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Technical Report

3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
FDD RACH and AICH Performance Requirements
(Release 4)

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Contents

Foreword

This Technical Specification 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 is a Technical Report concerning the WG4 work item "Performance specification of demodulation of common channels". In this report FDD RACH and AICH receptions are considered.

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.

[1] 3G TS 25.104

[2] 3G TS 25.133

[3] 3G TS 25.141

[4] 3G TS 25.101

[5] 3G TS 34.121

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply.

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

3.2 Symbols

3.3 Abbreviations

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

4 General

Current TSG RAN WG4 specifications do not contain performance requirements for FDD RACH and AICH reception. However, it has been previously agreed in RAN4 that performance requirements and tests should be included. In this technical report, the principles to define the requirements for RACH and AICH is derived. These performance requirements are related to the WG4 work item "Performance specification of demodulation of common channels" (this work item has not yet been approved by RAN).

5 RACH

This section describes the principle to define the performance requirements for RACH reception.

5.1 Simulation assumptions for RACH performance test

The following propagation conditions are used:

- Static propagation condition with Additive White Gaussian Noise (AWGN) as defined in Annex D.1 in TS 25.141. No fading or multi-path exist for this propagation model.
- Multi-path fading propagation condition Case 3 as defined in Annex D.2 in TS 25.141.

The simulations are divided into two parts: preamble detection and RACH message reception. Common parameters to both parts are listed in table 5.1 below.

Table 5.1. Common parameters to both parts.

Number of diversity antennas	2
Samples per chip	1
Pulse shaping filter	No
Propagation condition	Static / Case 3 fading
Number of signatures	1

5.1.1 Preamble Detection

Preamble detection is characterized by two parameters: probability of false alarm (Pfa) and probability of detection (Pd). Pfa is defined as a conditional probability of erroneous detection of the preamble when input is only noise (+interference). Pd is defined as conditional probability of detection of the preamble when the signal is present. Pfa is required to be 10^{-3} or smaller. Only one signature is used and the number is known by the detector.

Pfa and Pd refer to the overall probabilities.

5.1.2 RACH message reception

In simulation of RACH message part, perfect delay and channel estimates are used. Performance measure is block error rate (BLER). Summary of simulation parameters are in table 5.2.

Table 5.2. Simulation parameters for RACH message reception.

CRC		16 bits
Channel coding		Rate ½ convolutional encoding
Power ratio of preamble and message		0 dB
Transport block size in bits		168, 360
Power ratio of control and data channel	Block size: 168	-2.69 dB
	Block size: 360	-3.52 dB
Spreading factor	Block size: 168	64, 128
	Block size: 360	32, 64
Message length		10 ms, 20 ms
Rate Matching		Repetition
Eb/No		Total transmitted energy per user bit divided by noise variance.

5.2 Presentation of simulation results

5.2.1 Preamble detection

Simulation results of probability of detection in static propagation condition is depicted in table 5.3 (Tdocs R4-000559 and R4-000702 presented in WG4 #13).

Table 5.3. Preamble detection in static propagation condition. Required E_c/N_0 [dB] for P_d = 0.99 and 0.999.

	P_d = 0.99	P_d = 0.999
R4-000559 (Nokia)	-24.77 dB	-24.0 dB
R4-000702 (Ericsson)	-24.7 dB	-23.8 dB
R4-010111 (NTT DoCoMo)	-24.62	-23.62
R4-010177 (Motorola)	-24.0	-24.9
Average	-24.5	24.1

Simulation results of probability of detection in multipath fading Case 3 is depicted in table 5.4.

Table 5.4. Preamble detection in Rayleigh fading propagation condition Case 3. Required E_c/N_0 [dB] for P_d = 0.99 and 0.999.

	P_d = 0.99	P_d = 0.999
R4-000894 (Nokia)	-21.6 dB	-19.5 dB
R4-010177 (Motorola)	-19.5 dB	-17.3 dB
Average	-20.6 dB	-18.4 dB

5.2.2 RACH Message Reception with 10 ms TTI

Required Eb/No for BLER=10^{-1} and 10^{-2} in static propagation condition is depicted in table 5.5.

Table 5.5. RACH message reception in static propagation condition. Required E_b/N_0 [dB] for BLER=10^{-1} and 10^{-2}.

	TB size = 168 bits		TB size = 360 bits	
	BLER=10^{-1}	BLER=10^{-2}	BLER=10^{-1}	BLER=10^{-2}
R4-000559 (Nokia)	1.14 dB	2.05 dB	0.92 dB	1.78 dB
R4-000702 (Ericsson)	1.2 dB	2.05 dB	0.95 dB	1.75 dB
Average	1.17 dB	2.05 dB	0.94 dB	1.77 dB

Required Eb/No for BLER=10^{-1} and 10^{-2} in multipath fading Case 3 is depicted in table 5.6.

Table 5.6. RACH message reception in multipath fading Case3. Required E_b/N_0 [dB] for BLER=10^{-1} and 10^{-2}.

	TB size = 168 bits		TB size = 360 bits	
	BLER=10^{-1}	BLER=10^{-2}	BLER=10^{-1}	BLER=10^{-2}
Xxxxxx				
Xxxxxx				
Xxxxxx				

5.2.3 RACH Message Reception with 20 ms TTI

In actual tests, it was decided to use 20 ms TTI only to reduce the number of measurements.

Required Eb/No for BLER=10^{-1} and 10^{-2} in static propagation condition is depicted in table 5.7 for 20 ms TTI.

Table 5.7. RACH message reception in static propagation condition. Required E_b/N_0 [dB] for BLER=10^{-1} and 10^{-2}.

	TB size = 168 bits		TB size = 360 bits	
	BLER=10^{-1}	BLER=10^{-2}	BLER=10^{-1}	BLER=10^{-2}
R4-000894 (Nokia)	1.12	2.05	0.9	1.8
R4-000953 (NTT DoCoMo)	1.1	2.03	0.85	1.77
R4-000909 (Ericsson)	1.1	2.0	0.9	1.7
Average	1.1 dB	2.0 dB	0.9 dB	1.8 dB

Required Eb/No for BLER=10^{-1} and 10^{-2} in multipath fading Case 3 is depicted in table 5.8 for 20 ms TTI.

Table 5.8. RACH message reception in multipath fading Case3. Required E_b/N_0 [dB] for BLER=10^{-1} and 10^{-2}.

	TB size = 168 bits		TB size = 360 bits	
	BLER=10^{-1}	BLER=10^{-2}	BLER=10^{-1}	BLER=10^{-2}
R4-000894 (Nokia)	1.2	2.3	1.3	2.4
R4-000953 (NTT DoCoMo)	1.4	2.48	1.22	2.21
R4-000909 (Ericsson)	1.5	2.6	1.3	2.4
Average	1.4	2.5	1.3	2.3

5.3 Procedure for testing

Test signal generator sends a preamble followed by the actual RACH message. This pattern is repeated (see figure 5.1). The receiver tries to detect the preamble and the message. The block error rate is calculated.

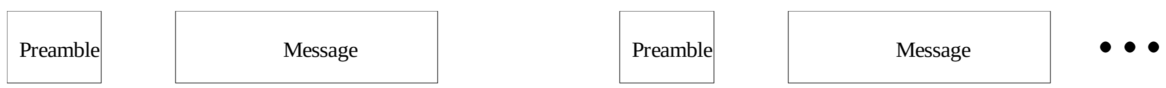

Figure 5.1.

5.4 Open Items

- The use of more than 1 signature in RACH preamble detection

5.5 Implementation margins

TBD

6 AICH

So far the AICH related issues are based on the WG4 Tdoc R4-000549.

6.1 Simulation assumptions for AICH performance tests

Simple static propagation condition with white Gaussian noise (AWGN) as defined in Annex B.2.1 in TS 25.101 is proposed to be simulated. This propagation condition has one tap with constant amplitude. Geometry parameter is proposed to be –1 dB as is the case with other tests in static propagation conditions.

It is also suggested to perform simulations in fading channel (Case 3 as specified in TS 25.101). However it is still for further studies to find out whether it is possible to have a final test measurement in fading channel or not. Geometry parameter is proposed to be –3 dB for this simulation.

The target of AICH performance test is to verify UE's ability to detect AI on AICH. For this purpose the probability of false alarm (Pfa) and probability of correct detection (Pd) of AI signature are introduced. Pfa is defined as a conditional probability of detection of AI signature given that an AI signature was not transmitted. Pd is defined as a conditional probability of correct detection of AI signature given that the AI signature is transmitted.

The proposal is to simulate AICH performance with 3 different values for Pfa: 1%, 5% and 10%.

Other downlink channels which are present in the simulations are P-CPICH, PCCPCH, SCH, PICH, OCNS and their powers are as specified in Annex C.3.2 of TS 25.101. In addition some new AICH related parameters are introduced to complete simulation assumptions. They are defined below.

AICH Power Offset: The UE is informed about the relative transmit power of the AICH (measured as the power per transmitted acquisition indicator) compared to the primary CPICH transmit power by the higher layers [25.214]. Range of possible values for relative power difference of CPICH and AICH is from –10 dB to 5 dB with 1 dB granularity. [25.331]. We propose that this parameter is used as a variable over its allowed range in simulations.

Number of other transmitted Acquisition Indicators: AICH may consist of up to 16 Acquisition Indicators. One AI is given for a UE under test and 15 AIs are allocated to other users. Thus the parameter in question equals 15 (consider this as the worst case scenario).

It is considered that Acquisition Indicator signature, which is used for a given UE under study in simulations will not have any effect on simulations results. Furthermore UE shall choose randomly the used AI signature so there is no way to force UE to use any particular signature in the AICH test. This is essential, to ensure that no implementation is required for testing purposes only.

There are also a couple of parameters related to AICH timing. However they are not considered to be important from AICH detection performance point of view. Thus these parameters are not defined.

All other parameters which were not listed here but are relevant for AICH performance tests should have the value as for the other performance tests in TS 25.101. As an example, such parameters are channel estimation (ideal) and samples per chip (1).

6.2 Items for discussion

Probability of false alarm Pfa: It is not clear what would be acceptable value in networks. It would be beneficial to use such values in tests which has background in real networks. If Pfa is not correctly set following behavior of the system is concluded:

When a UE is sending RACH preambles and in conjunction makes an erroneous decision assuming that network had responded with the positive AI, the UE will proceed the sequence and send the RACH message. Due to false alarm, it is likely that network will not receive correctly the RACH message since it was not even able to receive the RACH preamble correctly. This will reset the procedure and the UE has to start again RACH procedure from beginning.

In other words, false alarm will cause delays in connection set-up time. From a system point of view, there is no harm due to one extra RACH message since the power of it is under reception level thus will not cause too much interference to the system. Values for Pfa, which were proposed to be simulated, are 1%, 5% and 10 %.

Probability of correct detection Pd: The proper value to be used in networks is not clear. It would be beneficial to use such values in tests that have some background in real networks. If Pd is not correctly set following impacts can be seen.

If a network replies with positive or negative AI and UE fails to detect it, UE will send a new RACH preamble with an increased power level. Then the network replies again with AICH and hopefully this time the UE is able to detect correctly the AI on AICH. Assuming that UE fails to detect AICH only once this causes a delay of one access slot in the sub-channel group used, which equals 12 normal access slots and which corresponds to 16 ms delay in a connection set-up. It needs to bear in mind that other delays will occur as well when setting up RRC connection.

From a network point of view this situation means one extra preamble received with slightly increased power. No values are proposed for Pd in this document. Based on the simulation results further discussion can be taken what should be the correct requirement level.

Threshold in detection algorithm: Each manufacture has to use a certain threshold (either fixed or more advanced) valid for their detection algorithm. As the detection of AICH has not been specified in 3GPP, this may cause a problem of getting agreement of the possible values for Pd and Pfa. In general, it can be said that requiring lower Pfa values results in lower Pd. Also in AWGN channel it is easier to achieve lower Pfa values for a given Pd value compared to a case in a fading channel. As a way forward it is proposed that each manufacture proposes a required AICH Power Offset value for a given Pd which they can achieve while also Pfa requirement is met. Also a system background argumentation is welcomed when discussing this further.

7 Changes with respect to Release 99

7.1 Changes in 25.101

This section describes the necessary changes to UE conformance testing.

7.2 Changes in 34.121

This section describes the necessary changes to UE conformance testing.

7.3 Changes in 25.104

This section describes the necessary changes to base station conformance testing.

7.4 Changes in 25.141

This section describes the necessary changes to base station conformance testing.

8 Impacts to other WGs

8.1 WG1

8.2 WG2

8.3 WG3

8.4 T1/RS

9 Backward Compatibility

History

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Annex <X>:
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Change history							
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