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Technical Report

3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Requirements for Further Advancements for E-UTRA (LTE-Advanced) (Release 8)

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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

This document contains requirements for the further advancements for E-UTRA/E-UTRAN.

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 TD RP-080137: "Proposed SID on LTE-Advanced".

[2] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[3] 3GPP TR 25.913: “Requirements for Evolved UTRA (E-UTRA) and Evolved UTRAN (E-UTRAN)

[4] ITU-R Circular Letter 5/LCCE/2 on IMT-Advanced

[5] 3GPP TR 25.912: “Feasibility study for evolved Universal Terrestrial Radio Access (UTRA) and Universal Terrestrial Radio Access Network (UTRAN)”

3 Definitions, symbols and abbreviations

3.1 Definitions

Void

3.2 Symbols

Void

3.3 Abbreviations

For the purposes of the present document, the abbreviations defined in 3GPP TS 21.905 [2] and the following apply:

4 Introduction

At the 3GPP TSG RAN #39 meeting, the Study Item description on "Further Advancements for E-UTRA (LTE-Advanced)" was approved [1].

The justification of the Study Item was as follows;

IMT-Advanced is entering the phase of the process in ITU-R addressing the development of the terrestrial radio interface recommendations. To announce this stage of the process for IMT-Advanced, ITU-R has issued a Circular Letter(CL) to invite submission of candidate Radio Interface Technologies (RITs) or a set of RITs (SRITs) for IMT-Advanced. The key features of IMT-Advanced delineated in the CL are:

- a high degree of commonality of functionality worldwide while retaining the flexibility to support a wide range of services and applications in a cost efficient manner;
- compatibility of services within IMT and with fixed networks;
- capability of interworking with other radio access systems;
- high quality mobile services;
- user equipment suitable for worldwide use;
- user-friendly applications, services and equipment;
- worldwide roaming capability; and
- enhanced peak data rates to support advanced services and applications (100 Mbit/s for high and 1 Gbit/s for low mobility were established as targets for research) .

The base line requirements for IMT-Advanced will be concluded in ITU-R WP 5D #2 (June 2008) and communicated in an Addendum to the Circular Letter in the July 2008 timeframe.

In the WRC07, the following spectrum bands were proposed as additions to the prior identified bands, and the parts of the existing and new bands are globally or regionally identified for IMT, which is the new root term to encompass both IMT-2000 and IMT-Advanced.

- 450 MHz band
- UHF band (698-960 MHz)
- 2.3 GHz band
- C-band(3400-4200 MHz)

In 3GPP, E-UTRA should be further evolved for the future releases in accordance with:

- 3GPP operator requirements for the evolution of E-UTRA
- The need to meet/exceed the IMT-Advanced capabilities.

Considering the above, 3GPP TSG-RAN should study further advancements for E-UTRA (LTE-Advanced) toward meeting:

- Requirements for IMT-Advanced and provide ITU-R with proposals of RITs or SRITs according to the defined ITU-R time schedule provided in the Circular Letter and its Addendums.
- 3GPP operators requirements for the evolution of E-UTRA

5 Objective

The objective of Further Advancements for E-UTRA is as follows;

A) Define a framework for further advancements of E-UTRA and E-UTRAN (to be referred to as Advanced E-UTRA and Advanced EUTRAN considering:
   - The time schedule of ITU-R
   - That the work on Advanced E-UTRA and Advanced E-UTRAN must not introduce any delay to the completion of the Release 8 specification of E-UTRA and E-UTRAN
   - That the general enhancements of specifications for Release 8 E-UTRA and E-UTRAN are maintained and progressed in a focused and efficient manner.

B) Define requirements for Advanced E-UTRA and Advanced E-UTRAN based on the ITU-R requirements for IMT-Advanced as well as 3GPP operators own requirements for advancing Release 8 E-UTRA AND E-UTRAN considering:
   - E-UTRA radio technology and architecture improvements
   - Support for all radio modes of operation
   - Interworking with legacy RATs (scenarios and performance requirements)

- Backward compatibility of Advanced E-UTRA and Advanced E-UTRAN with Release 8 E-UTRA and E-UTRAN i.e.
  - an Release 8 E-UTRA terminal can work in an Advanced E-UTRAN,
  - an Advanced E-UTRA terminal can work in an Release 8 E-UTRAN and
  - non-backward compatible elements could be considered based on RAN decision
- Newly identified frequency bands and existing frequency bands, and their advantages and limitations, in particular, the consideration of the WRC-07 conclusions, to ensure that Advanced E-UTRA can accommodate radio channel bandwidths commensurate with the availability in parts of the world of wideband channels in the spectrum allocations (above 20 MHz) and at the same time being mindful on the need to accommodate those parts of the world where the spectrum allocations will not have availability of wideband channels

C) Identify potential solutions, technologies for the Advanced E-UTRA and Advanced E-UTRAN. The study areas include:
- Physical layer
- Radio interface layer 2 and RRC
- E-UTRAN architecture
- RF, including Aspects of wider channel bandwidth than 20 MHz
- Advanced system concepts

D) To develop documents that will serve as a basis for the documentation to be submitted to ITU-R to provide the 3GPP proposals for IMT-Advanced:

1. An "Early Proposal" submission that would be sent to ITU-R, to be agreed at RAN #41 (9-12 September 2008), for submission to WP 5D #3 (8-15 October 2008).

2. A "Complete Technology" submission that would be sent to ITU-R, to be agreed at RAN #44 (26-29 May 2009), for submission to WP 5D #5 (planned for 10-17 June 2009).

3. A "Final" submission to incorporate updates, additional specific details or feature additions, *and* the required self-evaluation that would be sent to ITU-R, to be agreed at RAN #45 (22-25 September 2009), for submission to WP 5D #6 (planned for 13-20 Oct 2009).

- 3GPP should take note, that by ITU-R convention, the formal submission deadline for ITU-R meetings has been established as 16:00 hours UTC, seven calendar days prior to the start of the meeting.

E) Make recommendations for future WIs

F) For reference, the Circular Letter as received from the ITU-R (and future Addendums to the same) are annexed to this Work Item and should become an integral part of the WI.

6 General requirements

The following general requirements are valid for Advanced E-UTRA and Advanced E-UTRAN

- Advanced E-UTRA and Advanced E-UTRAN shall be an evolution of Release 8 E-UTRA and E-UTRAN
- All relevant requirement in [3] are valid also for Advanced E-UTRA and Advanced E-UTRAN
- Advanced E-UTRA and Advanced E-UTRAN shall meet or exceed IMT-Advanced requirements within the ITU-R time plan

The expectancy is that Advanced E-UTRA should provide substantially higher performance compared to what is expected to be the IMT-Advanced requirements in ITU-R. The values provided in clauses 7 and 8 have been expressed as preferred performance of Advanced E-UTRA. These values are recognised as being very ambitious, especially in light of the ITU-R time plan, and the performance evaluation results generated for LTE R8, but are adopted as long term target for Advanced E-UTRA"

7 Capability-related requirements

7.1 Peak Data Rate

The peak data rate is the maximum data rate to be supported from a system requirement viewpoint (i.e. not from radio performance requirement viewpoint) regardless of radio interface parameters such as the transmission bandwidth and antenna configuration.

Advanced E-UTRA should support significantly increased instantaneous peak data rates.

At a minimum, Advanced E-UTRA should support the key feature of IMT-Advanced which is stated in the Circular Letter from the ITU-R as "enhanced peak data rates to support advanced services and applications (100 Mbit/s for high and 1 Gbit/s for low mobility were established as targets for research)"

The system should target a downlink peak data rate of 1 Gbps and an uplink peak data rate of 500 Mbps.

7.2 Latency

7.2.1 C-plane latency

The overall C-Plane latency shall be significantly decreased compared to EPS Rel-8. The C-Plane latency takes into account RAN and CN latencies (excluding the transfer latency on the S1 interface) in unloaded conditions.

The target for transition time from Idle mode (with IP address allocated) to Connected mode is less than 50 ms including the establishment of the user plane (excluding the S1 transfer delay).

The target for the transition from a "dormant state" in Connected Mode (i.e. DRX substate in Connected Mode in E-UTRAN) is less than 10 ms (excluding the DRX delay).

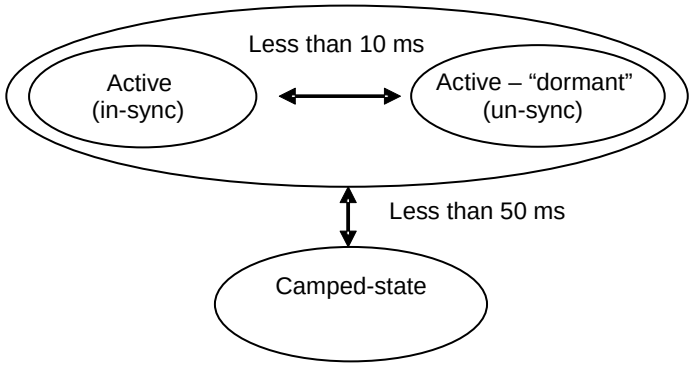

Figure 7.1: Requirements for state transitions

7.2.1.1 C-plane Capacity

The system should be able to support at least 300 active users without DRX in a 5 MHz bandwidth. The same number of RRC connections with DRX as in Release 8 E-UTRA and E-UTRAN (16k) is expected.

7.2.2 U-Plane Latency

Advanced E-UTRA and Advanced E-UTRAN should allow for reduced U-plane latency compared to Release 8 E-UTRA and E-UTRAN, specifically in situations where:

- The UE does not have a valid scheduling assignment
- The UE needs to synchronise and obtain a scheduling assignment

The U-Plane latency is defined as the minimum achievable user plane latency with the system configurations optimized for latency

8 System performance requirements

8.1 Spectrum efficiency

In this section, the target for peak spectrum efficiency, the average spectrum efficiency, and cell edge spectrum efficiency are defined. The target for average spectrum efficiency and the cell edge user throughput efficiency should be given a higher priority than the target for peak spectrum efficiency and VoIP capacity.

The target for average spectrum efficiency and the cell edge spectrum efficiency should be achieved simultaneously.

8.1.1 Peak spectrum efficiency

The peak spectrum efficiency is the highest data rate normalised by overall cell bandwidth assuming error-free conditions, when all available radio resources for the corresponding link direction are assigned to a single UE.

The system target to support downlink peak spectrum efficiency of 30 bps/Hz and uplink peak spectrum efficiency of 15 bps/Hz.

Assumption of antenna configuration is 8x8 or less for DL and 4x4 or less for UL

8.1.2 Average spectrum efficiency

Average spectrum efficiency is defined as the aggregate throughput of all users (the number of correctly received bits over a certain period of time) normalized by the overall cell bandwidth divided by the number of cells. The average spectrum efficiency is measured in b/s/Hz/cell.

Advanced E-UTRA should target the average spectrum efficiency to be as high as possible, given a reasonable system complexity.

The expectation at the end of the study item is that the values of all the targets (of the different configurations) will be made available, but currently the evaluation for the blanked out boxes in the table below, are a lower priority.

Advanced E-UTRA should target the average spectrum efficiencies in different environments below.

Table 8.1 Targets for average spectrum efficiency

Radio env. / Ant. Config		Case 1 [bps/Hz/cell]	Micro	Indoor	Rural/ High speed
UL	1x2	1.2			
	2x4	2.0			
DL	2x2	2.4			
	4x2	2.6			
	4x4	3.7			

NOTE: There is a need to define all the cases in the tables. Case 1 is defined in Annex A. Case 1 is included to permit 3GPP to compare Advanced E-UTRA to Release 8 E-UTRA. 3GPP should consider that the other environments would be based on the ITU-R environments (these are currently designated as High Speed, Base Coverage Urban, Microcellular, & Indoor). These environments are defined in Recommendation/Reports [IMT.TECH] and [IMT.EVAL] which are expected to be concluded in ITU-R WP 5D in early July 2008. Such definitions would ensure consistency with developing submissions to ITU-R for IMT-Advanced and for consistency with performing simulations, etc. Thus 3GPP would have 5 environments Case 1 plus the 4 ITU-R environments.

8.1.3 Cell edge user throughput

The cell edge user throughput is defined as the 5% point of CDF of the user throughput normalized with the overall cell bandwidth.

Advanced E-UTRA should target the cell edge user throughput to be as high as possible, given a reasonable system complexity.

A more homogeneous distribution of the user experience over the coverage area is highly desirable and therefore a special focus should be put on improving the cell edge performance.

The expectation at the end of the study item is that the values of all the targets (of the different configurations) will be made available, but currently the evaluation for the blanked out boxes in the table below, are a lower priority.

Advanced E-UTRA should target the cell edge user throughput below in different environments

Table 8.2 Targets for cell edge throughput

Radio env. / Ant. Config		Case 1 [bps/Hz/cell/user*]	Micro	Indoor	Rural/ High speed
UL	1x2	0.04			
	2x4	0.07			
DL	2x2	0.07			
	4x2	0.09			
	4x4	0.12			

* 10 users uniform-randomly dropped in the cell

NOTE: There is a need to define all the cases in the tables. Case 1 is defined in Annex A. Case 1 is included to permit 3GPP to compare Advanced E-UTRA to Release 8 E-UTRA. 3GPP should consider that the other environments would be based on the ITU-R environments (these are currently designated as High Speed, Base Coverage Urban, Microcellular, & Indoor). These environments are defined in Recommendation/Reports [IMT.TECH] and [IMT.EVAL] which are expected to be concluded in ITU-R WP 5D in early July 2008. Such definitions would ensure consistency with developing submissions to ITU-R for IMT-Advanced and for consistency with performing simulations, etc. Thus 3GPP would have 5 environments Case 1 plus the 4 ITU-R environments.

8.1.4 VoIP capacity

VoIP capacity should be improved relative to that shown in the evaluation for E-UTRA and E-UTRAN in [5] for all antenna configurations.

8.2 Mobility

The system shall support mobility across the cellular network for various mobile speeds up to 350km/h (or perhaps even up to 500km/h depending on the frequency band).

System performance shall be enhanced for 0 to 10km/h and preferably enhanced but at least no worse than E-UTRA and E-UTRAN for higher speeds

8.3 Coverage

Requirements for Coverage in Release 8 E-UTRA and E-UTRAN [3] are applicable for Advanced E-UTRA and Advanced E-UTRAN.

8.4 Further Enhanced MBMS

The targets for MBMS in Advanced E-UTRA and Advanced E-UTRAN should be better than those studied in Release 8 E-UTRA and E-UTRAN [3]. Specifically, the target spectrum efficiency for MBMS in Advanced E-UTRA should be better than that in Release 8 E-UTRA.

8.5 Network synchronization

Requirements for Network synchronization in Release 8 E-UTRA and E-UTRAN [3] are applicable for Advanced E-UTRA and Advanced E-UTRAN.

9 Deployment-related requirements

9.1 Deployment Scenarios

Advanced E-UTRA and Advanced E-UTRAN will be deployed as an evolution of Release 8 E-UTRA and E-UTRAN and on new bands. Advanced E-UTRA and Advanced E-UTRAN shall be backwards compatible with Release 8 E-UTRA and E-UTRAN in the sense that

- a Release 8 E-UTRA terminal can work in an Advanced E-UTRAN,
- an Advanced E-UTRA terminal can work in an Release 8 E-UTRAN

However, non-backward compatible element might be considered if significant gain or benefit can be achieved.

It should be expected to have increased deployment of indoor eNB and HNB in Advanced E-UTRAN.

In addition to the deployment scenario in Release 8 E-UTRA and E-UTRAN, the system shall be considered in indoor scenario.

9.2 Spectrum flexibility

The initial identified bands in addition to the already allocated bands in E-URA are follows:

- 450−470 MHz band,
- 698−862 MHz band,
- 790−862 MHz band,
- 2.3−2.4 GHz band,
- 3.4−4.2 GHz band, and
- 4.4-4.99 GHz band.

Advanced E-UTRA shall operate in spectrum allocations of different sizes including wider spectrum allocations than those of Release 8 E-UTRA to achieve higher performance and the target peak data rate, e.g. up to 100 MHz.

Main focus for wider bandwidth solution than 20MHz should be on consecutive spectrum, but Aggregation of the spectrum for Advanced E-UTRA should be supported considering reasonable UE complexity

FDD and TDD should be supported for existing paired and unpaired band, respectively

For new identified band, duplex mode should be studied considering, e.g. delay, spectrum efficiency, operation, BS and UE complexity and overall co-existence aspects especially on adjacent channels

9.3 Spectrum deployment

Advanced E-UTRA is required to cope with following scenarios:

a) Co-existence in the same geographical area and co-location with GERAN/UTRA/E-UTRA on adjacent channels.

b) Co-existence in the same geographical area and co-location between operators on adjacent channels.

c) Co-existence on overlapping and/or adjacent spectrum at country borders.

d) Advanced E-UTRA shall be possible to operate standalone, i.e. there is no need for any other carrier to be available.

e) All frequency bands should be allowed following release independent frequency band principles

f) Operation of Release 8 E-UTRA and Advanced E-UTRA in the same spectrum

9.4 Co-existence and interworking with legacy RATs

Following features already supported in previous releases are a pre-requisite for being supported by Advanced E-UTRAN:

- Handovers with legacy RATs
- Network sharing

The same inter-RAT interworking capabilities with at least same performance as in Release 8 E-UTRAN shall be supported.

Intra-RAT handover performance shall be same or better than Release 8 E-UTRAN.

HO requirements for Release 8 E-UTRAN – Advanced E-UTRAN shall be same as intra-Advanced E-UTRAN HO performance.

10 Requirements for E-UTRAN architecture and migration

Advanced E-UTRAN architecture should be based on Release 8 E-UTRAN architecture.

New architecture should be considered in Advanced E-UTRAN if significant benefit can be expected.

11 Radio Resource Management requirements

Radio resource management requirements of Release 8 E-UTRA and E-UTRAN [3] are applicable for Advanced E-UTRA and Advanced E-UTRAN.

12 Complexity requirements

Complexity requirements of Release 8 E-UTRA and E-UTRAN [3] are applicable for Advanced E-UTRA and Advanced E-UTRAN.

13 Cost-related requirements

- Low cost of the infrastructure deployment and terminal for Advanced E-UTRA and Advanced E-UTRAN shall be an essential element
- Power efficiency in the infrastructure and terminal shall be an essential element
- Backhauling shall minimize cost per bit
- Advanced E-UTRA and Advanced E-UTRAN should allow backhaul using LTE spectrum
- Further enhancements of SON and self configuration shall be an essential element, e.g.:
  - Special care with respect to SON shall be taken for special deployment scenarios like network sharing

  - Special care with respect to SON shall be taken for mass deployment scenarios like in the case of home eNBs, i.e. for In and Outbound Mobility for home eNode B and problems caused by incorrect behaviour of home eNBs.
  - Avoiding need for drive tests
  - Impact to UE complexity and power consumption needs to be taken into account
- Operation and maintenance tasks shall be minimized to the maximum possible extent. Where needed it should be based on open interfaces
- eNode B implementation cost efficiency and flexibility for multi-vendor deployments should be considered, such as RF requirements in specific scenarios or base station modularity aspects with e.g. remote radio units and open interfaces
- All the interfaces specified shall be open for multi-vendor equipment interoperability.

14 Service-related requirements

Service related requirements of Release 8 E-UTRA and E-UTRAN [3] are applicable for Advanced E-UTRA and Advanced E-UTRAN.

Annex A (informative):

A.1 System performance evaluation model:

One of the system performance evaluation models in Advanced E-UTRA (Case 1) is the same as the model used for E-UTRA. The carrier frequency (CF), Inter-site distance (ISD), operating bandwidth (BW), penetration loss (PLoss) and UE speed are given in Table A.1-1.

Table A.1-1 – 3GPP Case 1 model

Simulation Cases	CF (GHz)	ISD (meters)	BW (MHz)	PLoss (dB)	Speed (km/h)
1	2.0	500	10	20	3

Annex B (informative): Change history

Table A.1: Draft History

Change history					
Date	TSG #	TSG Doc.	Subject/Comment	Old	New
29/5/08	RAN#40	RP-080445	Submitted for approval at TSG RAN #40		1.0.0
06/2008			Report approved at TSG-RAN and placed under change control	1.0.0	8.0.0