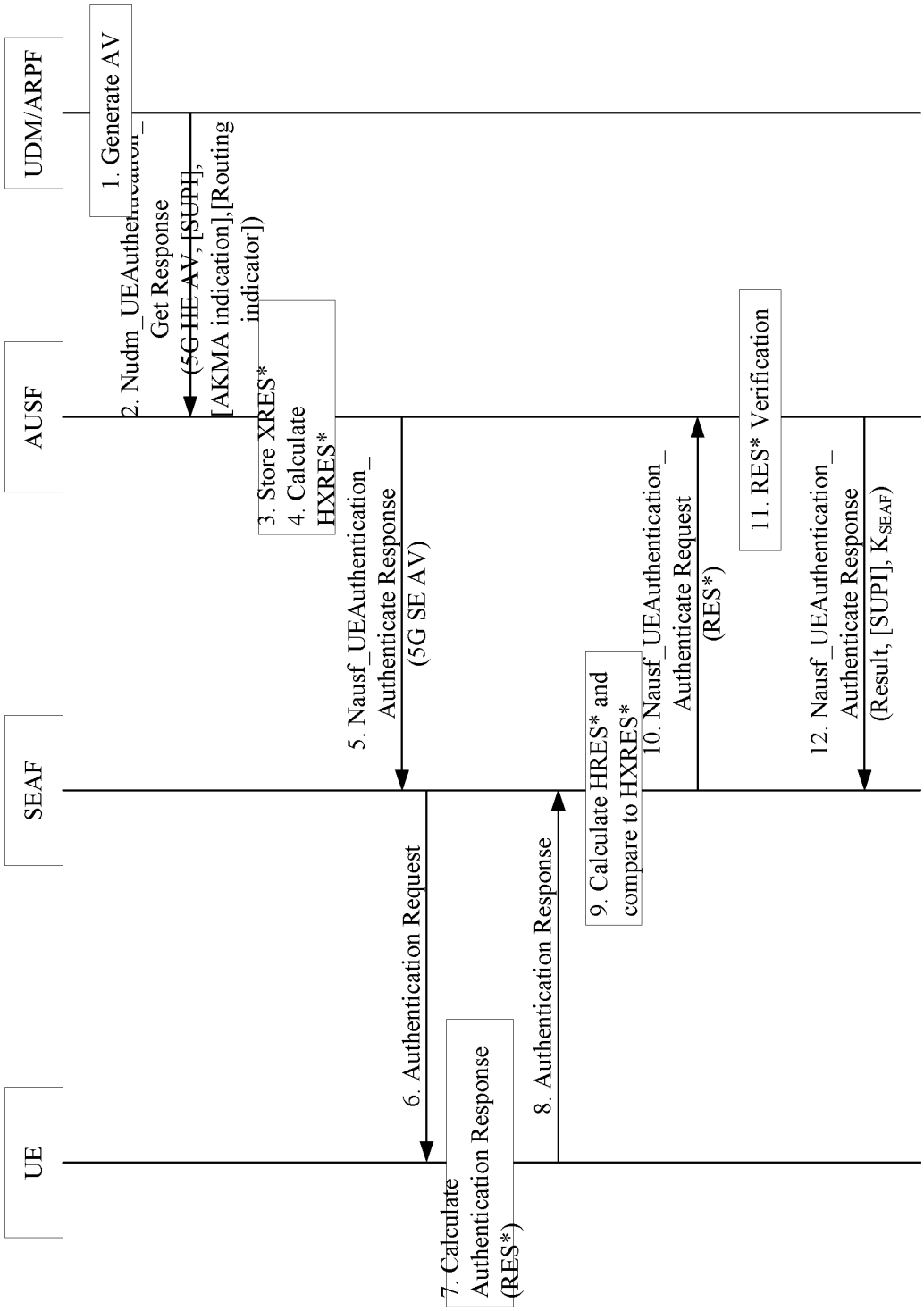

UDM/ARPF
AUSF
SEAF
UE
1. Generate AV
2. Nudm_UEAuthentication_
Get Response
(5G HE AV, [SUPI],
[AKMA indication],[Routing
indicator])
3. Store XRES*
4. Calculate
HXRES*
5. Nausf_UEAuthentication_
Authenticate Response
(5G SE AV)
6. Authentication Request
7. Calculate
Authentication Response
(RES*)
8. Authentication Response
9. Calculate HRES* and
compare to HXRES*
10. Nausf_UEAuthentication_
Authenticate Request
(RES*)
11. RES* Verification
12. Nausf_UEAuthentication_
Authenticate Response
(Result, [SUPI], $K_{SEAF}$)
300

Figure 3

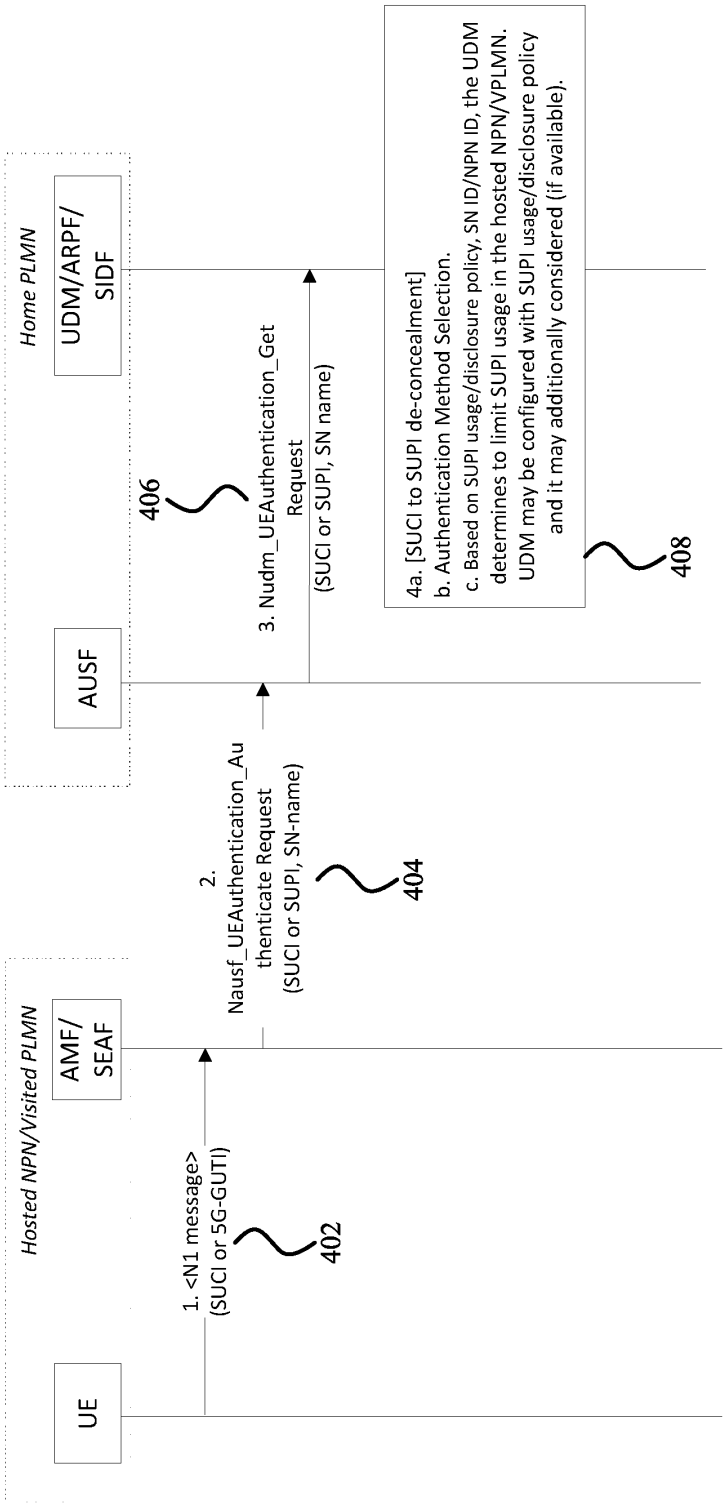

Hosted NPN/Visited PLMN
UE
AMF/ SEAF
Home PLMN
AUSF
UDM/ARPF/ SIDF
1. <N1 message> (SUCI or 5G-GUTI)
402
2. Nausf_UEAuthentication_Authenticate Request (SUCI or SUPI, SN-name)
404
3. Nudm_UEAuthentication_Get Request (SUCI or SUPI, SN name)
406
4a. [SUCI to SUPI de-concealment]
b. Authentication Method Selection.
c. Based on SUPI usage/disclosure policy, SN ID/NPN ID, the UDM determines to limit SUPI usage in the hosted NPN/VPLMN. UDM may be configured with SUPI usage/disclosure policy and it may additionally considered (if available).
408
400

Figure 4

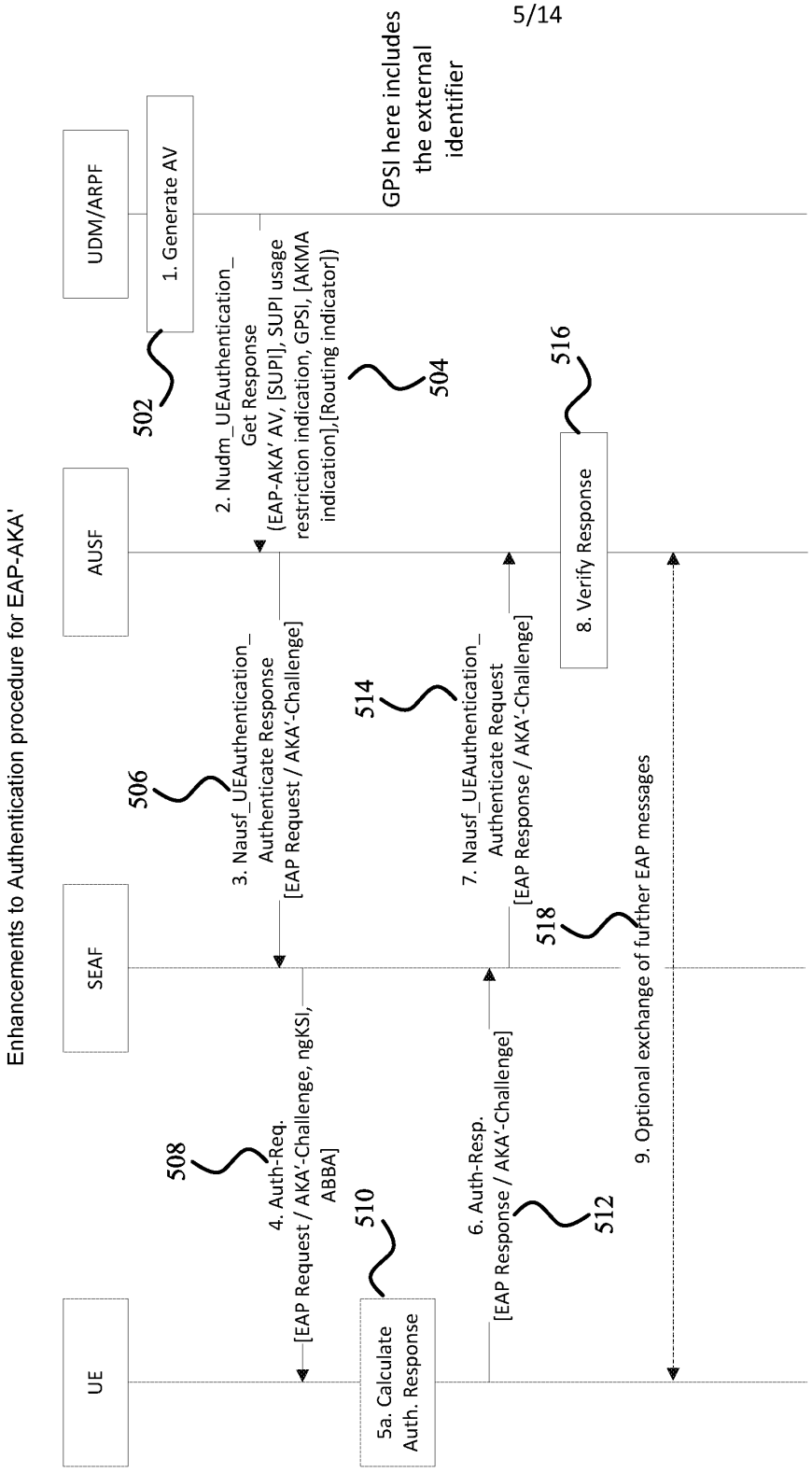

Enhancements to Authentication procedure for EAP-AKA'
UE
SEAF
AUSF
UDM/ARPF
1. Generate AV
GPSI here includes the external identifier
2. Nudm_UEAuthentication_ Get Response (EAP-AKA' AV, [SUPI], SUPI usage restriction indication, GPSI, [AKMA indication],[Routing indicator])
3. Nausf_UEAuthentication_ Authenticate Response [EAP Request / AKA'-Challenge]
4. Auth-Req. [EAP Request / AKA'-Challenge, ngKSI, ABBA]
5a. Calculate Auth. Response
6. Auth-Resp. [EAP Response / AKA'-Challenge]
7. Nausf_UEAuthentication_ Authenticate Request [EAP Response / AKA'-Challenge]
8. Verify Response
9. Optional exchange of further EAP messages
502
504
506
508
510
512
514
516
518
500

Figure 5A

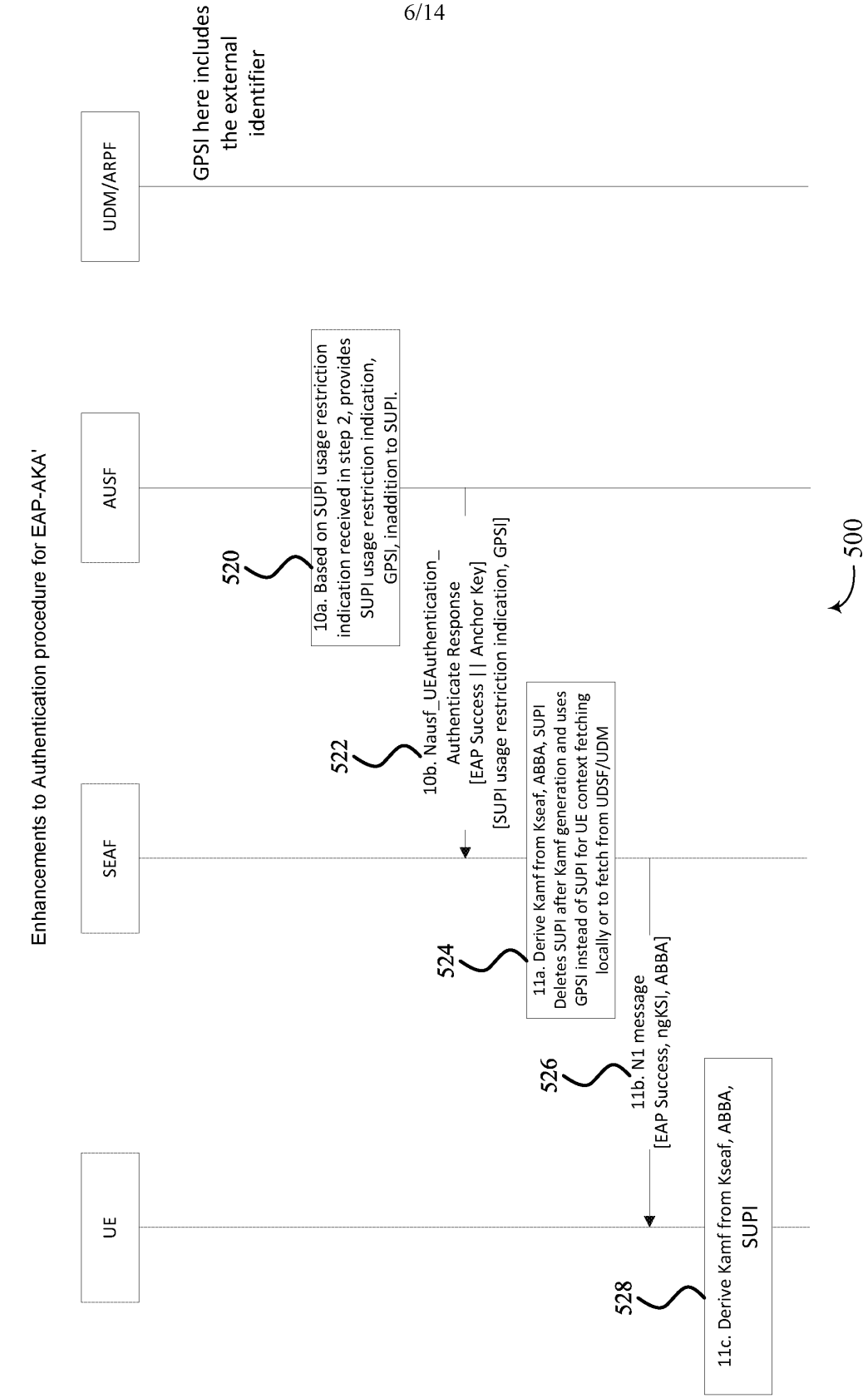

Enhancements to Authentication procedure for EAP-AKA'
UE
SEAF
AUSF
UDM/ARPF
GPSI here includes the external identifier
520
10a. Based on SUPI usage restriction indication received in step 2, provides SUPI usage restriction indication, GPSI, inaddition to SUPI.
522
10b. Nausf_UEAuthentication_ Authenticate Response [EAP Success || Anchor Key] [SUPI usage restriction indication, GPSI]
524
11a. Derive Kamf from Kseaf, ABBA, SUPI Deletes SUPI after Kamf generation and uses GPSI instead of SUPI for UE context fetching locally or to fetch from UDSF/UDM
526
11b. N1 message [EAP Success, ngKSI, ABBA]
528
11c. Derive Kamf from Kseaf, ABBA, SUPI
500

Figure 5B

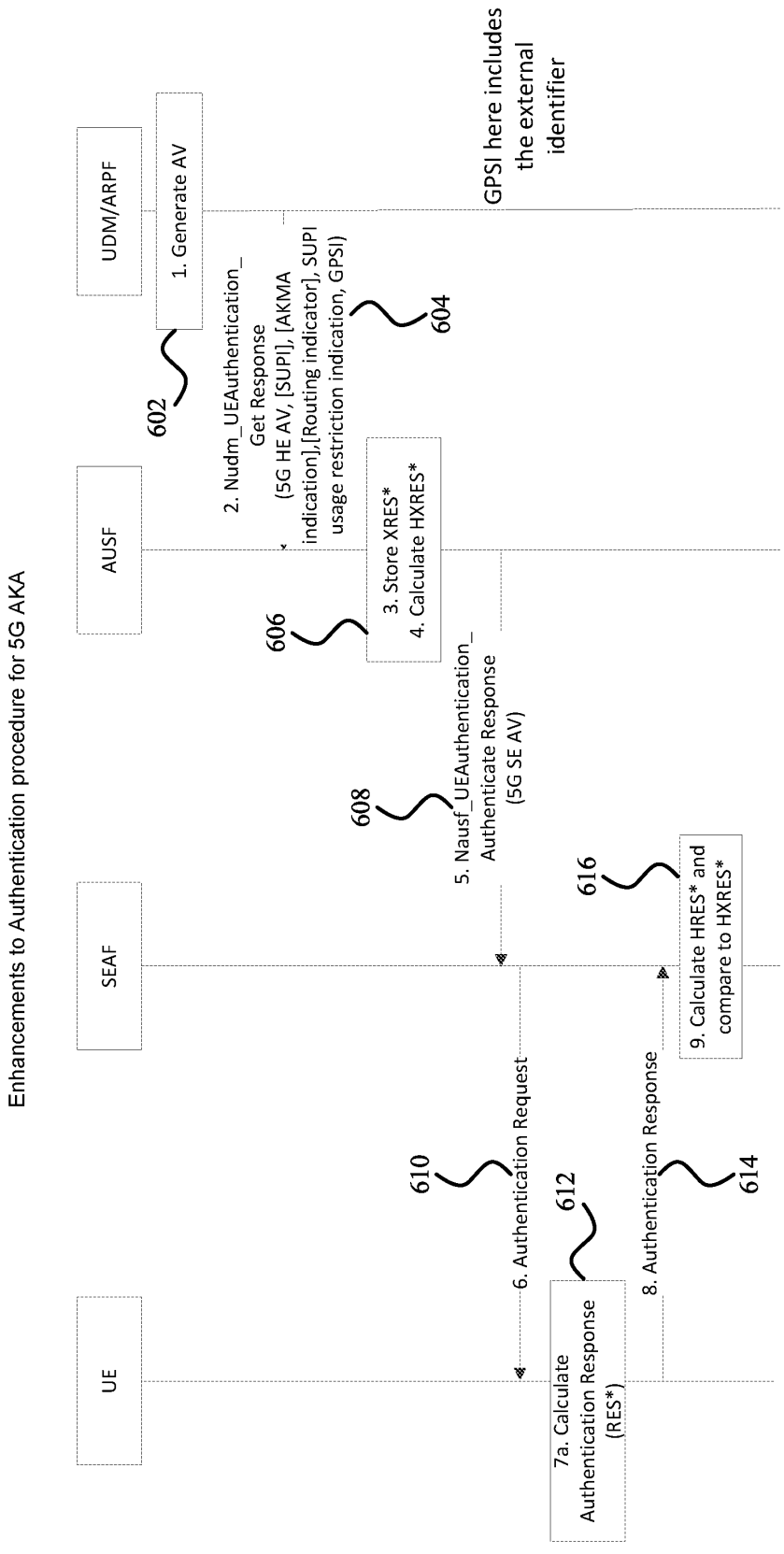

Enhancements to Authentication procedure for 5G AKA
UE
SEAF
AUSF
UDM/ARPF
1. Generate AV
602
2. Nudm_UEAuthentication_ Get Response (5G HE AV, [SUPI], [AKMA indication],[Routing indicator], SUPI usage restriction indication, GPSI)
604
GPSI here includes the external identifier
606
3. Store XRES* 4. Calculate HXRES*
608
5. Nausf_UEAuthentication_ Authenticate Response (5G SE AV)
610
6. Authentication Request
612
7a. Calculate Authentication Response (RES*)
614
8. Authentication Response
616
9. Calculate HRES* and compare to HXRES*
600

Figure 6A

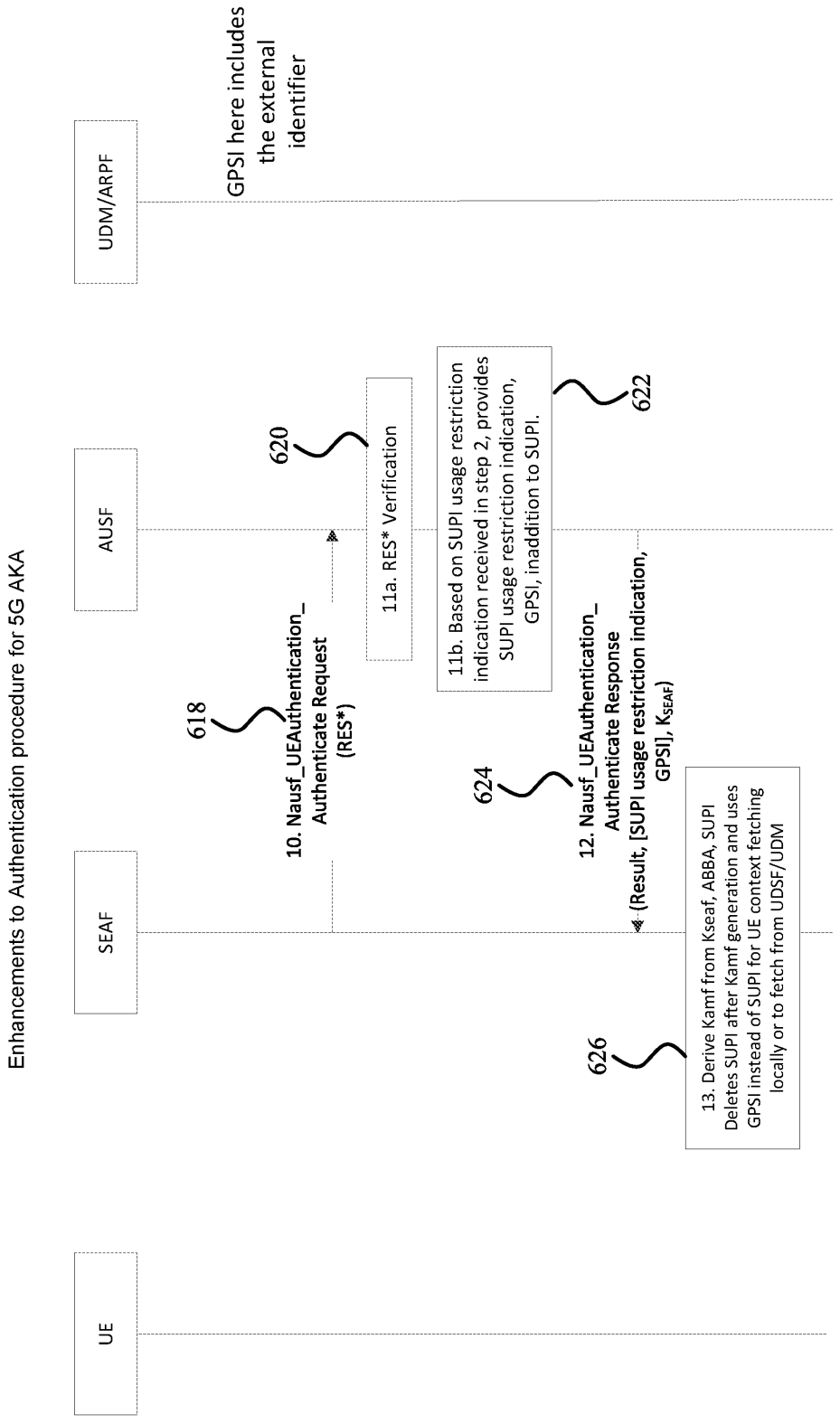

Enhancements to Authentication procedure for 5G AKA
UE
SEAF
AUSF
UDM/ARPF
GPSI here includes the external identifier
618
10. Nausf_UEAuthentication_ Authenticate Request (RES*)
620
11a. RES* Verification
11b. Based on SUPI usage restriction indication received in step 2, provides SUPI usage restriction indication, GPSI, inaddition to SUPI.
622
624
12. Nausf_UEAuthentication_ Authenticate Response (Result, [SUPI usage restriction indication, GPSI], $K_{SEAF}$)
626
13. Derive Kamf from Kseaf, ABBA, SUPI Deletes SUPI after Kamf generation and uses GPSI instead of SUPI for UE context fetching locally or to fetch from UDSF/UDM
600

Figure 6B

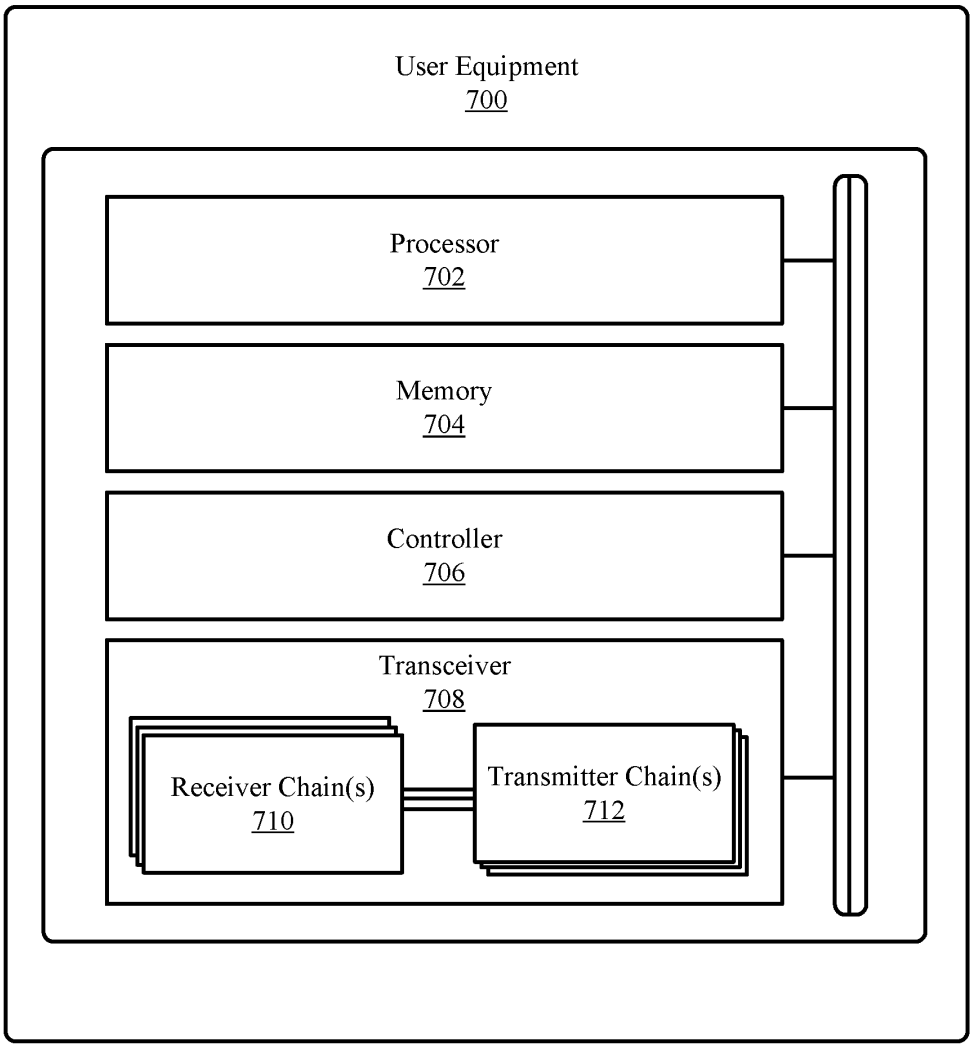

User Equipment
700
Processor
702
Memory
704
Controller
706
Transceiver
708
Receiver Chain(s)
710
Transmitter Chain(s)
712

Figure 7

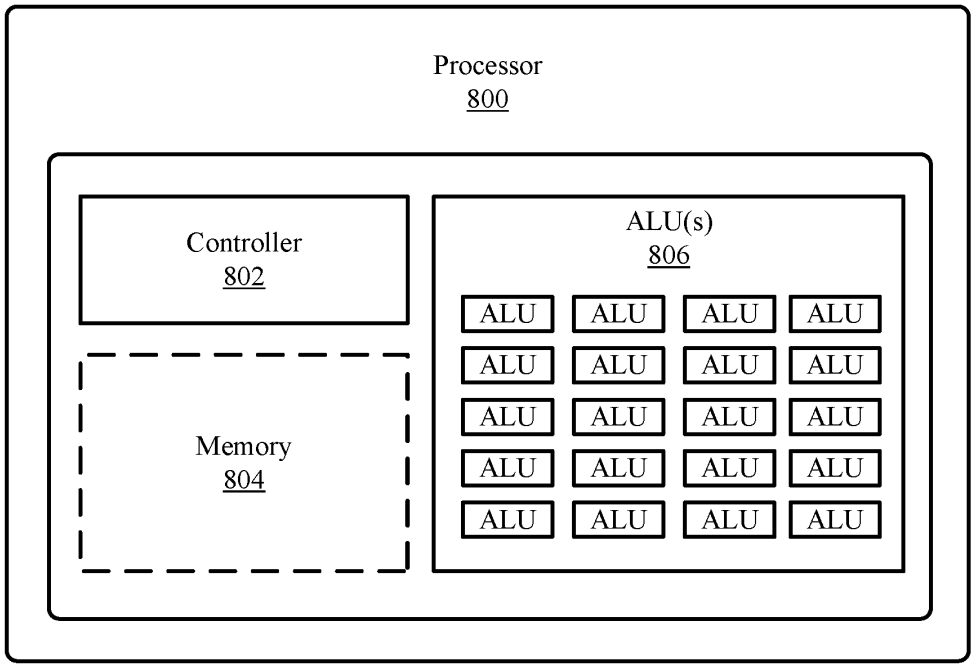

Processor
800
Controller
802
Memory
804
ALU(s)
806
ALU
ALU
ALU
ALU
ALU
ALU
ALU
ALU
ALU
ALU
ALU
ALU
ALU
ALU
ALU
ALU
ALU
ALU
ALU
ALU

Figure 8

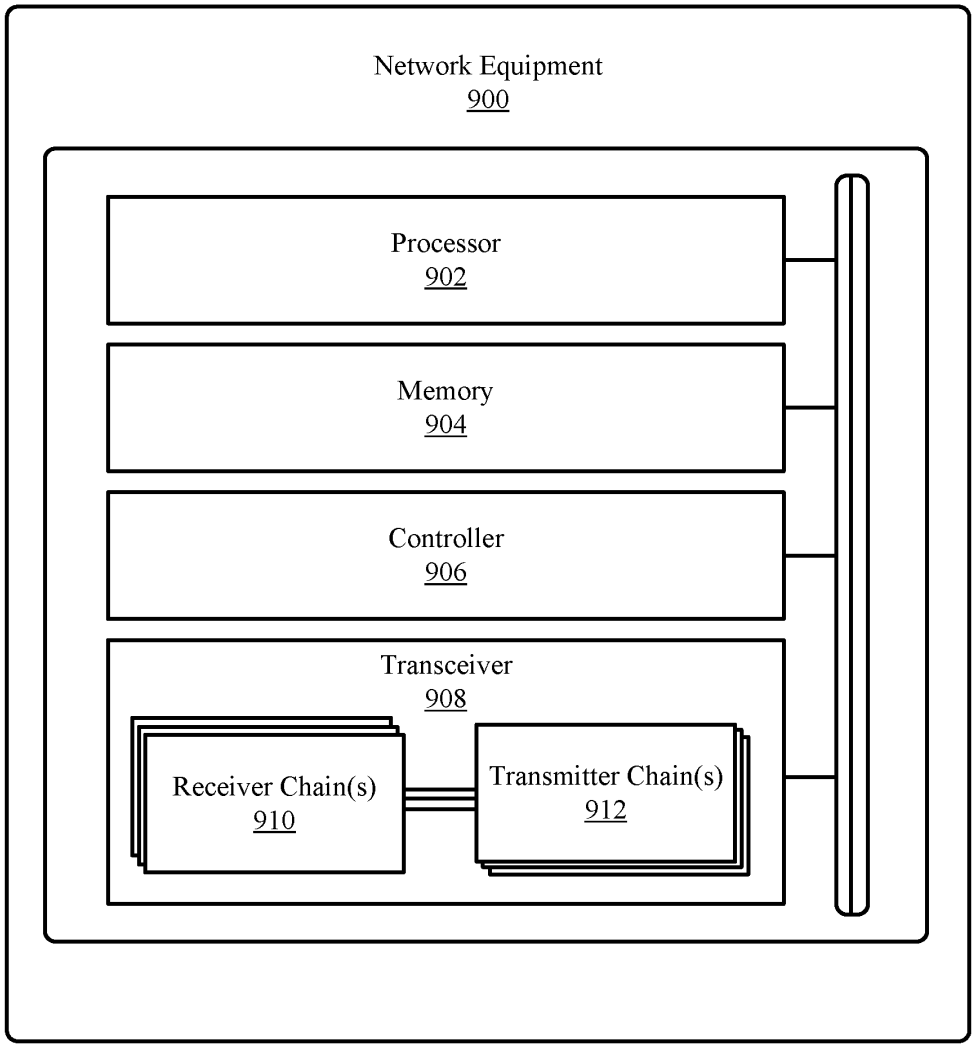

Network Equipment
900
Processor
902
Memory
904
Controller
906
Transceiver
908
Receiver Chain(s)
910
Transmitter Chain(s)
912

Figure 9

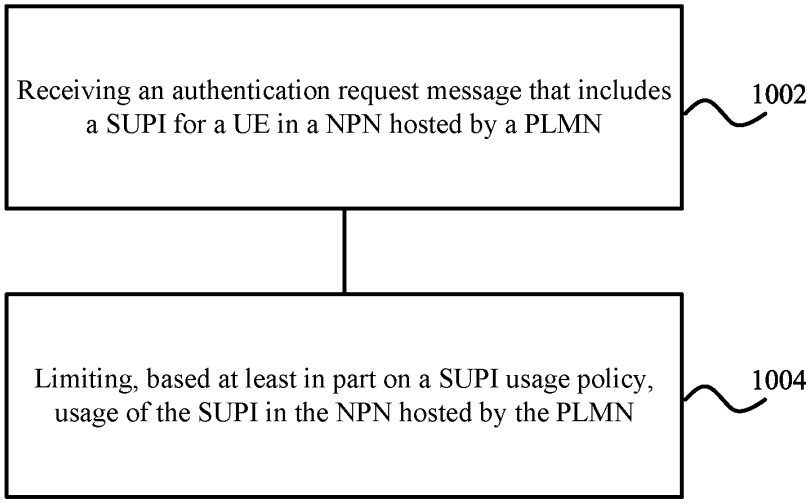

Receiving an authentication request message that includes a SUPI for a UE in a NPN hosted by a PLMN
1002
Limiting, based at least in part on a SUPI usage policy, usage of the SUPI in the NPN hosted by the PLMN
1004

Figure 10

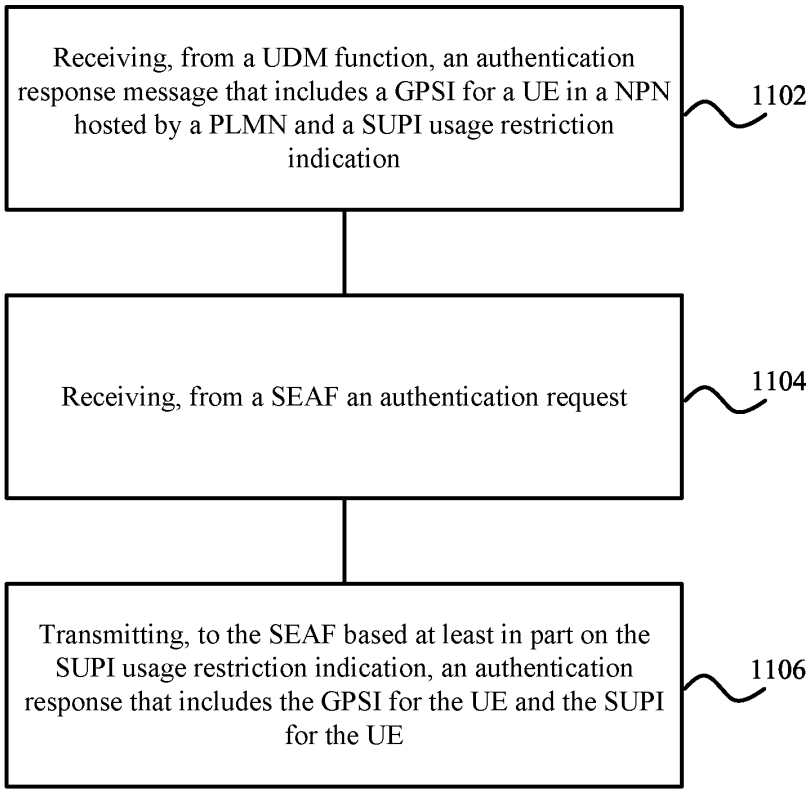

Receiving, from a UDM function, an authentication response message that includes a GPSI for a UE in a NPN hosted by a PLMN and a SUPI usage restriction indication
1102
Receiving, from a SEAF an authentication request
1104
Transmitting, to the SEAF based at least in part on the SUPI usage restriction indication, an authentication response that includes the GPSI for the UE and the SUPI for the UE
1106

Figure 11

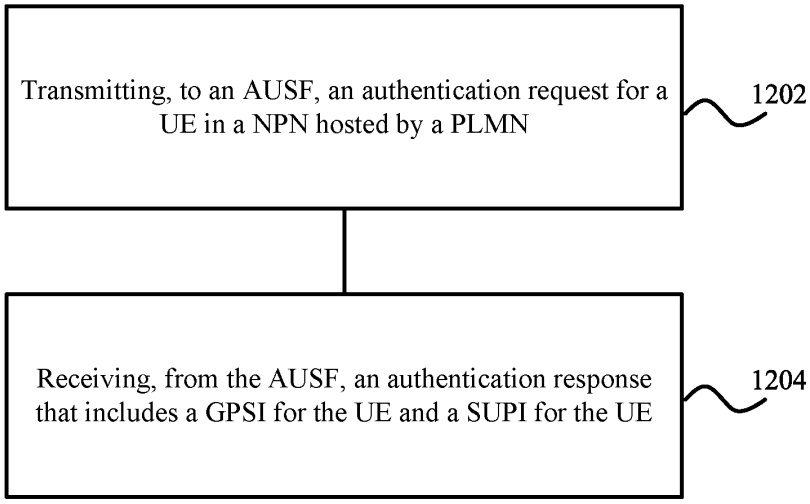

Transmitting, to an AUSF, an authentication request for a UE in a NPN hosted by a PLMN
1202
Receiving, from the AUSF, an authentication response that includes a GPSI for the UE and a SUPI for the UE
1204

Figure 12