

# ETSI TS 136 300 V15.8.0 (2020-01)



**LTE;**  
**Evolved Universal Terrestrial Radio Access (E-UTRA)**  
**and Evolved Universal Terrestrial**  
**Radio Access Network (E-UTRAN);**  
**Overall description;**  
**Stage 2**  
**(3GPP TS 36.300 version 15.8.0 Release 15)**



---

**Reference**RTS/TSGR-0236300vf80

---

---

**Keywords**LTE

---

**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 - NAF 742 C  
Association à but non lucratif enregistrée à la  
Sous-Préfecture de Grasse (06) N° 7803/88

---

**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](http://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://portal.etsi.org/People/CommitteeSupportStaff.aspx>

---

**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 2020.

All rights reserved.

**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.

---

## Intellectual Property Rights

### Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is 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 IPR Policy, no investigation, 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.

---

## 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.....   | 18 |
| 1 Scope .....   | 19 |
| 2 References .....  | 19 |
| 3 Definitions, symbols and abbreviations .....                      | 22 |
| 3.1 Definitions .....   | 22 |
| 3.2 Abbreviations .....   | 25 |
| 4 Overall architecture .....  | 30 |
| 4.0 General .....   | 30 |
| 4.1 Functional Split .....  | 31 |
| 4.2 Void.....   | 33 |
| 4.2.1 Void .....  | 33 |
| 4.2.2 Void .....  | 33 |
| 4.3 Radio Protocol architecture .....                               | 33 |
| 4.3.0 General.....  | 33 |
| 4.3.1 User plane .....  | 34 |
| 4.3.2 Control plane .....   | 34 |
| 4.4 Synchronization.....  | 35 |
| 4.5 IP fragmentation .....  | 35 |
| 4.6 Support of HeNBs .....  | 35 |
| 4.6.1 Architecture .....  | 35 |
| 4.6.2 Functional Split.....   | 37 |
| 4.6.3 Interfaces.....   | 39 |
| 4.6.3.1 Protocol Stack for S1 User Plane .....                      | 39 |
| 4.6.3.2 Protocol Stacks for S1 Control Plane .....                  | 40 |
| 4.6.3.3 Protocol Stack for S5 interface.....                        | 41 |
| 4.6.3.4 Protocol Stack for SGi interface.....                       | 41 |
| 4.6.3.5 Protocol Stack for X2 User Plane and X2 Control Plane ..... | 41 |
| 4.6.4 Void .....  | 41 |
| 4.6.5 Support of LIPA with HeNB .....                               | 41 |
| 4.6.6 Support of X2 GW .....  | 43 |
| 4.6.6.1 Enhanced TNL Address Discovery.....                         | 44 |
| 4.6.6.2 Routing of X2AP messages .....                              | 44 |
| 4.6.6.3 (H)eNB unavailability .....                                 | 44 |
| 4.6.6.4 (H)eNB registration.....                                    | 44 |
| 4.7 Support for relaying.....                                       | 44 |
| 4.7.1 General.....  | 44 |
| 4.7.2 Architecture .....  | 45 |
| 4.7.3 S1 and X2 user plane aspects.....                             | 45 |
| 4.7.4 S1 and X2 control plane aspects .....                         | 46 |
| 4.7.5 Radio protocol aspects .....                                  | 47 |
| 4.7.6 Signalling procedures .....                                   | 48 |
| 4.7.6.1 RN attach procedure.....                                    | 48 |
| 4.7.6.2 E-RAB activation/modification.....                          | 49 |
| 4.7.6.3 RN startup procedure .....                                  | 49 |
| 4.7.6.4 RN detach procedure.....                                    | 50 |
| 4.7.6.5 Neighbouring Information Transfer .....                     | 51 |
| 4.7.6.6 Mobility to or from RN .....                                | 51 |
| 4.7.7 Relay Node OAM Aspects .....                                  | 51 |
| 4.7.7.1 Architecture.....   | 51 |
| 4.7.7.2 OAM Traffic QoS Requirements .....                          | 52 |
| 4.7.7.3 Security Aspects.....                                       | 52 |

|           |  |    |
|-----------|--|----|
| 4.7.7.4   | Void.....  | 52 |
| 4.7.7.5   | OAM Requirements for Configuration Parameters.....                       | 52 |
| 4.7.7.5.1 | Parameters Associated with Relay Bearer Mapping.....                     | 52 |
| 4.8       | Support of SIPTO at the Local Network .....                              | 52 |
| 4.8.1     | General.....   | 52 |
| 4.8.2     | SIPTO at the Local Network with collocated L-GW.....                     | 53 |
| 4.8.3     | Support for SIPTO@LN with Stand-Alone Gateway.....                       | 54 |
| 4.9       | Support for Dual Connectivity .....                                      | 54 |
| 4.9.1     | General.....   | 54 |
| 4.9.2     | Radio Protocol Architecture .....  | 54 |
| 4.9.3     | Network Interfaces.....  | 55 |
| 4.9.3.1   | E-UTRAN Control Plane for Dual Connectivity .....                        | 55 |
| 4.9.3.2   | E-UTRAN User Plane for Dual Connectivity.....                            | 55 |
| 4.9.3.3   | Support of HeNBs for Dual Connectivity.....                              | 56 |
| 4.9.3.4   | Support of SIPTO@LN and LIPA for Dual Connectivity .....                 | 56 |
| 4.10      | NB-IoT .....   | 58 |
| 4.11      | Support for UE assistance information for local cache .....              | 58 |
| 5         | Physical Layer for E-UTRA.....   | 58 |
| 5.0       | Frame structures and channels.....                                       | 58 |
| 5.1       | Downlink Transmission Scheme.....  | 61 |
| 5.1.1     | Basic transmission scheme based on OFDM.....                             | 61 |
| 5.1.1a    | Basic transmission scheme based on OFDM for NB-IoT.....                  | 62 |
| 5.1.2     | Physical-layer processing .....  | 62 |
| 5.1.3     | Physical downlink control channels.....                                  | 62 |
| 5.1.4     | Downlink Reference signal and synchronization signals.....               | 64 |
| 5.1.4a    | Downlink Reference signal and synchronization signals for NB-IoT.....    | 64 |
| 5.1.5     | Downlink multi-antenna transmission.....                                 | 64 |
| 5.1.5a    | Downlink multi-antenna transmission for NB-IoT.....                      | 65 |
| 5.1.6     | MBSFN transmission.....  | 65 |
| 5.1.7     | Physical layer procedure.....  | 65 |
| 5.1.7.1   | Link adaptation .....  | 65 |
| 5.1.7.2   | Power Control .....  | 65 |
| 5.1.7.3   | Cell search.....   | 65 |
| 5.1.7.3a  | Cell search for NB-IoT.....  | 65 |
| 5.1.8     | Physical layer measurements definition.....                              | 65 |
| 5.1.9     | Coordinated Multi-Point transmission.....                                | 66 |
| 5.1.10    | Wake-up signal for NB-IoT.....   | 66 |
| 5.1.11    | Wake-up signal for BL UE or UE in enhanced coverage .....                | 66 |
| 5.2       | Uplink Transmission Scheme.....  | 66 |
| 5.2.1     | Basic transmission scheme .....  | 66 |
| 5.2.1a    | Basic transmission scheme for NB-IoT.....                                | 67 |
| 5.2.2     | Physical-layer processing .....  | 67 |
| 5.2.3     | Physical uplink control channel.....                                     | 68 |
| 5.2.3a    | Uplink control information for NB-IoT.....                               | 68 |
| 5.2.4     | Uplink Reference signal.....   | 68 |
| 5.2.4a    | Uplink Reference signal for NB-IoT .....                                 | 69 |
| 5.2.5     | Random access preamble.....  | 69 |
| 5.2.5a    | Random access preamble for NB-IoT.....                                   | 69 |
| 5.2.6     | Uplink multi-antenna transmission .....                                  | 69 |
| 5.2.7     | Physical channel procedure.....  | 70 |
| 5.2.7.1   | Link adaptation .....  | 70 |
| 5.2.7.2   | Uplink Power control .....   | 70 |
| 5.2.7.3   | Uplink timing control.....   | 70 |
| 5.2.8     | Coordinated Multi-Point reception .....                                  | 70 |
| 5.3       | Transport Channels.....  | 70 |
| 5.3.0     | Transport channel types .....  | 70 |
| 5.3.1     | Mapping between transport channels and physical channels.....            | 72 |
| 5.3.1a    | Mapping between transport channels and narrowband physical channels..... | 73 |
| 5.4       | E-UTRA physical layer model .....  | 73 |
| 5.4.1     | Void .....   | 74 |
| 5.4.2     | Void .....   | 74 |

|         |  |     |
|---------|--|-----|
| 5.5     | Carrier Aggregation.....                                     | 74  |
| 5.5.0   | General.....   | 74  |
| 5.5.1   | SRS switching between component carriers.....                | 74  |
| 5.5a    | Multi-carrier operation for NB-IoT.....                      | 75  |
| 5.6     | Sidelink.....  | 75  |
| 5.6.0   | General.....   | 75  |
| 5.6.1   | Basic transmission scheme.....                               | 75  |
| 5.6.2   | Physical-layer processing.....                               | 76  |
| 5.6.3   | Physical Sidelink control channel.....                       | 76  |
| 5.6.4   | Sidelink reference signals.....                              | 76  |
| 5.6.5   | Physical channel procedure.....                              | 76  |
| 5.6.5.1 | Sidelink power control.....                                  | 76  |
| 5.6.6   | Physical layer measurements definition.....                  | 76  |
| 5.7     | Licensed-Assisted Access.....                                | 76  |
| 5.7.0   | General.....   | 76  |
| 5.7.1   | Channel Access Priority Classes.....                         | 77  |
| 5.7.2   | Multiplexing of data.....                                    | 77  |
| 5.8     | Short Processing Time.....                                   | 78  |
| 5.9     | Short Transmission Time Interval.....                        | 78  |
| 6       | Layer 2.....   | 78  |
| 6.0     | Overview.....  | 78  |
| 6.1     | MAC Sublayer.....  | 80  |
| 6.1.0   | General.....   | 80  |
| 6.1.1   | Services and Functions.....                                  | 80  |
| 6.1.2   | Logical Channels.....  | 81  |
| 6.1.2.0 | General.....   | 81  |
| 6.1.2.1 | Control Channels.....  | 81  |
| 6.1.2.2 | Traffic Channels.....  | 82  |
| 6.1.3   | Mapping between logical channels and transport channels..... | 82  |
| 6.1.3.1 | Mapping in Uplink.....                                       | 82  |
| 6.1.3.2 | Mapping in Downlink.....                                     | 82  |
| 6.1.3.3 | Mapping in Sidelink.....                                     | 83  |
| 6.2     | RLC Sublayer.....  | 84  |
| 6.2.0   | General.....   | 84  |
| 6.2.1   | Services and Functions.....                                  | 84  |
| 6.2.2   | PDU Structure.....   | 84  |
| 6.3     | PDCP Sublayer.....   | 85  |
| 6.3.0   | General.....   | 85  |
| 6.3.1   | Services and Functions.....                                  | 85  |
| 6.3.2   | PDU Structure.....   | 86  |
| 6.4     | Carrier Aggregation.....                                     | 86  |
| 6.5     | Dual Connectivity.....                                       | 87  |
| 7       | RRC.....   | 89  |
| 7.0     | General.....   | 89  |
| 7.1     | Services and Functions.....                                  | 89  |
| 7.2     | RRC protocol states & state transitions.....                 | 90  |
| 7.3     | Transport of NAS messages.....                               | 91  |
| 7.3a    | CIoT signalling reduction optimizations.....                 | 91  |
| 7.3a.1  | General.....   | 91  |
| 7.3a.2  | Control Plane CIoT EPS optimizations.....                    | 91  |
| 7.3a.3  | User Plane CIoT EPS optimizations.....                       | 92  |
| 7.3b    | EDT.....   | 95  |
| 7.3b.1  | General.....   | 95  |
| 7.3b.2  | EDT for Control Plane CIoT EPS optimizations.....            | 95  |
| 7.3b.3  | EDT for User Plane CIoT EPS optimizations.....               | 96  |
| 7.4     | System Information.....                                      | 99  |
| 7.5     | Carrier Aggregation.....                                     | 101 |
| 7.6     | Dual Connectivity.....                                       | 102 |
| 8       | E-UTRAN identities.....                                      | 103 |
| 8.1     | E-UTRA related UE identities.....                            | 103 |

|              |  |     |
|--------------|--|-----|
| 8.2          | Network entity related Identities .....  | 103 |
| 8.3          | Sidelink communication and V2X Sidelink Communication related identities ..... | 104 |
| 8.4          | MBMS related identities .....  | 105 |
| 9            | ARQ and HARQ .....   | 105 |
| 9.0          | General .....  | 105 |
| 9.1          | HARQ principles.....   | 105 |
| 9.2          | ARQ principles.....  | 107 |
| 9.3          | Void.....  | 107 |
| 10           | Mobility.....  | 107 |
| 10.0         | General .....  | 107 |
| 10.1         | Intra E-UTRAN.....   | 108 |
| 10.1.0       | General.....   | 108 |
| 10.1.1       | Mobility Management in ECM-IDLE .....  | 108 |
| 10.1.1.1     | Cell selection.....  | 108 |
| 10.1.1.2     | Cell reselection.....  | 108 |
| 10.1.1.3     | Void.....  | 109 |
| 10.1.1.4     | Void.....  | 109 |
| 10.1.1.5     | Void.....  | 109 |
| 10.1.2       | Mobility Management in ECM-CONNECTED/CM-CONNECTED.....                         | 109 |
| 10.1.2.0     | General .....  | 109 |
| 10.1.2.1     | Handover .....   | 111 |
| 10.1.2.1.1   | C-plane handling .....   | 111 |
| 10.1.2.1.2   | U-plane handling .....   | 114 |
| 10.1.2.2     | Path Switch .....  | 115 |
| 10.1.2.2.1   | Path Switch upon handover .....  | 115 |
| 10.1.2.2.2   | Path Update upon Dual Connectivity specific activities.....                    | 116 |
| 10.1.2.2.3   | Path Switch upon UE context resume .....                                       | 116 |
| 10.1.2.3     | Data forwarding .....  | 116 |
| 10.1.2.3.1   | For RLC-AM DRBs .....  | 116 |
| 10.1.2.3.2   | For RLC-UM DRBs .....  | 117 |
| 10.1.2.3.3   | SRB handling .....   | 117 |
| 10.1.2.3.4   | User data forwarding for Dual Connectivity .....                               | 117 |
| 10.1.2.4     | Void.....  | 118 |
| 10.1.2.5     | Void.....  | 118 |
| 10.1.2.6     | Void.....  | 118 |
| 10.1.2.7     | Timing Advance.....  | 118 |
| 10.1.2.8     | Dual Connectivity operation .....  | 119 |
| 10.1.2.8.1   | SeNB Addition .....  | 119 |
| 10.1.2.8.2   | SeNB Modification.....   | 120 |
| 10.1.2.8.2.1 | Intra-MeNB handover involving SCG change.....                                  | 122 |
| 10.1.2.8.3   | SeNB Release .....   | 123 |
| 10.1.2.8.4   | Change of SeNB .....   | 125 |
| 10.1.2.8.5   | MeNB to eNB Change.....  | 126 |
| 10.1.2.8.6   | SCG change .....   | 127 |
| 10.1.2.8.7   | eNB to MeNB change .....   | 127 |
| 10.1.2.8.8   | Inter-MeNB handover without SeNB change.....                                   | 128 |
| 10.1.2.8.9   | Addition of a hybrid HeNB as the SeNB.....                                     | 131 |
| 10.1.2.9     | LWA mobility .....   | 132 |
| 10.1.2.9.1   | Inter-eNB handover without WT change.....                                      | 132 |
| 10.1.2.10    | EN-DC Operation .....  | 134 |
| 10.1.3       | Measurements .....   | 134 |
| 10.1.3.0     | General .....  | 134 |
| 10.1.3.1     | Intra-frequency neighbour (cell) measurements.....                             | 136 |
| 10.1.3.2     | Inter-frequency neighbour (cell) measurements.....                             | 136 |
| 10.1.4       | Paging and C-plane establishment .....   | 136 |
| 10.1.5       | Random Access Procedure .....  | 137 |
| 10.1.5.0     | General .....  | 137 |
| 10.1.5.1     | Contention based random access procedure.....                                  | 138 |
| 10.1.5.2     | Non-contention based random access procedure .....                             | 141 |
| 10.1.5.3     | Interaction model between L1 and L2/3 for Random Access Procedure .....        | 142 |

|                |   |     |
|----------------|---|-----|
| 10.1.6         | Radio Link Failure .....  | 142 |
| 10.1.7         | Radio Access Network Sharing .....  | 144 |
| 10.1.8         | Handling of Roaming and Area Restrictions for UEs in ECM-CONNECTED .....                | 144 |
| 10.1.8a        | Handling of Roaming and Access Restrictions for UEs in ECM-CONNECTED .....              | 144 |
| 10.1.9         | Mobility in RRC_INACTIVE .....  | 144 |
| 10.1.9.1       | Overview .....  | 144 |
| 10.1.9.2       | Cell Reselection .....  | 145 |
| 10.1.9.3       | RAN-Based Notification Area .....   | 145 |
| 10.1.9.4       | State Transitions .....   | 145 |
| 10.1.9.4.1     | UE triggered transition from RRC_INACTIVE to RRC_CONNECTED .....                        | 145 |
| 10.1.9.4.2     | Network triggered transition from RRC_INACTIVE to RRC_CONNECTED .....                   | 145 |
| 10.1.9.5       | RNA update .....  | 145 |
| 10.2           | Inter RAT .....   | 145 |
| 10.2.0         | General .....   | 145 |
| 10.2.1         | Cell reselection .....  | 145 |
| 10.2.2         | Handover .....  | 146 |
| 10.2.2a        | Inter-RAT cell change order to GERAN with NACC .....                                    | 147 |
| 10.2.2b        | Inter-RAT handovers from E-UTRAN .....  | 147 |
| 10.2.2b.1      | Data forwarding .....   | 147 |
| 10.2.2b.1.1    | For RLC-AM bearers .....  | 147 |
| 10.2.2b.1.2    | For RLC-UM bearers .....  | 147 |
| 10.2.2c        | Intra-EUTRA inter-system Handover .....   | 148 |
| 10.2.3         | Measurements .....  | 148 |
| 10.2.3.1       | Inter-RAT handovers from E-UTRAN .....  | 148 |
| 10.2.3.2       | Inter-RAT handovers to E-UTRAN .....  | 148 |
| 10.2.3.3       | Inter-RAT cell reselection from E-UTRAN .....   | 148 |
| 10.2.3.4       | Limiting measurement load at UE .....   | 148 |
| 10.2.4         | Network Aspects .....   | 149 |
| 10.2.5         | CS fallback .....   | 149 |
| 10.3           | Mobility between E-UTRAN and Non-3GPP radio technologies .....                          | 150 |
| 10.3.1         | UE Capability Configuration .....   | 150 |
| 10.3.2         | Mobility between E-UTRAN and cdma2000 network .....                                     | 150 |
| 10.3.2.1       | Tunnelling of cdma2000 Messages over E-UTRAN between UE and cdma2000 Access Nodes ..... | 151 |
| 10.3.2.2       | Mobility between E-UTRAN and HRPD .....   | 152 |
| 10.3.2.2.1     | Mobility from E-UTRAN to HRPD .....   | 152 |
| 10.3.2.2.1.1   | HRPD System Information Transmission in E-UTRAN .....                                   | 152 |
| 10.3.2.2.1.2   | Measuring HRPD from E-UTRAN .....   | 152 |
| 10.3.2.2.1.2.1 | Idle Mode Measurement Control .....   | 152 |
| 10.3.2.2.1.2.2 | Active Mode Measurement Control .....   | 152 |
| 10.3.2.2.1.2.3 | Active Mode Measurement .....   | 152 |
| 10.3.2.2.1.3   | Pre-registration to HRPD Procedure .....  | 152 |
| 10.3.2.2.1.4   | E-UTRAN to HRPD Cell Re-selection .....   | 153 |
| 10.3.2.2.1.5   | E-UTRAN to HRPD Handover .....  | 153 |
| 10.3.2.2.2     | Mobility from HRPD to E-UTRAN .....   | 153 |
| 10.3.2.3       | Mobility between E-UTRAN and cdma2000 1xRTT .....                                       | 153 |
| 10.3.2.3.1     | Mobility from E-UTRAN to cdma2000 1xRTT .....   | 153 |
| 10.3.2.3.1.1   | cdma2000 1xRTT System Information Transmission in E-UTRAN .....                         | 153 |
| 10.3.2.3.1.2   | Measuring cdma2000 1xRTT from E-UTRAN .....   | 153 |
| 10.3.2.3.1.2.1 | Idle Mode Measurement Control .....   | 154 |
| 10.3.2.3.1.2.2 | Active Mode Measurement Control .....   | 154 |
| 10.3.2.3.1.2.3 | Active Mode Measurement .....   | 154 |
| 10.3.2.3.1.3   | E-UTRAN to cdma2000 1xRTT Cell Re-selection .....                                       | 154 |
| 10.3.2.3.1.4   | E-UTRAN to cdma2000 1xRTT Handover .....  | 154 |
| 10.3.2.3.2     | Mobility from cdma2000 1xRTT to E-UTRAN .....   | 154 |
| 10.3.2.3.3     | 1xRTT CS Fallback .....   | 155 |
| 10.3.3         | CDMA2000 interworking in LTE shared networks .....                                      | 156 |
| 10.4           | Area Restrictions .....   | 156 |
| 10.4a          | Roaming and Access Restrictions .....   | 157 |
| 10.5           | Mobility to and from CSG and Hybrid cells .....   | 157 |
| 10.5.0         | Principles for idle-mode mobility with CSG cells .....                                  | 157 |
| 10.5.0.1       | Intra-frequency mobility .....  | 157 |
| 10.5.0.2       | Inter-frequency mobility .....  | 157 |



|          |   |     |
|----------|---|-----|
| 10.5.0.3 | Inter-RAT Mobility .....                          | 157 |
| 10.5.1   | Inbound mobility to CSG cells .....               | 157 |
| 10.5.1.1 | RRC_IDLE.....                                     | 157 |
| 10.5.1.2 | RRC_CONNECTED.....                                | 158 |
| 10.5.2   | Outbound mobility from CSG cells .....            | 160 |
| 10.5.2.1 | RRC_IDLE.....                                     | 160 |
| 10.5.2.2 | RRC_CONNECTED.....                                | 160 |
| 10.6     | Measurement Model.....                            | 161 |
| 10.7     | Hybrid Cells .....                                | 161 |
| 10.7.0   | General.....                                      | 161 |
| 10.7.1   | RRC_IDLE .....                                    | 161 |
| 10.7.2   | RRC_CONNECTED .....                               | 162 |
| 10.7.2.1 | Inbound Mobility .....                            | 162 |
| 10.7.2.2 | Outbound Mobility.....                            | 162 |
| 11       | Scheduling and Rate Control.....                  | 162 |
| 11.0     | General .....                                     | 162 |
| 11.1     | Basic Scheduler Operation .....                   | 162 |
| 11.1.1   | Downlink Scheduling .....                         | 163 |
| 11.1.2   | Uplink Scheduling .....                           | 164 |
| 11.2     | Activation/Deactivation Mechanism .....           | 165 |
| 11.3     | Measurements to Support Scheduler Operation ..... | 165 |
| 11.4     | Rate Control of GBR, MBR and UE-AMBR .....        | 166 |
| 11.4.1   | Downlink .....                                    | 166 |
| 11.4.2   | Uplink .....                                      | 166 |
| 11.4.3   | UE-AMBR for Dual Connectivity.....                | 166 |
| 11.5     | CQI reporting for Scheduling.....                 | 166 |
| 11.6     | Explicit Congestion Notification.....             | 167 |
| 11.7     | DL channel quality reporting in NB-IoT.....       | 167 |
| 12       | DRX in RRC_CONNECTED .....                        | 167 |
| 13       | QoS.....  | 169 |
| 13.0     | General .....                                     | 169 |
| 13.1     | Bearer service architecture .....                 | 169 |
| 13.2     | QoS parameters .....                              | 170 |
| 13.3     | QoS support in Hybrid Cells .....                 | 170 |
| 14       | Security.....                                     | 171 |
| 14.1     | Overview and Principles .....                     | 171 |
| 14.2     | Security termination points.....                  | 174 |
| 14.3     | State Transitions and Mobility .....              | 175 |
| 14.3.1   | RRC_IDLE to RRC_CONNECTED .....                   | 175 |
| 14.3.2   | RRC_CONNECTED to RRC_IDLE .....                   | 175 |
| 14.3.3   | Intra E-UTRAN Mobility .....                      | 175 |
| 14.3.4   | SeNB Removal .....                                | 175 |
| 14.4     | AS Key Change in RRC_CONNECTED .....              | 176 |
| 14.5     | Security Interworking.....                        | 176 |
| 14.6     | RN integrity protection for DRB(s).....           | 176 |
| 15       | MBMS.....   | 176 |
| 15.0     | MBMS-Specific Definitions.....                    | 176 |
| 15.1     | General .....                                     | 177 |
| 15.1.0   | Overview .....                                    | 177 |
| 15.1.1   | E-MBMS Logical Architecture.....                  | 178 |
| 15.1.2   | E-MBMS User Plane Protocol Architecture.....      | 180 |
| 15.1.3   | E-MBMS Control Plane Protocol Architecture .....  | 180 |
| 15.2     | MBMS Cells.....                                   | 181 |
| 15.2.1   | MBMS-dedicated cell .....                         | 181 |
| 15.2.2   | MBMS/Unicast-mixed cell .....                     | 181 |
| 15.2.2.1 | FeMBMS/Unicast-mixed cell .....                   | 181 |
| 15.3     | MBMS Transmission.....                            | 181 |
| 15.3.1   | General.....                                      | 181 |
| 15.3.2   | Single-cell transmission .....                    | 181 |

|            |  |     |
|------------|--|-----|
| 15.3.3     | Multi-cell transmission .....                          | 182 |
| 15.3.4     | MBMS Reception States.....                             | 184 |
| 15.3.5     | MCCH Structure .....                                   | 184 |
| 15.3.5a    | SC-MCCH structure .....                                | 185 |
| 15.3.6     | MBMS signalling on BCCH.....                           | 185 |
| 15.3.7     | MBMS User Data flow synchronisation.....               | 186 |
| 15.3.8     | Synchronisation of MCCH Update Signalling via M2 ..... | 187 |
| 15.3.9     | IP Multicast Distribution .....                        | 187 |
| 15.4       | Service Continuity.....                                | 187 |
| 15.5       | Network sharing .....                                  | 189 |
| 15.6       | Network Functions for Support of Multiplexing.....     | 189 |
| 15.7       | Procedures .....                                       | 190 |
| 15.7.1     | Procedures for Broadcast mode .....                    | 190 |
| 15.7.1.1   | Session Start procedure .....                          | 190 |
| 15.7.1.2   | Session Stop procedure .....                           | 191 |
| 15.7a      | M1 Interface .....                                     | 192 |
| 15.7a.1    | M1 User Plane .....                                    | 192 |
| 15.8       | M2 Interface .....                                     | 193 |
| 15.8.1     | M2 Control Plane.....                                  | 193 |
| 15.8.2     | M2 Interface Functions.....                            | 194 |
| 15.8.2.1   | General .....  | 194 |
| 15.8.2.2   | MBMS Session Handling Function.....                    | 194 |
| 15.8.2.3   | MBMS Scheduling Information Provision Function .....   | 194 |
| 15.8.2.4   | M2 Interface Management Function .....                 | 194 |
| 15.8.2.5   | M2 Configuration Function.....                         | 194 |
| 15.8.2.6   | MBMS Service Counting Function.....                    | 194 |
| 15.8.2.7   | MBMS Service Suspension and Resumption Function.....   | 194 |
| 15.8.2.8   | MBMS Overload Notification Function.....               | 195 |
| 15.8.3     | M2 Interface Signalling Procedures.....                | 195 |
| 15.8.3.1   | General .....  | 195 |
| 15.8.3.2   | MBMS Session signalling procedure.....                 | 195 |
| 15.8.3.3   | MBMS Scheduling Information procedure.....             | 195 |
| 15.8.3.4   | M2 Interface Management procedures.....                | 195 |
| 15.8.3.4.1 | Reset procedure .....                                  | 195 |
| 15.8.3.4.2 | Error Indication procedure.....                        | 195 |
| 15.8.3.5   | M2 Configuration procedures .....                      | 195 |
| 15.8.3.5.1 | M2 Setup procedure .....                               | 195 |
| 15.8.3.5.2 | eNB Configuration Update procedure.....                | 195 |
| 15.8.3.5.3 | MCE Configuration Update procedure.....                | 196 |
| 15.8.3.6   | MBMS Service Counting procedures .....                 | 196 |
| 15.8.3.6.1 | MBMS Service Counting procedure .....                  | 196 |
| 15.8.3.6.2 | MBMS Service Counting Results Report procedure.....    | 196 |
| 15.8.3.7   | MBMS Overload Notification procedure.....              | 196 |
| 15.9       | M3 Interface .....                                     | 196 |
| 15.9.1     | M3 Control Plane.....                                  | 196 |
| 15.9.2     | M3 Interface Functions .....                           | 197 |
| 15.9.2.1   | General .....  | 197 |
| 15.9.2.2   | MBMS Session Handling Function.....                    | 197 |
| 15.9.2.3   | M3 Interface Management Function .....                 | 197 |
| 15.9.2.4   | M3 Configuration Function.....                         | 197 |
| 15.9.3     | M3 Interface Signalling Procedures.....                | 197 |
| 15.9.3.1   | General .....  | 197 |
| 15.9.3.2   | MBMS Session signalling procedure.....                 | 197 |
| 15.9.3.3   | M3 Interface Management procedures.....                | 198 |
| 15.9.3.3.1 | Reset procedure .....                                  | 198 |
| 15.9.3.3.2 | Error Indication procedure.....                        | 198 |
| 15.9.3.4   | M3 Configuration procedures .....                      | 198 |
| 15.9.3.4.1 | M3 Setup procedure .....                               | 198 |
| 15.9.3.4.2 | MCE Configuration Update procedure.....                | 198 |
| 15.10      | MBMS Counting .....                                    | 198 |
| 15.10.1    | General.....   | 198 |
| 15.10.2    | Counting Procedure .....                               | 198 |

|            |  |     |
|------------|--|-----|
| 15.11      | MBMS service reception using Receive Only Mode .....                                   | 199 |
| 16         | Radio Resource Management aspects .....  | 199 |
| 16.0       | General .....  | 199 |
| 16.1       | RRM functions .....  | 199 |
| 16.1.1     | Radio Bearer Control (RBC) .....   | 199 |
| 16.1.2     | Radio Admission Control (RAC).....   | 199 |
| 16.1.3     | Connection Mobility Control (CMC) .....  | 200 |
| 16.1.4     | Dynamic Resource Allocation (DRA) - Packet Scheduling (PS) .....                       | 200 |
| 16.1.5     | Inter-cell Interference Coordination (ICIC).....                                       | 200 |
| 16.1.5.0   | General .....  | 200 |
| 16.1.5.1   | UE configurations for time domain ICIC.....  | 201 |
| 16.1.5.2   | OAM requirements for time domain ICIC .....  | 201 |
| 16.1.5.2.1 | Configuration for CSG cell.....  | 201 |
| 16.1.5.2.2 | Configuration for interfering non-CSG cell.....  | 201 |
| 16.1.6     | Load Balancing (LB) .....  | 201 |
| 16.1.7     | Inter-RAT Radio Resource Management .....  | 202 |
| 16.1.8     | Subscriber Profile ID for RAT/Frequency Priority.....                                  | 202 |
| 16.1.9     | Inter-eNB CoMP.....  | 202 |
| 16.1.10    | Cell on/off and cell discovery .....   | 202 |
| 16.2       | RRM architecture .....   | 202 |
| 16.2.1     | Centralised Handling of certain RRM Functions.....                                     | 202 |
| 16.2.2     | De-Centralised RRM .....   | 203 |
| 16.2.2.1   | UE History Information .....   | 203 |
| 16.2.3     | Void .....   | 203 |
| 16.3       | UE assistance information for RRM, and UE power optimisations and UE overheating ..... | 203 |
| 17         | Void.....  | 204 |
| 17.1       | Void.....  | 204 |
| 18         | UE capabilities .....  | 204 |
| 19         | S1 Interface .....   | 205 |
| 19.1       | S1 User plane .....  | 205 |
| 19.2       | S1 Control Plane.....  | 206 |
| 19.2.0     | General.....   | 206 |
| 19.2.1     | S1 Interface Functions .....   | 207 |
| 19.2.1.0   | General .....  | 207 |
| 19.2.1.1   | S1 Paging function .....   | 208 |
| 19.2.1.2   | S1 UE Context Management function.....   | 208 |
| 19.2.1.3   | Initial Context Setup Function .....   | 208 |
| 19.2.1.3a  | UE Context Modification Function.....  | 208 |
| 19.2.1.3b  | UE Context Resume Function.....  | 208 |
| 19.2.1.4   | Mobility Functions for UEs in ECM-CONNECTED .....                                      | 208 |
| 19.2.1.4.1 | Intra-LTE Handover .....   | 208 |
| 19.2.1.4.2 | Inter-3GPP-RAT Handover.....   | 209 |
| 19.2.1.5   | E-RAB Service Management function.....   | 209 |
| 19.2.1.6   | NAS Signalling Transport function.....   | 209 |
| 19.2.1.7   | NAS Node Selection Function (NNSF) .....   | 209 |
| 19.2.1.8   | S1-interface management functions .....  | 209 |
| 19.2.1.9   | MME Load balancing Function .....  | 209 |
| 19.2.1.10  | Location Reporting Function .....  | 210 |
| 19.2.1.11  | Warning Message Transmission function.....   | 210 |
| 19.2.1.12  | Overload Function.....   | 210 |
| 19.2.1.13  | RAN Information Management Function .....  | 210 |
| 19.2.1.14  | S1 CDMA2000 Tunnelling function.....   | 210 |
| 19.2.1.15  | Configuration Transfer Function.....   | 210 |
| 19.2.1.16  | LPPa Signalling Transport function.....  | 210 |
| 19.2.1.17  | Trace Function .....   | 210 |
| 19.2.1.18  | UE Radio Capability Match .....  | 210 |
| 19.2.1.19  | Retrieve UE Information Function.....  | 210 |
| 19.2.1.20  | UE Information Transfer Function.....  | 211 |
| 19.2.1.21  | Report of Secondary RAT data volumes Function.....                                     | 211 |

|             |  |     |
|-------------|--|-----|
| 19.2.2      | S1 Interface Signalling Procedures .....                 | 211 |
| 19.2.2.0    | General .....  | 211 |
| 19.2.2.1    | Paging procedure.....                                    | 211 |
| 19.2.2.2    | S1 UE Context Release procedure .....                    | 211 |
| 19.2.2.2.0  | General .....  | 211 |
| 19.2.2.2.1  | S1 UE Context Release (EPC triggered) .....              | 212 |
| 19.2.2.2.2  | S1 UE Context Release Request (eNB triggered).....       | 212 |
| 19.2.2.3    | Initial Context Setup procedure.....                     | 212 |
| 19.2.2.3a   | UE Context Modification procedure .....                  | 213 |
| 19.2.2.4    | E-RAB signalling procedures.....                         | 214 |
| 19.2.2.4.1  | E-RAB Setup procedure .....                              | 214 |
| 19.2.2.4.2  | E-RAB Modification procedure .....                       | 215 |
| 19.2.2.4.3  | E-RAB Release procedure.....                             | 216 |
| 19.2.2.4.4  | E-RAB Release Indication procedure.....                  | 217 |
| 19.2.2.4.5  | E-RAB Modification Indication procedure .....            | 217 |
| 19.2.2.5    | Handover signalling procedures.....                      | 217 |
| 19.2.2.5.0  | General .....  | 217 |
| 19.2.2.5.1  | Handover Preparation procedure .....                     | 218 |
| 19.2.2.5.2  | Handover Resource Allocation procedure.....              | 218 |
| 19.2.2.5.3  | Handover Notification procedure .....                    | 219 |
| 19.2.2.5.4  | Handover Cancellation .....                              | 219 |
| 19.2.2.5.5  | Path Switch procedure .....                              | 220 |
| 19.2.2.5.6  | Message sequence diagrams .....                          | 220 |
| 19.2.2.5.7  | eNB Status Transfer procedure.....                       | 228 |
| 19.2.2.5.8  | MME Status Transfer procedure .....                      | 229 |
| 19.2.2.6    | NAS transport procedures .....                           | 229 |
| 19.2.2.7    | S1 interface Management procedures .....                 | 232 |
| 19.2.2.7.1  | Reset procedure .....                                    | 232 |
| 19.2.2.7.1a | eNB initiated Reset procedure .....                      | 232 |
| 19.2.2.7.1b | MME initiated Reset procedure.....                       | 233 |
| 19.2.2.7.2  | Error Indication functions and procedures.....           | 233 |
| 19.2.2.7.2a | eNB initiated error indication .....                     | 233 |
| 19.2.2.7.2b | MME initiated error indication.....                      | 233 |
| 19.2.2.8    | S1 Setup procedure .....                                 | 234 |
| 19.2.2.9    | eNB Configuration Update procedure .....                 | 234 |
| 19.2.2.9a   | eNB Configuration Transfer procedure.....                | 235 |
| 19.2.2.10   | MME Configuration Update procedure .....                 | 235 |
| 19.2.2.10a  | MME Configuration Transfer procedure .....               | 236 |
| 19.2.2.11   | Location Reporting procedures .....                      | 236 |
| 19.2.2.11.0 | General .....  | 236 |
| 19.2.2.11.1 | Location Reporting Control procedure.....                | 237 |
| 19.2.2.11.2 | Location Report procedure .....                          | 237 |
| 19.2.2.11.3 | Location Report Failure Indication procedure.....        | 237 |
| 19.2.2.12   | Overload procedure .....                                 | 238 |
| 19.2.2.12.1 | Overload Start procedure.....                            | 238 |
| 19.2.2.12.2 | Overload Stop procedure .....                            | 238 |
| 19.2.2.13   | Write-Replace Warning procedure.....                     | 239 |
| 19.2.2.14   | eNB Direct Information Transfer procedure .....          | 239 |
| 19.2.2.15   | MME Direct Information Transfer procedure.....           | 240 |
| 19.2.2.16   | S1 CDMA2000 Tunnelling procedures.....                   | 240 |
| 19.2.2.16.1 | Downlink S1 CDMA2000 Tunnelling procedure.....           | 240 |
| 19.2.2.16.2 | Uplink S1 CDMA2000 Tunnelling procedure.....             | 240 |
| 19.2.2.17   | Kill procedure .....                                     | 241 |
| 19.2.2.18   | LPPa Transport procedures .....                          | 241 |
| 19.2.2.18.0 | General .....  | 241 |
| 19.2.2.18.1 | Downlink UE Associated LPPa Transport procedure .....    | 242 |
| 19.2.2.18.2 | Uplink UE Associated LPPa Transport procedure .....      | 242 |
| 19.2.2.18.3 | Downlink Non UE Associated LPPa Transport procedure..... | 242 |
| 19.2.2.18.4 | Uplink Non UE Associated LPPa Transport procedure .....  | 243 |
| 19.2.2.19   | Trace procedures .....                                   | 243 |
| 19.2.2.19.0 | General .....  | 243 |
| 19.2.2.19.1 | Trace Start procedure .....                              | 243 |

|             |   |     |
|-------------|---|-----|
| 19.2.2.19.2 | Trace Failure Indication procedure.....                     | 244 |
| 19.2.2.19.3 | Deactivate Trace procedure.....                             | 244 |
| 19.2.2.19.4 | Cell Traffic Trace procedure.....                           | 244 |
| 19.2.2.20   | UE Capability Info Indication procedure.....                | 244 |
| 19.2.2.21   | UE Radio Capability Match procedure.....                    | 245 |
| 19.2.2.22   | PWS Restart Indication procedure.....                       | 245 |
| 19.2.2.23   | PWS Failure Indication procedure.....                       | 246 |
| 19.2.2.24   | UE Context Modification Indication procedure.....           | 246 |
| 19.2.2.25   | Connection Establishment Indication procedure.....          | 247 |
| 19.2.2.26   | UE Context Suspend procedure.....                           | 247 |
| 19.2.2.27   | UE Context Resume procedure.....                            | 248 |
| 19.2.2.28   | Retrieve UE Information procedure.....                      | 248 |
| 19.2.2.29   | UE Information Transfer procedure.....                      | 249 |
| 19.2.2.30   | eNB CP Relocation Indication.....                           | 249 |
| 19.2.2.31   | MME CP Relocation Indication.....                           | 250 |
| 19.2.2.32   | Secondary RAT Report.....                                   | 250 |
| 20          | X2 Interface.....   | 250 |
| 20.1        | User Plane.....   | 250 |
| 20.1.1      | Flow Control Functions.....                                 | 251 |
| 20.2        | Control Plane.....  | 251 |
| 20.2.0      | X2-CP Overview.....   | 251 |
| 20.2.1      | X2-CP Functions.....  | 252 |
| 20.2.2      | X2-CP Procedures.....                                       | 253 |
| 20.2.2.0    | Overview of X2-CP procedures.....                           | 253 |
| 20.2.2.1    | Handover Preparation procedure.....                         | 253 |
| 20.2.2.2    | Handover Cancel procedure.....                              | 253 |
| 20.2.2.2a   | SeNB Addition Preparation procedure.....                    | 254 |
| 20.2.2.2b   | SeNB Reconfiguration Completion procedure.....              | 254 |
| 20.2.2.2c   | MeNB initiated SeNB Modification Preparation procedure..... | 254 |
| 20.2.2.2d   | SeNB initiated SeNB Modification procedure.....             | 255 |
| 20.2.2.2e   | MeNB initiated SeNB Release procedure.....                  | 255 |
| 20.2.2.2f   | SeNB initiated SeNB Release procedure.....                  | 256 |
| 20.2.2.2g   | SeNB Counter Check procedure.....                           | 256 |
| 20.2.2.3    | UE Context Release procedure.....                           | 256 |
| 20.2.2.4    | SN Status Transfer procedure.....                           | 257 |
| 20.2.2.5    | Error Indication procedure.....                             | 258 |
| 20.2.2.6    | Load Indication procedure.....                              | 259 |
| 20.2.2.7    | X2 Setup procedure.....                                     | 260 |
| 20.2.2.8    | eNB Configuration Update procedure.....                     | 260 |
| 20.2.2.9    | Reset procedure.....  | 261 |
| 20.2.2.10   | Resource Status Reporting Initiation procedure.....         | 262 |
| 20.2.2.11   | Resource Status Reporting procedure.....                    | 262 |
| 20.2.2.12   | Radio Link Failure Indication procedure.....                | 262 |
| 20.2.2.13   | Handover Report procedure.....                              | 263 |
| 20.2.2.14   | Mobility Settings Change procedure.....                     | 263 |
| 20.2.2.15   | Cell Activation procedure.....                              | 264 |
| 20.2.2.16   | X2 Release procedure.....                                   | 264 |
| 20.2.2.17   | X2AP Message Transfer procedure.....                        | 265 |
| 20.2.2.18   | X2 Removal procedure.....                                   | 265 |
| 20.2.2.19   | Retrieve UE Context.....                                    | 266 |
| 20.2.2.20   | SgNB Addition Preparation procedure.....                    | 267 |
| 20.2.2.21   | SgNB Reconfiguration Completion procedure.....              | 268 |
| 20.2.2.22   | MeNB initiated SgNB Modification Preparation procedure..... | 268 |
| 20.2.2.23   | SgNB initiated SgNB Modification Preparation procedure..... | 268 |
| 20.2.2.24   | MeNB initiated SgNB Release procedure.....                  | 269 |
| 20.2.2.25   | SgNB initiated SgNB Release procedure.....                  | 269 |
| 20.2.2.26   | SgNB initiated SgNB Change procedure.....                   | 269 |
| 20.2.2.27   | SgNB Counter Check procedure.....                           | 270 |
| 20.2.2.28   | EN-DC X2 Setup procedure.....                               | 270 |
| 20.2.2.29   | EN-DC Configuration Update procedure.....                   | 271 |
| 20.2.2.31   | E-UTRA - NR Cell Resource Coordination procedure.....       | 272 |