

ETSI TS 133 501 V17.7.0 (2022-09)



5G; Security architecture and procedures for 5G System (3GPP TS 33.501 version 17.7.0 Release 17)

[ETSI TS 133 501 V17.7.0 \(2022-09\)](https://standards.iteh.ai/catalog/standards/sist/5d3db86e-1ee6-4264-9b01-0e0f74cd1154/etsi-ts-133-501-v17-7-0-2022-09)

<https://standards.iteh.ai/catalog/standards/sist/5d3db86e-1ee6-4264-9b01-0e0f74cd1154/etsi-ts-133-501-v17-7-0-2022-09>



Reference

RTS/TSGS-0333501vh70

Keywords

5G, SECURITY

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Important notice

The present document can be downloaded from:

<http://www.etsi.org/standards-search>

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format at www.etsi.org/deliver.

Users of the present document should be aware that the document may be subject to revision or change of status.

Information on the current status of this and other ETSI documents is available at

<https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx>

If you find errors in the present document, please send your comment to one of the following services:

<https://standards-portal.etsi.org/People/CommitteeSupportStaff.aspx> 4264-9b01-

If you find a security vulnerability in the present document, please report it through our

Coordinated Vulnerability Disclosure Program:

<https://www.etsi.org/standards/coordinated-vulnerability-disclosure>

Notice of disclaimer & limitation of liability

The information provided in the present deliverable is directed solely to professionals who have the appropriate degree of experience to understand and interpret its content in accordance with generally accepted engineering or other professional standard and applicable regulations.

No recommendation as to products and services or vendors is made or should be implied.

No representation or warranty is made that this deliverable is technically accurate or sufficient or conforms to any law and/or governmental rule and/or regulation and further, no representation or warranty is made of merchantability or fitness for any particular purpose or against infringement of intellectual property rights.

In no event shall ETSI be held liable for loss of profits or any other incidental or consequential damages.

Any software contained in this deliverable is provided "AS IS" with no warranties, express or implied, including but not limited to, the warranties of merchantability, fitness for a particular purpose and non-infringement of intellectual property rights and ETSI shall not be held liable in any event for any damages whatsoever (including, without limitation, damages for loss of profits, business interruption, loss of information, or any other pecuniary loss) arising out of or related to the use of or inability to use the software.

Copyright Notification

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.

The content of the PDF version shall not be modified without the written authorization of ETSI.

The copyright and the foregoing restriction extend to reproduction in all media.

© ETSI 2022.
All rights reserved.

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: "*Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards*", which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (<https://ipr.etsi.org/>).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™** and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM®** and the GSM logo are trademarks registered and owned by the GSM Association.

Legal Notice

This Technical Specification (TS) has been produced by ETSI 3rd Generation Partnership Project (3GPP).

The present document may refer to technical specifications or reports using their 3GPP identities. These shall be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between 3GPP and ETSI identities can be found under <http://webapp.etsi.org/key/queryform.asp>.

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Contents

Intellectual Property Rights	2
Legal Notice	2
Modal verbs terminology.....	2
Foreword.....	16
1 Scope	17
2 References	17
3 Definitions and abbreviations.....	21
3.1 Definitions	21
3.2 Abbreviations	24
4 Overview of security architecture	26
4.1 Security domains	26
4.2 Security at the perimeter of the 5G Core network.....	27
4.2.0 General.....	27
4.2.1 Security Edge Protection Proxy (SEPP)	27
4.2.2 Inter-PLMN UP Security (IPUPS).....	28
4.3 Security entities in the 5G Core network.....	28
5 Security requirements and features	28
5.1 General security requirements	28
5.1.1 Mitigation of bidding down attacks	28
5.1.2 Authentication and Authorization.....	28
5.1.3 Requirements on 5GC and NG-RAN related to keys	29
5.2 Requirements on the UE.....	29
5.2.1 General.....	29
5.2.2 User data and signalling data confidentiality	29
5.2.3 User data and signalling data integrity.....	29
5.2.4 Secure storage and processing of subscription credentials	30
5.2.5 Subscriber privacy	30
5.3 Requirements on the gNB	31
5.3.1 General.....	31
5.3.2 User data and signalling data confidentiality	31
5.3.3 User data and signalling data integrity.....	31
5.3.4 Requirements for the gNB setup and configuration.....	32
5.3.5 Requirements for key management inside the gNB.....	32
5.3.6 Requirements for handling user plane data for the gNB	32
5.3.7 Requirements for handling control plane data for the gNB	33
5.3.8 Requirements for secure environment of the gNB.....	33
5.3.9 Requirements for the gNB F1 interfaces.....	33
5.3.10 Requirements for the gNB E1 interfaces	33
5.4 Requirements on the ng-eNB	33
5.5 Requirements on the AMF	34
5.5.1 Signalling data confidentiality	34
5.5.2 Signalling data integrity.....	34
5.5.3 Subscriber privacy	34
5.6 Requirements on the SEAF	34
5.7 Void.....	35
5.8 Requirements on the UDM.....	35
5.8.1 Generic requirements.....	35
5.8.2 Subscriber privacy related requirements to UDM and SIDF	35
5.8a Requirements on AUSF.....	35
5.9 Core network security	35
5.9.1 Trust boundaries	35
5.9.2 Requirements on service-based architecture.....	35
5.9.2.1 Security Requirements for service registration, discovery and authorization	35

5.9.2.2	NRF security requirements	36
5.9.2.3	NEF security requirements.....	36
5.9.2.4	Requirements on the Service Communication Proxy (SCP)	36
5.9.3	Requirements for e2e core network interconnection security	36
5.9.3.1	General	36
5.9.3.2	Requirements for Security Edge Protection Proxy (SEPP)	37
5.9.3.3	Protection of attributes	38
5.9.3.4	Requirements for IPUPS functionality.....	38
5.10	Visibility and configurability	38
5.10.1	Security visibility.....	38
5.10.2	Security configurability	39
5.11	Requirements for algorithms, and algorithm selection.....	39
5.11.1	Algorithm identifier values	39
5.11.1.1	Ciphering algorithm identifier values.....	39
5.11.1.2	Integrity algorithm identifier values.....	39
5.11.2	Requirements for algorithm selection	39
5.12	Requirements on 5G-RG	40
5.13	Requirements on NSSAAF	40
6	Security procedures between UE and 5G network functions	40
6.0	General	40
6.1	Primary authentication and key agreement	41
6.1.1	Authentication framework	41
6.1.1.1	General	41
6.1.1.2	EAP framework.....	42
6.1.1.3	Granularity of anchor key binding to serving network.....	42
6.1.1.4	Construction of the serving network name.....	42
6.1.1.4.1	Serving network name	42
6.1.1.4.2	Construction of the serving network name by the UE.....	42
6.1.1.4.3	Construction of the serving network name by the SEAF	43
6.1.2	Initiation of authentication and selection of authentication method	43
6.1.3	Authentication procedures	44
6.1.3.1	Authentication procedure for EAP-AKA'	44
6.1.3.2	Authentication procedure for 5G AKA	47
6.1.3.2.0	5G AKA	47
6.1.3.2.1	Void.....	49
6.1.3.2.2	RES* verification failure in SEAF or AUSF or both	49
6.1.3.3	Synchronization failure or MAC failure	49
6.1.3.3.1	Synchronization failure or MAC failure in USIM.....	49
6.1.3.3.2	Synchronization failure recovery in Home Network	49
6.1.4	Linking increased home control to subsequent procedures	50
6.1.4.1	Introduction	50
6.1.4.1a	Linking authentication confirmation to Nudm_UECM_Registration procedure from AMF.....	51
6.1.4.2	Guidance on linking authentication confirmation to Nudm_UECM_Registration procedure from AMF.....	51
6.2	Key hierarchy, key derivation, and distribution scheme	52
6.2.1	Key hierarchy.....	52
6.2.2	Key derivation and distribution scheme.....	54
6.2.2.1	Keys in network entities	54
6.2.2.2	Keys in the UE	56
6.2.3	Handling of user-related keys	58
6.2.3.1	Key setting	58
6.2.3.2	Key identification.....	58
6.2.3.3	Key lifetimes	59
6.3	Security contexts	60
6.3.1	Distribution of security contexts	60
6.3.1.1	General	60
6.3.1.2	Distribution of subscriber identities and security data within one 5G serving network domain	60
6.3.1.3	Distribution of subscriber identities and security data between 5G serving network domains	60
6.3.1.4	Distribution of subscriber identities and security data between 5G and EPS serving network domains	60
6.3.2	Multiple registrations in same or different serving networks	61

6.3.2.0	General	61
6.3.2.1	Multiple registrations in different PLMNs	61
6.3.2.2	Multiple registrations in the same PLMN	61
6.4	NAS security mechanisms	62
6.4.1	General	62
6.4.2	Security for multiple NAS connections	62
6.4.2.1	Multiple active NAS connections with different PLMNs	62
6.4.2.2	Multiple active NAS connections in the same PLMN's serving network	62
6.4.3	NAS integrity mechanisms	63
6.4.3.0	General	63
6.4.3.1	NAS input parameters to integrity algorithm	63
6.4.3.2	NAS integrity activation	64
6.4.3.3	NAS integrity failure handling	64
6.4.4	NAS confidentiality mechanisms	64
6.4.4.0	General	64
6.4.4.1	NAS input parameters to confidentiality algorithm	64
6.4.4.2	NAS confidentiality activation	64
6.4.5	Handling of NAS COUNTs	64
6.4.6	Protection of initial NAS message	65
6.4.7	Security aspects of SMS over NAS	66
6.5	RRC security mechanisms	66
6.5.1	RRC integrity mechanisms	66
6.5.2	RRC confidentiality mechanisms	67
6.5.3	RRC UE capability transfer procedure	67
6.6	UP security mechanisms	67
6.6.1	UP security policy	67
6.6.2	UP security activation mechanism	68
6.6.3	UP confidentiality mechanisms	70
6.6.4	UP integrity mechanisms	70
6.6.4.1	General	70
6.6.4.2	UP integrity mechanisms between the UE and the gNB	70
6.6.4.3	UP integrity mechanisms between the UE and the ng-eNB	70
6.7	Security algorithm selection, key establishment and security mode command procedure	71
6.7.1	Procedures for NAS algorithm selection	71
6.7.1.1	Initial NAS security context establishment	71
6.7.1.2	AMF change	71
6.7.2	NAS security mode command procedure	71
6.7.3	Procedures for AS algorithm selection	73
6.7.3.0	Initial AS security context establishment	73
6.7.3.1	Xn-handover	73
6.7.3.2	N2-handover	73
6.7.3.3	Intra-gNB-CU handover/intra-ng-eNB handover	74
6.7.3.4	Transitions from RRC_INACTIVE to RRC_CONNECTED states	74
6.7.3.5	RNA Update procedure	74
6.7.3.6	Algorithm negotiation for unauthenticated UEs in LSM	74
6.7.4	AS security mode command procedure	75
6.8	Security handling in state transitions	76
6.8.1	Key handling at connection and registration state transitions	76
6.8.1.1	Key handling at transitions between RM-DEREGISTERED and RM-REGISTERED states	76
6.8.1.1.0	General	76
6.8.1.1.1	Transition from RM-REGISTERED to RM-DEREGISTERED	76
6.8.1.1.2	Transition from RM-DEREGISTERED to RM-REGISTERED	77
6.8.1.1.2.1	General	77
6.8.1.1.2.2	Full native 5G NAS security context available	78
6.8.1.1.2.3	Full native 5G NAS security context not available	78
6.8.1.1.2.4	UE registration over a second access type to the same AMF	79
6.8.1.2	Key handling at transitions between CM-IDLE and CM-CONNECTED states	79
6.8.1.2.0	General	79
6.8.1.2.1	Transition from CM-IDLE to CM-CONNECTED	79
6.8.1.2.2	Establishment of keys for cryptographically protected radio bearers in 3GPP access	80
6.8.1.2.3	Establishment of keys for cryptographically protected traffic in non-3GPP access	80
6.8.1.2.4	Transition from CM-CONNECTED to CM-IDLE	81

6.8.1.3	Key handling for the Registration procedure when registered in NG-RAN.....	81
6.8.2	Security handling at RRC state transitions	82
6.8.2.1	Security handling at transitions between RRC_INACTIVE and RRC_CONNECTED states.....	82
6.8.2.1.1	General	82
6.8.2.1.2	State transition from RRC_CONNECTED to RRC_INACTIVE.....	82
6.8.2.1.3	State transition from RRC_INACTIVE to RRC_CONNECTED to a new gNB/ng-eNB	82
6.8.2.1.4	State transition from RRC_INACTIVE to RRC_CONNECTED to the same gNB/ng-eNB	84
6.8.2.2	Key handling during mobility in RRC_INACTIVE state	84
6.8.2.2.1	General	84
6.8.2.2.2	RAN-based notification area update to a new gNB/ng-eNB	84
6.8.2.2.3	RAN-based notification area update to the same gNB/ng-eNB	84
6.9	Security handling in mobility	85
6.9.1	Void	85
6.9.2	Key handling in handover.....	85
6.9.2.1	General.....	85
6.9.2.1.1	Access stratum.....	85
6.9.2.1.2	Non access stratum	86
6.9.2.2	Key derivations for context modification procedure.....	86
6.9.2.3	Key derivations during handover	87
6.9.2.3.1	Intra-gNB-CU handover and intra-ng-eNB handover	87
6.9.2.3.2	Xn-handover	87
6.9.2.3.3	N2-Handover	88
6.9.2.3.4	UE handling.....	89
6.9.3	Key handling in mobility registration update	90
6.9.4	Key-change-on-the-fly.....	92
6.9.4.1	General.....	92
6.9.4.2	NAS key re-keying.....	92
6.9.4.3	NAS key refresh.....	92
6.9.4.4	AS key re-keying	93
6.9.4.5	AS key refresh.....	93
6.9.5	Rules on concurrent running of security procedures.....	94
6.9.5.1	Rules related to AS and NAS security context synchronization	94
6.9.5.2	Rules related to parallel NAS connections	94
6.9.6	Security handling in registration with AMF reallocation via direct NAS reroute.....	94
6.10	Dual connectivity	95
6.10.1	Introduction.....	95
6.10.1.1	General.....	95
6.10.1.2	Dual Connectivity protocol architecture for MR-DC with 5GC	95
6.10.2	Security mechanisms and procedures for DC	96
6.10.2.1	SN Addition or modification.....	96
6.10.2.2	Secondary Node key update.....	98
6.10.2.2.1	General	98
6.10.2.2.2	MN initiated	98
6.10.2.2.3	SN initiated.....	98
6.10.2.3	SN release and change	98
6.10.3	Establishing the security context between the UE and SN	98
6.10.3.1	SN Counter maintenance.....	98
6.10.3.2	Derivation of keys	99
6.10.3.3	Negotiation of security algorithms.....	99
6.10.4	Protection of traffic between UE and SN.....	99
6.10.5	Handover Procedure	101
6.10.6	Signalling procedure for PDCP COUNT check.....	101
6.10.7	Radio link failure recovery	101
6.11	Security handling for RRC connection re-establishment procedure.....	101
6.12	Subscription identifier privacy	103
6.12.1	Subscription permanent identifier.....	103
6.12.2	Subscription concealed identifier.....	103
6.12.3	Subscription temporary identifier	104
6.12.4	Subscription identification procedure	105
6.12.5	Subscription identifier de-concealing function (SIDF).....	105
6.13	Signalling procedure for PDCP COUNT check	105
6.14	Steering of roaming security mechanism	106

6.14.1	General.....	106
6.14.2	Security mechanisms	107
6.14.2.1	Procedure for steering of UE in VPLMN during registration	107
6.14.2.2	Procedure for steering of UE in VPLMN or HPLMN after registration	108
6.14.2.3	SoR Counter	110
6.15	UE parameters update via UDM control plane procedure security mechanism	111
6.15.1	General.....	111
6.15.2	Security mechanisms	111
6.15.2.1	Procedure for UE Parameters Update	111
6.15.2.2	UE Parameters Update Counter	112
6.16	Security handling in Cellular IoT	113
6.16.1	Security handling in Control Plane CIoT 5GS Optimization.....	113
6.16.1.1	Security procedures for Small Data Transfer in Control Plane CIoT 5GS Optimisation.....	113
6.16.1.2	Security procedures for RRCConnectionRe-establishment Procedure in Control Plane CIoT 5GS Optimization.....	113
6.16.2.1	General	114
6.16.2.2	Connection Suspend.....	114
6.16.2.3	Connection Resume in CM-IDLE with Suspend to a new ng-eNB	115
6.16.2.4	Connection Resume in CM-IDLE with Suspend to the same ng-eNB.....	116
6.16.3	Protection of Non-IP Data Delivery (NIDD) interfaces.....	116
6.16.4	Security handling in NAS based redirection from 5GS to EPS	117
7	Security for non-3GPP access to the 5G core network	117
7.1	General	117
7.1a	Determining trust relationship in the UE.....	117
7.2	Security procedures	118
7.2.1	Authentication for Untrusted non-3GPP Access.....	118
7A	Security for trusted non-3GPP access to the 5G core network.....	120
7A.1	General	120
7A.2	Security procedures	121
7A.2.1	Authentication for trusted non-3GPP access	121
7A.2.2	Void	124
7A.2.3	Key hierarchy for trusted non-3GPP access	124
7A.2.4	Authentication for devices that do not support 5GC NAS over WLAN access.....	124
7B	Security for wireline access to the 5G core network.....	127
7B.1	General	127
7B.2	Authentication for 5G-RG.....	127
7B.3	Authentication for FN-RG.....	129
7B.4	Authentication for UE behind 5G-RG and FN-RG	131
7B.5	Subscriber privacy for wireline access	131
7B.6	Subscriber privacy for N5CW over trusted WLAN access	131
8	Security of interworking.....	131
8.1	General	131
8.2	Registration procedure for mobility from EPS to 5GS over N26.....	132
8.3	Handover procedure from 5GS to EPS over N26.....	133
8.3.1	General.....	133
8.3.2	Procedure	133
8.4	Handover from EPS to 5GS over N26.....	136
8.4.1	General.....	136
8.4.2	Procedure	137
8.5	Idle mode mobility from 5GS to EPS over N26.....	139
8.5.1	General.....	139
8.5.2	TAU Procedure	140
8.6	Mapping of security contexts	141
8.6.1	Mapping of a 5G security context to an EPS security context.....	141
8.6.2	Mapping of an EPS security context to a 5G security context.....	141
8.7	Interworking without N26 interface in single-registration mode	142
9	Security procedures for non-service based interfaces	142
9.1	General	142
9.1.1	Use of NDS/IP	142

9.1.2	Implementation requirements	142
9.1.3	QoS considerations	142
9.2	Security mechanisms for the N2 interface.....	143
9.3	Security requirements and procedures on N3.....	143
9.4	Security mechanisms for the Xn interface.....	143
9.5	Interfaces based on DIAMETER or GTP.....	144
9.5.1	Void.....	144
9.6	Void.....	144
9.7	Void.....	144
9.8	Security mechanisms for protection of the gNB internal interfaces	144
9.8.1	General.....	144
9.8.2	Security mechanisms for the F1 interface.....	144
9.8.3	Security mechanisms for the E1 interface.....	145
9.9	Security mechanisms for non-SBA interfaces internal to the 5GC and between PLMNs.....	145
9.10	Security mechanisms for the interface between W-5GAN and 5GC	145
10	Security aspects of IMS emergency session handling.....	146
10.1	General	146
10.2	Security procedures and their applicability	146
10.2.1	Authenticated IMS Emergency Sessions	146
10.2.1.1	General	146
10.2.1.2	UE in RM-DEREGISTERED state requests a PDU Session for IMS Emergency services.....	146
10.2.1.3	UE in RM-REGISTERED state requests a PDU Session for IMS Emergency services.....	147
10.2.2	Unauthenticated IMS Emergency Sessions	147
10.2.2.1	General	147
10.2.2.2	UE sets up an IMS Emergency session with emergency registration	148
10.2.2.3	Key generation for Unauthenticated IMS Emergency Sessions.....	149
10.2.2.3.1	General	149
10.2.2.3.2	Handover	149
11	Security procedures between UE and external data networks via the 5G Network	150
11.1	EAP based secondary authentication by an external DN-AAA server	150
11.1.1	General.....	150
11.1.2	Authentication.....	151
11.1.3	Re-Authentication.....	154
11.1.4	Secondary authentication and authorization revocation.....	155
12	Security aspects of Network Exposure Function (NEF)	155
12.1	General	155
12.2	Mutual authentication.....	155
12.3	Protection of the NEF – AF interface.....	155
12.4	Authorization of Application Function’s requests.....	156
12.5	Support for CAPIF	156
13	Service Based Interfaces (SBI).....	156
13.1	Protection at the network or transport layer	156
13.1.0	General.....	156
13.1.1	TLS protection between NF and SEPP.....	156
13.1.1.0	General	156
13.1.1.1	TLS protection based on telescopic FQDN and wildcard certificate	157
13.1.1.2	TLS protection based on 3gpp-Sbi-Target-apiRoot HTTP header.....	157
13.1.2	Protection between SEPPs	157
13.2	Application layer security on the N32 interface	158
13.2.1	General.....	158
13.2.2	N32-c connection between SEPPs.....	159
13.2.2.1	General	159
13.2.2.2	Procedure for Key agreement and Parameter exchange.....	160
13.2.2.3	Procedure for error detection and handling in SEPP.....	160
13.2.2.4	N32-f Context	161
13.2.2.4.0	N32-f parts.....	161
13.2.2.4.1	N32-f context ID.....	161
13.2.2.4.2	N32-f peer information.....	162
13.2.2.4.3	N32-f security context	162

13.2.2.4.4	N32-f context information	162
13.2.3	Protection policies for N32 application layer solution	162
13.2.3.1	Overview of protection policies	162
13.2.3.2	Data-type encryption policy	163
13.2.3.3	NF API data-type placement mapping	163
13.2.3.4	Modification policy	163
13.2.3.5	Provisioning of the policies in the SEPP	164
13.2.3.6	Precedence of policies in the SEPP	164
13.2.4	N32-f connection between SEPPs	165
13.2.4.1	General	165
13.2.4.2	Overall Message payload structure for message reformatting at SEPP	165
13.2.4.3	Message reformatting in sending SEPP	166
13.2.4.3.1	dataToIntegrityProtect	166
13.2.4.3.1.1	clearTextEncapsulatedMessage	166
13.2.4.3.1.2	metadata	166
13.2.4.3.2	dataToIntegrityProtectAndCipher	167
13.2.4.4	Protection using JSON Web Encryption (JWE)	167
13.2.4.4.0	General	167
13.2.4.4.1	N32-f key hierarchy	167
13.2.4.5	Message modifications in IPX	168
13.2.4.5.1	modifiedDataToIntegrityProtect	168
13.2.4.5.2	Modifications by IPX	169
13.2.4.6	Protecting IPX modifications using JSON Web Signature (JWS)	169
13.2.4.7	Message verification by the receiving SEPP	170
13.2.4.8	Procedure	170
13.2.4.9	JOSE profile	173
13.3	Authentication and static authorization	173
13.3.0	Static authorization	173
13.3.1	Authentication and authorization between network functions and NRF	173
13.3.1.1	Direct communication	173
13.3.1.2	Indirect communication	173
13.3.1.3	Authorization of discovery request and error handling	174
13.3.2	Authentication and authorization between network functions	174
13.3.2.1	Direct communication	174
13.3.2.2	Indirect communication	174
13.3.2.3	Inter-PLMN NF to NF communication	175
13.3.2.4	Error handling	175
13.3.3	Authentication and authorization between SEPP and network functions	175
13.3.4	Authentication and authorization between SEPPs	175
13.3.6	Authentication and authorization between SCP and network functions	175
13.3.7	Authentication and authorization between SCPs	176
13.3.8	Client credentials assertion based authentication	176
13.3.8.1	General	176
13.3.8.2	Client credentials assertion	176
13.3.8.3	Verification of Client credentials assertion	177
13.4	Authorization of NF service access	177
13.4.1	OAuth 2.0 based authorization of Network Function service access	177
13.4.1.0	General	177
13.4.1.1	Service access authorization within the PLMN	178
13.4.1.1.1	OAuth 2.0 roles	178
13.4.1.1.2	Service Request Process	178
13.4.1.1A	Service access authorization in interconnect scenarios	181
13.4.1.2	Service access authorization in roaming scenarios	181
13.4.1.2.1	OAuth 2.0 roles	181
13.4.1.2.2	Service Request Process	182
13.4.1.3	Service access authorization in indirect communication scenarios	185
13.4.1.3.1	Authorization for indirect communication without delegated discovery procedure	185
13.4.1.3.1.1	With mutual authentication between NF Service Consumer and NRF at the transport layer ..	185
13.4.1.3.1.2	Without mutual authentication between NF and NRF at the transport layer	187
13.4.1.3.2	Authorization for indirect communication with delegated discovery procedure	188
13.5	Security capability negotiation between SEPPs	189

14	Security related services.....	190
14.1	Services provided by AUSF	190
14.1.1	General.....	190
14.1.2	Nausf_UEAuthentication service.....	191
14.1.2.1	Nausf_UEAuthentication_Authenticate service operation.....	191
14.1.2.2	Nausf_UEAuthentication_deregister service operation	191
14.1.2.3	Nausf_UEAuthentication_ProseAuthenticate service operation.....	192
14.1.3	Nausf_SoRProtection service	192
14.1.4	Nausf_UPUProtection service	192
14.1.5	Void	193
14.2	Services provided by UDM	193
14.2.1	General.....	193
14.2.2	Nudm_UEAuthentication_Get service operation	193
14.2.3	Nudm_UEAuthentication_ResultConfirmation service operation.....	193
14.2.4	Nudm_UEAuthentication_GetProseAv service operation.....	193
14.2.5	Nudm_UEAuthentication_GetGbaAv service operation.....	193
14.3	Services provided by NRF	194
14.3.1	General.....	194
14.3.2	Nnrf_AccessToken_Get Service Operation.....	194
14.4	Services provided by NSSAAF.....	194
14.4.1	Nnssaaf_NSSAA services.....	194
14.4.1.1	General	194
14.4.1.2	Nnssaaf_NSSAA_Authenticate service operation	195
14.4.1.3	Nnssaaf_NSSAA_Re-AuthenticationNotification service operation	195
14.4.1.4	Nnssaaf_NSSAA_RevocationNotification service operation	195
14.4.2	Nnssaaf_AIW services.....	195
14.4.2.1	General.....	195
14.4.2.2	Nnssaaf_AIW_Authenticate service operation	196
15	Management security for network slices.....	196
15.1	General	196
15.2	Mutual authentication.....	196
15.3	Protection of management interactions between the management service consumer and the management service producer	197
15.4	Authorization of management service consumer's request	197
16	Security procedures for network slices.....	197
16.1	General	197
16.2	Authorization for network slice access.....	197
16.3	Network slice specific authentication and authorization	198
16.4	AAA Server triggered Network Slice-Specific Re-authentication and Re-authorization procedure.....	200
16.5	AAA Server triggered Slice-Specific Authorization Revocation	201
16.6	AF Authorization for network slice quota-usage information notification/retrieval	202
16.6.1	Introduction.....	202
16.6.2	General.....	202
16.6.3	Subscription/unsubscription procedure of NSACF notification service	202
Annex A (normative): Key derivation functions		204
A.1	KDF interface and input parameter construction	204
A.1.1	General	204
A.1.2	FC value allocations	204
A.2	K_{AUSF} derivation function	204
A.3	CK' and IK' derivation function	204
A.4	RES^* and $XRES^*$ derivation function	205
A.5	$HRES^*$ and $HXRES^*$ derivation function	205
A.6	K_{SEAF} derivation function	205
A.7	K_{AMF} derivation function	206
A.7.0	Parameters for the input S to the KDF	206

A.7.1	ABBA parameter values.....	206
A.8	Algorithm key derivation functions	206
A.9	K_{gNB} , K_{WAGF} , K_{TNGF} , K_{TWIF} and K_{N3IWF} derivation function.....	207
A.10	NH derivation function.....	208
A.11	K_{NG-RAN}^* derivation function for target gNB	208
A.12	K_{NG-RAN}^* derivation function for target ng-eNB	208
A.13	K_{AMF} to K_{AMF}' derivation in mobility.....	209
A.14	K_{AMF} to K_{ASME}' derivation for interworking	209
A.14.1	Idle mode mobility	209
A.14.2	Handover	209
A.15	K_{ASME} to K_{AMF}' derivation for interworking	209
A.15.1	Idle mode mobility	209
A.15.2	Handover	210
A.16	Derivation of K_{SN} for dual connectivity	210
A.17	SoR-MAC- I_{AUSF} generation function	210
A.18	SoR-MAC- I_{UE} generation function	211
A.19	UPU-MAC- I_{AUSF} generation function	211
A.20	UPU-MAC- I_{UE} generation function	211
A.21	K_{AMF} to K_{ASME_SRVCC} derivation for interworking	212
A.22	K_{TIPSec} and K_{TNAP} derivation function.....	212
A.23	K_{IAB} generation function	212
Annex B (informative): Using additional EAP methods for primary authentication		214
B.1	Introduction	214
B.2	Primary authentication and key agreement	214
B.2.1	EAP TLS	214
B.2.1.1	Security procedures.....	214
B.2.1.2	Privacy considerations	217
B.2.1.2.1	EAP TLS without subscription identifier privacy	217
B.2.1.2.2	EAP TLS with subscription identifier privacy	217
B.2.2	Revocation of subscriber certificates	218
B.3	Key derivation	218
Annex C (normative): Protection schemes for concealing the subscription permanent identifier.....		220
C.1	Introduction	220
C.2	Null-scheme	220
C.3	Elliptic Curve Integrated Encryption Scheme (ECIES)	221
C.3.1	General	221
C.3.2	Processing on UE side	221
C.3.3	Processing on home network side	222
C.3.4	ECIES profiles.....	222
C.3.4.0	General.....	222
C.3.4.1	Profile A	223
C.3.4.2	Profile B.....	223
C.4	Implementers' test data	224
C.4.1	General	224

C.4.2	Null-scheme	224
C.4.2.1	IMS-based SUPI.....	224
C.4.2.2	Network specific identifier-based SUPI	224
C.4.3	ECIES Profile A	224
C.4.3.1	IMS-based SUPI.....	224
C.4.3.2	Network specific identifier-based SUPI	225
C.4.4	ECIES Profile B	226
C.4.4.1	IMS-based SUPI.....	226
C.4.4.2	Network specific identifier-based SUPI	227
Annex D (normative): Algorithms for ciphering and integrity protection		228
D.1	Null ciphering and integrity protection algorithms	228
D.2	Ciphering algorithms.....	228
D.2.1	128-bit Ciphering algorithms	228
D.2.1.1	Inputs and outputs.....	228
D.2.1.2	128-NEA1	229
D.2.1.3	128-NEA2.....	229
D.2.1.4	128-NEA3.....	229
D.3	Integrity algorithms	229
D.3.1	128-Bit integrity algorithms	229
D.3.1.1	Inputs and outputs.....	229
D.3.1.2	128-NIA1	230
D.3.1.3	128-NIA2.....	230
D.3.1.4	128-NIA3.....	230
D.4	Test Data for the security algorithms	230
D.4.1	General	230
D.4.2	128-NEA1	230
D.4.3	128-NIA1	230
D.4.4	128-NEA2	230
D.4.5	128-NIA2	231
D.4.6	128-NEA3	231
D.4.7	128-NIA3	231
Annex E (informative): UE-assisted network-based detection of false base station.....		232
E.1	Introduction	232
E.2	Examples of using measurement reports.....	232
Annex F (normative): 3GPP 5G profile for EAP-AKA'		233
F.1	Introduction	233
F.2	Subscriber privacy.....	233
F.3	Subscriber identity and key derivation.....	234
F.4	Void.....	234
Annex G (informative): Application layer security on the N32 interface.....		235
G.1	Introduction	235
G.2	Structure of HTTP Message	235
Annex H (informative): Void		237
Annex I (normative): Non-public networks.....		238
I.1	General	238
I.2	Authentication in standalone non-public networks	238
I.2.1	General	238
I.2.2	EAP framework, selection of authentication method, and EAP method credentials.....	238

I.2.2.1	General.....	238
I.2.2.2	Credentials holder using AAA server for primary authentication	239
I.2.2.2.1	General.....	239
I.2.2.2.2	Procedure	239
I.2.3	Key hierarchy, key derivation and key distribution.....	241
I.2.3.1	General.....	241
I.2.3.2	Credentials holder using AAA server for primary authentication	242
I.2.4	Credentials Holder using AUSF and UDM for primary authentication.....	243
I.3	Serving network name for standalone non-public networks	243
I.3.1	General	243
I.3.2	Definition of SN Id for standalone non-public networks	243
I.4	Modification of CAG ID list in the UE.....	243
I.5	SUPI privacy for standalone non-public networks.....	243
I.6	Authentication in Public Network Integrated Non-Public Networks (PNI-NPN).....	244
I.7	Authorization aspects in SNPNs	244
I.7.1	Credentials holder using AUSF and UDM for primary authentication	244
I.8	SEPP and interconnect related security procedures	244
I.8.1	Credentials holder using AUSF and UDM for primary authentication	244
I.9	Security of UE onboarding in SNPNs.....	244
I.9.1	General	244
I.9.2	Authentication	245
I.9.2.1	Requirements	245
I.9.2.2	Primary authentication without using DCS	245
I.9.2.3	Primary authentication using DCS.....	245
I.9.2.4	Secondary authentication.....	245
I.9.2.4.1	Secondary authentication using DCS	245
I.9.2.4.2	Secondary authentication using DN-AAA	245
Annex J (normative):	SRVCC from 5G to UTRAN.....	246
J.1	SRVCC from NR to UTRAN.....	246
J.1.1	General.....	246
J.1.2	Procedure.....	246
J.2	Emergency call in SRVCC from NR to UTRAN.....	247
J.2.1	General.....	247
J.2.2	Procedure.....	247
Annex K (normative):	Security for 5GLAN services	248
K.1	General	248
K.2	Authentication and authorization	248
K.3	Handling of UP security policy	248
Annex L (normative):	Security for TSC service.....	249
L.1	General	249
L.2	Access security for a 5GS TSC-enabled UE	249
L.3	Protection of user plane data in TSC including (g)PTP control messages in bridge mode.....	249
L.4	Exposure of time synchronisation	249
Annex M (normative):	Security for Integrated Access and Backhaul (IAB).....	250
M.1	General	250
M.2	Security requirements and features	250
M.2.1	Requirements on the IAB-node (IAB-UE).....	250

M.2.2	Requirements on the IAB donor.....	250
M.2.3	Requirements on the 5GC supporting IAB architecture.....	250
M.2.4	Requirements for secure environment.....	250
M.2.5	Requirements on the F1 interface.....	250
M.3	IAB-node Integration Procedure.....	251
M.3.1	General.....	251
M.3.2	Authentication and Authorization of IAB-node (Phase-1).....	251
M.3.3	Security mechanisms for F1 interface between the IAB-node (gNB-DU) and the IAB-donor-CU (Phase-3).....	251
M.3.3.1	General.....	251
M.3.3.2	Security mechanisms for the F1 interface.....	251
M.4	Protection of management traffic between IAB-node and OAM.....	252
Annex N (normative): Security for URLLC services.....		253
N.1	General.....	253
N.2	Security support on redundant transmission.....	253
N.2.1	Redundant user plane paths based on dual connectivity.....	253
N.2.1.1	Introduction.....	253
N.2.2.2	Security policy aspects.....	253
N.2.2	Redundant transmission on N3/N9 interfaces.....	254
Annex O (Informative): Authentication for non-5G capable devices behind residential gateways.....		255
O.1	General.....	255
O.2	Baseline for using non-5G capable devices with 5GC.....	255
O.3	Authentication procedure.....	255
Annex P (informative): Security Aspects of DNS and ICMP.....		260
P.1	General.....	260
P.2	Security aspects of DNS.....	260
P.3	Security aspects of ICMP.....	260
Annex Q (informative): Security and privacy in 5G system location services.....		261
Annex R (informative): Authorization aspects in communication models for NF/NF services interaction.....		262
Annex S (normative): Support for Non-seamless WLAN offload (NSWO) in 5GS.....		264
S.1	Introduction.....	264
S.2	General.....	264
S.3	Authentication procedure.....	264
S.3.1	5G NSWO co-existence with EPS NSWO.....	264
S.3.2	5G NSWO procedures.....	265
S.4	Roaming.....	266
Annex T (normative): Security for edge computing.....		267
T.1	General.....	267
T.2	Security of network exposure to edge application server.....	267
Annex U (informative): Primary authentication using EAP-TTLS in SNPNs.....		268
U.1	Introduction.....	268