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Technical Report

3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Study on LTE TDD-FDD joint operation including Carrier Aggregation (Release 12)

Keywords
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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.

Introduction

E-UTRA supports duplex modes of both FDD and TDD. While the interworking mechanisms between E-UTRA FDD and TDD have been specified, the behaviour of terminals simultaneously connected to the network on two (or more) bands with different duplex modes has not been specified. Efficient TDD and FDD spectrum usage and utilization of different technologies jointly are getting more and more important for the future LTE deployments in order to cope with increased throughput and capacity needs. This increases need for supporting joint LTE TDD-FDD joint operations such that both spectrum resources can be fully utilized to improve system performance and user experience.

The use of carrier aggregation (CA) offers means to increase the peak data rates and throughput by aggregating, as has been discovered during Release 10 LTE CA work, and it has been enhanced during Release 11 LTE CA enhancement work. It is expected that in the future LTE FDD – TDD CA deployment scenarios either TDD or FDD cell may be as PCell and therefore, support for generic LTE FDD- TDD CA would be needed.

At the 3GPP TSG RAN #60 meeting a new WI "LTE TDD – FDD Joint Operation" was agreed to start study and specify solutions to enhance LTE TDD – FDD joint operation depending on the outcome of the initial scenario evaluation phase of the work item. This document captures findings in the course of this discussion.

1 Scope

The present document contains a Study on FDD and TDD joint operation for E-UTRA and E-UTRAN.

The objective of the present document is as follows:

- Identify deployment scenarios of joint operation on FDD and TDD spectrum, and network/UE requirement to support joint FDD/TDD operation;
- Based on the identified deployment scenarios and network/UE requirements, identify possible solutions for FDD - TDD joint operation.
- Based on the above, consider whether such solutions, if any, need to be added to the Work Item itself, or in separate Work Items.

2 References

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

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

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TR 36.932: “Scenarios and Requirements for Small Cell Enhancement”.

[3] 3GPP TR36.932 V0.2.0, Scenarios and Requirements for Small Cell Enhancement for E-UTRA and E-UTRAN

[4] 3GPP TR36.842 V0.2.0, Study on Small Cell Enhancements for E-UTRA and E-UTRAN – Higher layer aspects

[5] RP-122033: "New Study Item Description: Small Cell enhancements for E-UTRA and E-UTRAN - Higher layer aspects".

3 Definitions, symbols and abbreviations

Delete from the above heading those words which are not applicable.

Clause numbering depends on applicability and should be renumbered accordingly.

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

Definition format (Normal)

<defined term>: *<definition>.*

example: text used to clarify abstract rules by applying them literally.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Symbol format (EW)

<symbol> <Explanation>

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply.
An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

Abbreviation format (EW)

<ACRONYM> <Explanation>

4 Scenarios and requirements

4.1 Scenarios

4.1.1 Deployment scenarios

The TDD - FDD joint operation would consider the following deployment scenarios:

- FDD+TDD co-located (CA scenarios 1-3), and FDD+TDD non-co-located with ideal backhaul (CA scenario 4)
- FDD+TDD non-co-located (small cell scenarios 2a, 2b, and macro-macro scenario), with non-ideal backhaul, subject to the outcome of the non-ideal backhaul related study items where relevant.

4.1.2 Backhaul assumptions

The candidate backhaul condition supporting TDD - FDD joint operation is described in [3]. A categorization of non-ideal backhaul, and good to ideal backhaul based on operators input can be considered.

4.1.3 Carrier frequency related assumptions

The following combination of TDD and FDD spectrum supporting TDD and FDD joint operation can be considered,

- Carrier frequency of TDD is far away enough from joint operated FDD carrier frequencies
- Carrier frequency of TDD is near the UL band of joint operated FDD
- Carrier frequency of TDD is near the DL band of joint operated FDD
- Carrier frequency of TDD locates between the UL band and DL band of joint operated FDD

Additionally, the following situation may be assumed taking into account UE roaming case,

- The carrier frequency of TDD above is defined as FDD in different region, and
- The carrier frequency of FDD above is defined as TDD in different region
- In one case, a UE could be signalling the capability that it supports this frequency (band X) for FDD and the same frequency (band Y) for TDD.

4.2 Requirements

4.2.1 Prerequisite of TDD-FDD joint operation

UEs supporting FDD - TDD joint operation shall be able to access both legacy FDD and legacy TDD single mode carriers.

Legacy FDD UEs and UEs supporting FDD - TDD joint operation may camp on and connect to the FDD carrier, which is part of the jointly operated FDD/TDD network.

Legacy TDD UEs and UEs supporting FDD - TDD joint operation may camp on and connect to the TDD carrier, which is part of the jointly operated FDD/TDD network.

Network architecture enhancement in order to facilitate FDD - TDD joint operation, e.g., for non-ideal backhaul, can be considered. Keeping the minimum network architecture change is still of interest from operators' perspective.

4.2.2 Terminal requirements

Solutions can be considered which support UEs which do not have one or more of the following capabilities, as well as solutions which require one or more of these capabilities:

- simultaneous reception on FDD and TDD carriers (i.e. DL aggregation)
- simultaneous transmission on FDD and TDD (i.e. UL aggregation)
- simultaneous transmission and reception on FDD and TDD (i.e. full duplex)

4.2.3 Network requirements

<Editor's Note: FFS whether the case of FDD and TDD being non-synchronised is supported for non-ideal backhaul>

4.2.4 Performance requirements

The following benefits can be considered for TDD - FDD joint operation,

- UE throughput
  - The UE can achieve higher throughput by simultaneously receiving and/or transmitting from both TDD and FDD carrier.
- Load balancing
  - UE can experience higher throughput by using lower loaded carrier.
  - Network can utilize the resource more efficiently between TDD and FDD carrier.
- Coverage / Mobility
  - It is of interest from operators' perspective that the carrier with lower carrier frequency provides sufficient coverage / mobility while another carrier with higher carrier frequency is used to improve throughput offloading, which may also provide mobility robustness.
- Network capacity
  - It would be desirable from the Operator perspective to increase the frequency utilization.

5 Potential TDD/FDD joint operation solutions

<Editor's Notes: This section identify possible other solutions for FDD-TDD joint operation in addition to LTE TDD-FDD carrier aggregation according to the agreement in RP-130888>

5.1 Dual connectivity

The definition and applicable scenarios for dual connectivity deployments is described in [4] and the Applicable scenarios and potential L1 spec impacts of dual connectivity are discussed in [3]. Basically, the dual connectivity may be designed to be applicable regardless of the combination of duplex modes (i.e., FDD+FDD, TDD+TDD, and TDD+FDD).

If it is decided to specify dual connectivity as a result of the RAN2 small cell enhancement SI [5], and it is decided to support a solution that is not based on CA for TDD-FDD joint operation, then it would be desirable that the dual connectivity feature would be designed to support TDD-FDD dual connectivity in the applicable scenarios, in addition to TDD-TDD and FDD-FDD dual connectivity.

6 Conclusions and recommendations

- The LTE TDD-FDD carrier aggregation solution according to the agreement in RP-130888 is identified for TDD-FDD joint operation solution in case ideal-backhaul is assumed.
- If it is decided to specify dual connectivity as a result of the RAN2 small cell enhancement SI, and it is decided to support a solution that is not based on CA for TDD-FDD joint operation, then it would be desirable that the dual connectivity feature would be designed to support TDD-FDD dual connectivity in the applicable scenarios, in addition to TDD-TDD and FDD-FDD dual connectivity.
- Identify whether there are any relevant scenarios and requirements that are not satisfied by the above two bullets, and if so, identify appropriate solutions.

Annex A:
Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2013-08	RAN1#74	R1-134020	-	-	MCC clean-up, RAN reflector email dicussion and including RAN1 agreed TPs from R1-134020	-	0.1.0