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Technical Report

3rd Generation Partnership Project; Technical Specification Group Radio Access Network; LTE Advanced intra-band contiguous Carrier Aggregation in Band 3; (Release 12)



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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

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1 Scope

The present document is a technical report of the work item for LTE-Advanced Intra-band Contiguous Carrier Aggregation in Band 3 which was approved at TSG RAN #57 [3]. The report provides background, analysis of the requirements, and a list of recommended changes to the specifications.

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] ITU-R-REC-M.1036-3, "RECOMMENDATION ITU-R M.1036-3"
- [3] RP-121352, "LTE-Advanced Intra-band Contiguous Carrier Aggregation in Band 3".
- [4] R4-125584, "Operating bands and bandwidths for LTE_CA_C_B3".
- [5] R4-125612, "TP of SEM for LTE_CA_C_B3".
- [6] R4-125567, "Work plan for LTE_CA_C_B3".
- [7] R4-125579, "Expected changes to E-UTRA specifications for introducing CA in Band 3".
- [8] R4-125588, "TP of blocking requirements for LTE_CA_C_B3".
- [9] R4-125595, "TP of UE maximum output power LTE_CA_C_B3".
- [10] R4-125603, "TP of UE reference sensitivity for LTE_CA_C_B3".
- [11] R4-125617, "TP of RRM requirements for LTE_CA_C_B3".
- [12] R4-125644, "TP of BS RF requirements for LTE_CA_C_B3".
- [13] R4-125646, "TP of UE and BS demodulation performance for LTE_CA_C_B3".
- [14] R4-126516, "Spectrum and regulation review for LTE_CA_C_B3."
- [15] R4-130416, "TP of background & task for LTE_CA_C_B3"
- [16] R4-130324, "MPR for CA in Band 3 for transmission with contiguous RBs"

3 Definitions, symbols and abbreviations

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].

<Text to be added>

<defined term>: <definition>.

3.2 Symbols

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

<Text to be added>

<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].

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4 Background

Band 3 is a major FDD band which has been allocated globally. Some operators have been granted with more than 20MHz bandwidth.

Building on the generic intra-band carrier aggregation work based on Band 1, this work item proposes to start the work on intra-band contiguous carrier aggregation for Band 3 to support deployment of LTE-advanced.

The output of this work item should also consider regional regulation requirements for the BS.

4.1 Task description

This WI is to specify the band specific core and performance requirements for intra-band contiguous carrier aggregation in band 3:

- a. Specifying the core requirements for BS and UE in RAN4 specifications, and taking the coexistence with adjacent Band 39 into account.
- b. Specifying band specific RRM requirements in RAN4 if any.
- c. Specifying performance requirements for BS and UE in RAN4 specifications.
- d. Specifying conformance testing in RAN5 specifications (to be captured by a separate work item at a later stage).

4.2 Spectrum and regulatory review

This Work Item [3] is based on the spectrum arrangement as shown in Table 4.2-1[2].

Table 4.2-1 Frequency arrangements in the band 1710-1880 MHz

Mobile station transmitter (MHz)	Centre gap (MHz)	Base station transmitter (MHz)	Duplex separation (MHz)	Un-paired spectrum (e.g. for TDD) (MHz)
1710-1785	20	1805-1880	95	None

The frequency band 1710-1785 MHz is paired with 1805-1880 MHz for FDD operation with the mobile transmit within the lower band and base transmit within the upper band. This paired spectrum blocks are designated as Band 3 in 3GPP EUTRA specifications.

Band 3 is a major FDD band which has been allocated in region 1 and region 3. Some operators have been granted with more than 20MHz bandwidth.

5 Band and channel bandwidth arrangement

5.1 CA Operating bands

The CA operating band for Band 3 is defined in Table 5.1-1.

Table 5.1-1 Intra band CA operating bands

E-UTRA CA Band	E-UTRA Band	Uplink (UL) operating band			Downlink (DL) operating band			Duplex Mode
		BS receive / UE transmit			BS transmit / UE receive			
		FUL_low	–	FUL_high	FDL_low	–	FDL_high	
CA_3	3	1710MHz	–	1785MHz	1805MHz	–	1880MHz	FDD

5.2 CA channel bandwidth

Table 5.2-1 defines the supported E-UTRA bandwidths for intra-band contiguous CA in Band 3. 20 MHz, 15MHz, 10MHz and 5 MHz component carrier channel bandwidths are proposed to be supported in Band 3 contiguous carrier aggregation.

Table 5.2-1: Supported E-UTRA bandwidths per CA operating band for intra-band contiguous CA

CA operating band / channel bandwidth							
E-UTRA CA Band	E-UTRA Bands	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
CA_3C	3			Yes	Yes	Yes	Yes
Note 1: Combinations of component carriers with unequal channel bandwidth should be considered. The maximum number of CCs for combination is two.							

6 E-UTRA RF requirements for UE

6.1 Transmitter characteristics

6.1.1 UE maximum output power

Section 6.2.2 in TS36.101 specifies the UE maximum output power requirements for Band 3 UE. In LTE_CA_C_B3 WI it's proposed to reuse the result in Table 6.6.2-1 and a row is required to be added into Table 6.2.2A-1 as follow.

Table 6.1.1-1: CA UE Power Class

EUTRA band	Class 1 (dBm)	Tolerance (dB)	Class 2 (dBm)	Tolerance (dB)	Class 3 (dBm)	Tolerance (dB)	Class 4 (dBm)	Tolerance (dB)
CA_3C					23	+2/-2 ^c		
Note 1: The above tolerances are applicable for UE(s) that support up to 4 E-UTRA operating bands. For UE(s) that support 5 or more E-UTRA bands the maximum output power is expected to decrease with each additional band and is FFS								
Note 2: For transmission bandwidths (TS36.101 Figure 5.6-1) confined within $F_{UL,low}$ and $F_{UL,low} + 4$ MHz or $F_{UL,high} - 4$ MHz and $F_{UL,high}$, the maximum output power requirement is relaxed by reducing the lower tolerance limit by 1.5 dB								
Note 3: $P_{PowerClass}$ is the maximum UE power specified without taking into account the tolerance								
Note 4: For intra-band contiguous carrier aggregation the maximum power requirement should apply to the total transmitted power over all component carriers (per UE).								

6.1.2 UE Maximum Output power for modulation / channel bandwidth for CA

For intra-band contiguous carrier aggregation the allowed Maximum Power Reduction (MPR) for the maximum output power due to higher order modulation and contiguously aggregated transmit bandwidth configuration (resource blocks) is specified in Table 6.2.x. In case the modulation format is different on different component carriers then the MPR is determined by the rules applied to higher order of those modulations.

Table 6.2.x: Maximum Power Reduction (MPR) for Power Class 3

Modulation	CA bandwidth Class C					MPR (dB)
	25 RB + 100 RB	50 RB + 100 RB	75 RB + 75 RB	75 RB / 100 RB	100 RB + 100 RB	
QPSK	> 8 and ≤ 25	> 12 and ≤ 50	> 16 and ≤ 75	> 16 and ≤ 75	> 18 and ≤ 100	≤ 1
QPSK	> 25	> 50	> 75	> 75	> 100	≤ 2
16 QAM	≤ 8	≤ 12	≤ 16	≤ 16	≤ 18	≤ 1
16 QAM	> 8 and ≤ 25	> 12 and ≤ 50	> 16 and ≤ 75	> 16 and ≤ 75	> 18 and ≤ 100	≤ 2
16 QAM	> 25	> 50	> 75	> 75	> 100	≤ 3

6.1.3 Spectrum emission mask minimum requirement

For CA Bandwidth Class C, the power of any UE emission shall not exceed the levels specified in Table 6.1.2-1 for the specified aggregated channel bandwidth. For frequencies greater than F_{OOB} as specified in Table 6.1.2-1 the spurious requirements in clause 6.1.2 are applicable.

Table 6.1.2-1: General E-UTRA CA spectrum emission mask for Bandwidth Class C

Δf_{OOB} (MHz)	Spectrum emission limit [dBm]/BW _{Channel_CA}					Measurement bandwidth
	25RB+100RB (24.95MHz)	50RB+100RB (29.9MHz)	75RB+75RB (30MHz)	75RB+100RB (34.85MHz)	100RB+100RB (39.8MHz)	
± 0-1	-22	-22.5	-22.5	-23.5	-24	30 kHz
± 1-5	-10	-10	-10	-10	-10	1 MHz
± 5-24.95	-13	-13	-13	-13	-13	1 MHz
± 24.95-29.9	-25	-13	-13	-13	-13	1 MHz
± 29.9-29.95	-25	-13	-13	-13	-13	1 MHz
± 29.95-30		-25	-13	-13	-13	1 MHz
± 30-34.85		-25	-25	-13	-13	1 MHz
± 34.85-34.9		-25	-25	-25	-13	1 MHz
± 34.9-35			-25	-25	-13	1 MHz
± 35-39.8				-25	-13	1 MHz
± 39.8-39.85				-25	-25	1 MHz
± 39.85-44.8					-25	1 MHz

6.2 Receiver characteristics

6.2.1 UE Reference sensitivity

From the section 7.3.1A in TS36.101 it is known that the reference sensitivity for CA is defined to be met with both downlink component carrier active and each component carrier shall meet the requirements specified in clause 7.3.1. For avoiding the effect from the uplink signal, the noise at PA output which is generated by UL allocation should be small enough to reduce the interference on DL signal when testing REFSSENS, so the UL allocation for CA should be restricted as shown in table 7.3.1A-1 in TS36.101.

In order to establish the UL allocation for CA band 3, the way how to establish the UL allocation for CA band 1 is recalled in the following figure 6.2.1.

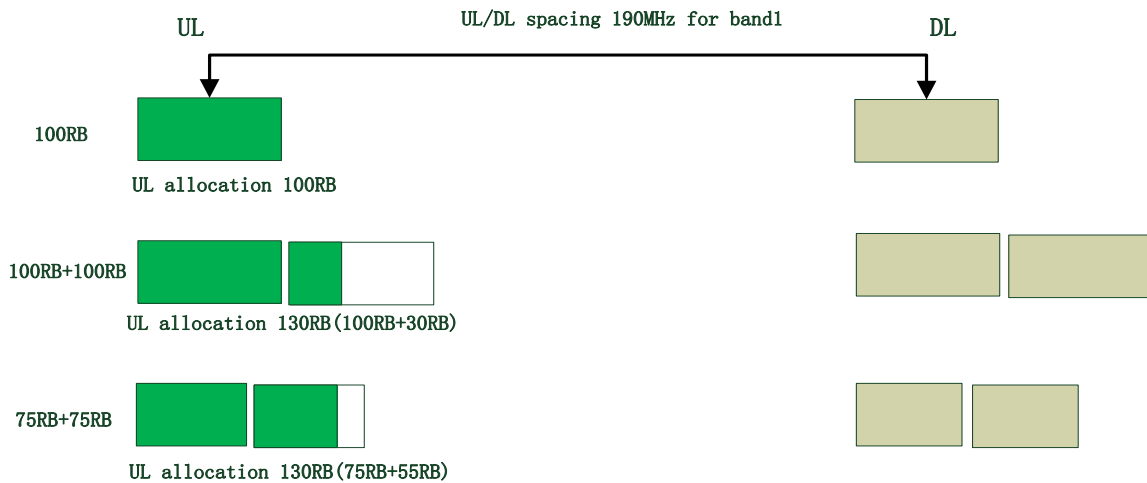


Figure 6.2.1 UL allocation for CA band 1 in TS36.101 when testing REFSSENS

From above figure 6.2.1, it can be seen that the UL allocation should be restricted to 130RBs when testing REFSSENS for CA band 1. It means when UL allocation is 130RB, the effect of UL signal on DL signal is so slight that can be ignored when testing REFSSENS, no matter 100RB+100RB combinations or 75RB+75RB combinations. For band 7, the UL/DL spacing is 120MHz according to TS 36.101, which is smaller than 190MHz for band 1. When testing REFSSENS in TS36.101 R8, the UL allocation is also restricted to 50RB rather than 100RB for 20MHz, so, for CA, it is preferred that keeping the UL allocation 50RB for reducing the interference on DL signal. In order to compare with CA band1, the following figure 6.2.2 is also given for CA band 3.

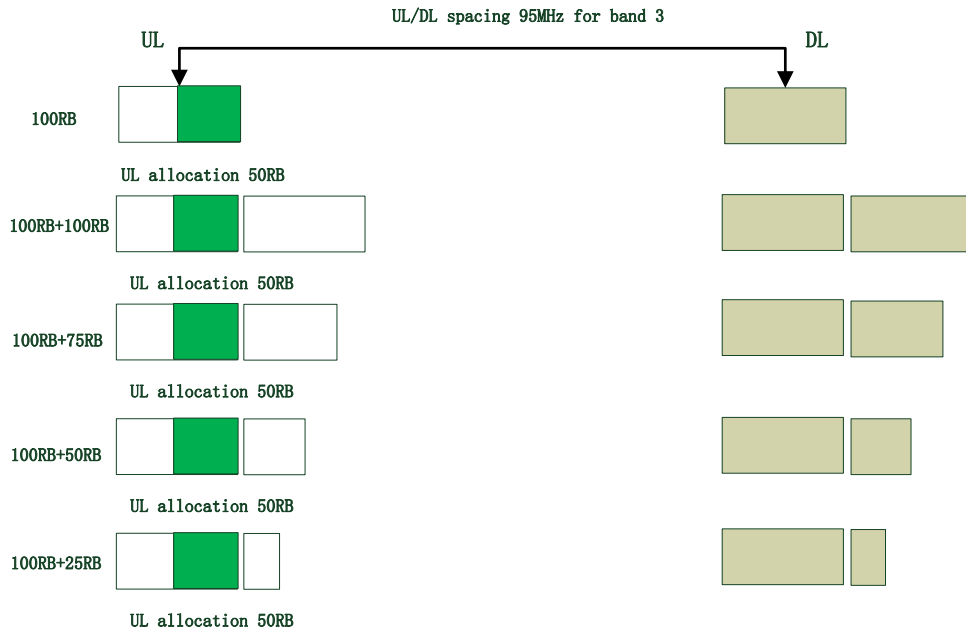


Figure 6.2.2 UL allocation for CA band 3 in TS 36.101 when testing REFSENS

Based on the above analysis, it is proposed that the uplink configuration for CA band 3 when testing REFSENS is shown in table 6.2.1.

In addition, in order to avoid the confusion of UL allocation in PCC and SCC, the Note 4 is added in the following table 6.2.1.

Table 6.2.1: Intra-band CA uplink configuration for reference sensitivity

CA Band / Aggregated channel bandwidth / NRB / Duplex mode											
CA Band	100RB+25RB		100RB+75RB		100RB+50RB		75RB+75RB		100RB+100RB		Duplex Mode
CA_3C	PCC	SCC	PCC	SCC	PCC	SCC	PCC	SCC	PCC	SCC	FDD
	50	0	50	0	50	0	n/a	n/a	50	0	
NOTE 1. The carrier centre frequency of SCC in the UL operating band is configured closer to the DL operating band. NOTE 2. The transmitted power over both PCC and SCC shall be set to P_{UMAX} as defined in clause 6.2.5 in TS36.101. NOTE 3. The UL resource blocks in both PCC and SCC shall be confined within the transmission bandwidth configuration for the channel bandwidth (Table 5.6-1 in TS36.101). NOTE 4. The UL resource blocks in PCC shall be located as close as possible to the downlink operating band, while the UL resource blocks in SCC shall be located as far as possible from the downlink operating band.											

6.2.2 In-band blocking

Section 7.6.1.1A in TS 36.101 specifies the in-band blocking requirements for CA. There are no special blocking requirements for Band 3 relative to the other bands, so no changes need to be made to the existing requirements for CA.

All that is required is to modify Table 7.6.1.1A-2 to indicate that the same requirement that is applied to Band 1 and Band 40 CA also applies to Band 3 CA, as shown in the following table.

Table 6.2.2-1: In-band blocking

CA operating band	Parameter	Unit	Case 1	Case 2
		$P_{\text{Interferer}}$	dBm	-56
	$F_{\text{Interferer}}$	MHz	$= -F_{\text{offset}} - F_{\text{offset, case 1}}$ & $= +F_{\text{offset}} + F_{\text{offset, case 1}}$	$\leq -F_{\text{offset}} - F_{\text{offset, case 2}}$ & $\geq +F_{\text{offset}} + F_{\text{offset, case 2}}$
CA 1C, CA 40C, CA 7C, CA 3C	$F_{\text{Interferer}}$ (Range)	MHz	(Note 2)	$F_{\text{DL, low}} - 15$ to $F_{\text{DL, high}} + 15$
<p>Note 1: For certain bands, the unwanted modulated interfering signal may not fall inside the UE receive band, but within the first 15 MHz below or above the UE receive band</p> <p>Note 2: For each carrier frequency the requirement is valid for two frequencies: a. the carrier frequency $-BW/2 - F_{\text{offset, case 1}}$ and b. the carrier frequency $+BW/2 + F_{\text{offset, case 1}}$</p> <p>Note 3: F_{offset} is the frequency offset from the center frequency of the adjacent CC being tested to the edge of aggregated channel bandwidth.</p> <p>Note 4: The $F_{\text{interferer}}$ (offset) is relative to the center frequency of the adjacent CC being tested and shall be further adjusted to $\lfloor F_{\text{interferer}} / (0.015 + 0.5) \rfloor 0.015 + 0.0075$ MHz to be offset from the sub-carrier raster.</p>				

6.2.3 Out-of-band blocking

Section 7.6.2.1A in TS 36.101 specifies the out-of-band blocking requirements for CA. There are no special blocking requirements for Band 3 relative to the other bands, so no changes need to be made to the existing requirements for CA.

All that is required is to modify Table 7.6.2.1A-2 to indicate that the same requirement that is applied to Band 1 and Band 40 CA also applies to Band 7 CA, as shown in the following table.

Table 6.2.3-1: Out of band blocking

CA operating band	Parameter	Units	Frequency		
			range 1	range 2	range 3
	$P_{\text{Interferer}}$	dBm	-44	-30	-15
CA 1C, CA 40C, CA 7C, CA 3C	$F_{\text{Interferer}}$ (CW)	MHz	$F_{\text{DL, low}} - 15$ to $F_{\text{DL, low}} - 60$ $F_{\text{DL, high}} + 15$ to $F_{\text{DL, high}} + 60$	$F_{\text{DL, low}} - 60$ to $F_{\text{DL, low}} - 85$ $F_{\text{DL, high}} + 60$ to $F_{\text{DL, high}} + 85$	$F_{\text{DL, low}} - 85$ to 1 MHz $F_{\text{DL, high}} + 85$ to +12750 MHz

7 E-UTRA RRM requirements for UE

A study of the existing technical specifications was conducted. The study concluded that no impact to UE RRM specifications is required.

8 E-UTRA RF requirements for BS

8.1 Transmitter characteristics

CA_3 could refer to use the requirements of BS Transmitter characteristics in current TS36.104.

8.2 Receiver characteristics

CA_3 could refer to use the requirements of BS Receiver characteristics in current TS36.104.

9 E-UTRA demodulation performance for BS and UE

A study of the UE and BS demodulation performance requirements in section 8 of TS 36.101 and TS 36.104 was conducted. Since the demodulation performance requirements in both specifications are band agnostic, and there is no specific UE and BS demodulation performance required for Band 3 contiguous CA, it is concluded that there is no change to the demodulation performance needed to introduce support for Band 3 contiguous CA.

10 Summary of required changes to E-UTRA specifications

10.1 Required changes to TS36.101

Expected changes in TS 36.101 are shown in Table 1.

Table 1 Expected changes in TS 36.101

Section	Requirement	Expected Changes in TS 36.101
5.5A	Operating bands for CA	A new row is expected to be added in Table 5.5A-1 to add CA_3 to the supported Intra band CA operating bands.
5.6A.1	Channel bandwidths per operating band for CA	A new row is expected to be added in Table 5.6A.1-1 for the supported E-UTRA bandwidths of intra-band contiguous B3 CA.
6.2.2A	UE Maximum Output Power for intra-band contiguous CA	A new row is expected to be added in Table 6.2.2A-1. It's proposed to evaluate the appropriate UE maximum output power requirement for intra-band contiguous B3 CA.
6.2.4A	UE Maximum Output Power with additional requirements for CA	It's proposed to evaluate the appropriate A-MPR requirement for intra-band contiguous Band 3 CA.
6.6.3.2A	Spurious emission band UE co-existence for CA	A new row is expected to be added in Table 6.6.3.2A-1 for spurious emission of intra-band contiguous Band 3 CA co-existence with other Band.
7.3.1A	Minimum requirements (QPSK) for CA	A new row is expected to be added in Table 7.3.1A-1 for intra-band CA uplink configuration for reference sensitivity.
7.6.1.1A	In-band blocking for intra-band contiguous CA	Appropriate changes are expected in Table 7.6.1.1A-2. It's proposed to evaluate whether the existing CA_1C in-band blocking requirement is valid for CA_3C or not.
7.6.2.1A	Out-of-band blocking for intra-band contiguous CA	Appropriate changes are expected in Table 7.6.2.1A-2. It's proposed to evaluate whether the existing CA_1C out-of-band blocking requirement is valid for CA_3C or not.

10.2 Required changes to TS36.104

Foreseen changes in TS 36.104 are shown in Table 2.

Table 2 Expected changes in TS 36.104

Section	Requirement	Expected Changes in TS 36.104
5.5	Operating bands	A new row is expected to be added in Table 5.5-2 to support Band 3 intra-band contiguous CA configuration.

10.3 Required changes to TS36.133

No foreseen changes in TS 36.133.

10.4 Required changes to TS36.141

Foreseen changes in TS 36.141 are shown in Table 3.

Table 3 Expected changes in TS 36.141

Section	Requirement	Expected Changes in TS 36.141
5.5	Operating bands	A new row is expected to be added in Table 5.5-2 to support Band 3 intra-band contiguous CA configuration.

10.5 Required changes to TS36.307

Foreseen changes in TS 36.307 are shown in Table 4.

Table 4 Expected changes in TS 36.307

Section	Requirement	Expected Changes in TS 36.307
X	Band 3 independent of release	Expect to add some changes to 36.307 Rel-10 and Rel-11 to provide the appropriate pointers to the Rel-12 spec to enable backdating of band 3 CA to Rel-10 and Rel-11.

10.6 Required changes to TS37.104

<Text to be added>

10.7 Required changes to TS37.141

<Text to be added>

11 Project plan

1. By end of RAN4 #64bis in Santa Rosa (Oct 2012): to provide and approve skeleton TR.
2. By end of RAN4 #67 in Fukuoka (May 2013): to reach agreement of the UE Tx and UE Rx requirements
3. By end of RAN4 #68 (Aug 2013): to clean up the rests of the Tx and Rx requirements
 - All the requirements are captured in Technical Report.
 - Technical report presented to RAN plenary #61 for information
4. By end of RAN4 #70 (Nov 2013): to have all the CRs agreed
 - All CRs to be presented in RAN #62 for approval.
 - Technical reports presented to RAN #62 for final approval.

Annex A: Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2012-10	RAN4#64 bis	R4-125575			Skeleton	N/A	0.0.1
2012-11	RAN4#65	R4-126522			Incorporated agreed text proposals in RAN4#64bis. Added Band 3 operating bands and bandwidths, expected changes, work plan, spectrum and regulation review, BS RF requirements, UE maximum output power, UE RRM requirements, reference sensitivity, blocking requirements, UE and BS demodulation performance based on [3]–[13]	0.0.1	0.1.0
2013-01	RAN4#66	R4-130417			Incorporated agreed text proposals in RAN4#65. Added Band 3 spectrum and regulation review based on [2], [14]	0.1.0	0.2.0
2013-04	RAN4#66-BIS	RP-130989			Incorporated agreed text proposals in RAN4#65. Added Band 3 background and task, UE maximum output power for modulation / channel bandwidth for CA based on [15], [16]	0.2.0	0.3.0