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Presentation of Specification to TSG or WG

Presentation to:	**TSG-RAN Meeting #13**
Agenda item:	**9.1.2 BS Classification**
Document for presentation:	**TR 25.951 Version 1.1.0**
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Abstract of document:
This TR is used to report the progress on FDD Base Station classification WI. This TR will define the criteria used in BS classification and describe the assumed RF system scenarios and the derivation of new radio requirements. Impact on other RAN working groups and backward compatibility are also considered.

Changes since last presentation to TSG-RAN Meeting #12:
Update based on TSG RAN WG4 meeting#17 approved input documents R4-010597 and R4-010598

Outstanding Issues:
Simulation results, or other justifications, are needed to determine missing parameters.

Contentious Issues:
None

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Technical Report

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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 on Release 2000 work item “FDD Base Station Classification”.

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 TR 25.942

[5] UMTS 30.03

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 have been done according to the requirements for the macrocell base stations (NodeBs). For the UTRA evolution requirement specifications for other types of base stations are needed as well to take into account different use scenarios and radio environments. In this technical report, base station classification is described and requirements for each base station class are derived.

5 System scenarios

This section describes the system scenarios for UTRA operation that are considered when defining base station classes. It also includes typical radio parameters that are used to derive requirements.

5.1 Indoor Environment

5.1.1 Path Loss Model

The indoor path loss model expressed in dB is in the following form, which is derived from the COST 231 indoor model:

$$L = 37 + 20\ \mathrm{Log}_{10}(R) + \Sigma\ k_{wi}\ L_{wi} + 18.3\ n^{((n+2)/(n+1)-0.46)}$$

where:

R transmitter-receiver separation given in metres

k_{wi} number of penetrated walls of type i

L_{wi} loss of wall type i

n number of penetrated floors

Two types of internal walls are considered. Light internal walls with a loss factor of 3.4 dB and regular internal walls with a loss factor of 6.9 dB.

If internal walls are not modelled individually, the indoor path loss model is represented by the following formula:

$$L = 37 + 30\ \mathrm{Log10}(R) + 18.3\ n\ ((n+2)/(n+1)-0.46)$$

where:

R transmitter-receiver separation given in metres;

n number of penetrated floors

Slow fading deviation in pico environment is assumed to be 6 dB.

5.2 Mixed Indoor – Outdoor Environment

5.2.1 Propagation Model

Distance attenuation inside a building is a pico cell model as defined in Chapter 5.1.1. In outdoors UMTS30.03 model is used [5].

Attenuation from outdoors to indoors is sketched in Figure 5.1 below. In figure star denotes receiving object and circle transmitting object. Receivers are projected to virtual positions. Attenuation is calculated using micro propagation model between transmitter and each virtual position. Indoor attenuation is calculated between virtual transmitters and the receiver. Finally, lowest pathloss is selected for further calculations. Only one floor is considered.

The total pathloss between outdoor transmitter and indoor receiver is calculated as

$$L = L_{micro} + L_{OW} + \Sigma\ k_{wi}\ L_{wi} + a * R\ ,$$

where:

L_{micro} Micro cell pathloss according UMTS30.03 Outdoor to Indoor and Pedestrian Test Environment pathloss model

LOW outdoor wall penetration loss [dB]

R virtual transmitter-receiver separation given in metres;

kwi number of penetrated walls of type i;

Lwi loss of wall type i;

a = 0.8 attenuation [dB/m]

Slow fading deviation in mixed pico-micro environment shall be 6 dB.

Propagation from indoors to outdoors would be symmetrical with above models.

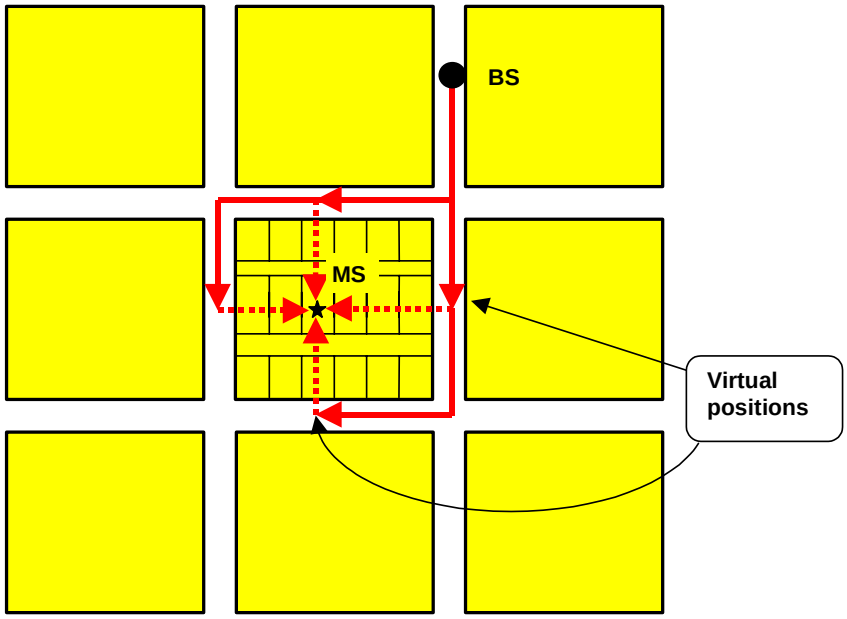

Figure 5.1: Simulation scenario and propagation model.

Parameters related to propagation models are summarised in Table 5.1.

Table 5.1: Parameters related to mixed indoor - outdoor propagation model

Parameter	value
Inside wall loss	6.9 dB
Outside wall loss	10 dB
Slow fading deviation in indoors	6 dB
Slow fading deviation in outdoors	6 dB
Building size	110 x 110 meters
Street size	110 x 15 meters
Room size	22 x 25 meters
Number of rooms	5 rooms in 4 rows
Corridor size	110 x 5 meters
Number of corridors	2
Size of entrance point	5 meters
Number of base stations	4 .. 6
BS coordinates	tba

5.3 Minimum coupling loss (MCL)

Minimum Coupling Loss (MCL) is defined as the minimum distance loss including antenna gain measured between antenna connectors.

5.3.1 MCL for Local Area scenario

The minimum coupling loss between UEs is independent of the scenario, therefore the same minimum coupling loss is assumed for all environments.
Local area BSs are usually mounted under the ceiling, on wall or some other exposed position. In [4] chapter 4.1.1.2 a minimal separation of 2 metres between UE and indoor BS is assumed. Free space path loss is defined in [4] as:

$$\text{Path loss [dB]} = 38.25 + 20 \log10(d\ [m])$$

Taking into account 0 dBi antenna gain for Local area BS and UE and a body loss of 1 dB at the terminal, a MCL of 45.27 dB is obtained. The additional 2 dB cable loss at the BS as proposed in TR 25.942 is not considered.

The assumed MCL values are summarised in table 5.2.

Table 5.2: Minimum Coupling Losses

	MCL
MS ↔ MS	40 dB
Local area BS ↔ MS	45 dB
Local area BS ↔ Local area BS	45 dB

5.4 FDD Base Station Classification for microcells

5.4.1 Background

A new FDD Base Station Classification is proposed in 3G. In paragraph 6.1.1, the Minimum Coupling Loss between the BS and the UE is used as criteria to classify the BS's in Wide Area Base Station (coupling losses $\geq$ 53dB) and Local Area Base Stations. (coupling losses < 53dB). The classical macro and micro base stations would be included in the first group (Wide Area) and the pico base station would be equivalent to the Local Area new class.

The calculations presented in this section indicate that at least one additional base station class in needed between macro and pico classes.

5.4.2 Introduction

This section presents some indications for the following requirements: blocking in-band, Adjacent Channel Selectivity (ACS), Intermodulation Characteristics and Reference Sensitivity Level for possible micro Base Station (BS) class. The calculations have been carried out based on the Minimum Coupling Losses (MCL) for micro and macrocell scenario stated in TR 25.942. The outcome of this brief study should be the input to discuss whether the classification of the base station should split them into macro, micro and pico or it is feasible to have only two classes: wide area and local area base stations. Further investigations are needed to obtain the figures that are still missing in this report and in some cases, system simulation shall be done to find out the likelihood of the different scenarios and specially, how likely the worst-case scenarios are.

5.4.3 Results

5.4.3.1 Blocking inband

The blocking calculations have been performed taking the output power requirements stated in TS 25.101, the MCL required for macro and microcell scenarios in TR 25.942 and the maximum inband blocking interferer allowed in TS 25.104. All these figures are collected in table1.

Table 1. Requirements used for blocking calculations

Requirement	
MS output power	(class 3) +24dBm +1/-3dB
	(class 4) +21dBm ±2dB
MCL	(macrocells) 70dB
	(microcells) 53dB
Inband blocking requirement	interfering signal level –40dBm
	(6dB sensitivity degradation)
	equivalent interferer level –100.3dBm

Taking into account the maximum MS output powers for both class 3 and 4, and the MCL for macro and microcell scenarios, the corresponding values of sensitivity degradation in terms of receiver blocking are listed in table 2. A linear approximation is used to estimate the sensitivity degradation at the BS FDD receiver and the mobile is supposed to be an uncoordinated one connected to a macro cell and transmitting at full power.

Table 2. Sensitivity degradation due to blocking for MCL=70dB and MCL=53dB

MCL	worst-case interferer level at antenna	equivalent interferer level	Sensitivity degradation
(macrocell) 70dB	25dBm –70dB = -45dBm	-105,3dBm	3dB
(microcell) 53dB	25dBm – 53dB = -28dBm	-88,3dBm	17dB

The equivalent interferer level for the macrocell MCL case is –105,3dBm, approximately the noise floor at the BS antenna. It means that the sensitivity degradation is 3dB. In the second case, when microcell MCL is used, the equivalent interferer level is –88,3dBm and this value corresponds to approximately 17dB.

To have the same level of sensitivity degradation as for the macrocell MCL case when the MCL value for microcells is used, the blocking requirement shall be hardened by 17dB: from (–40dBm) to (–23dBm).

Table 3. Proposal for the inband blocking requirement

Inband Blocking	
MCL	53dB
Inband blocking requirement	interfering signal level –23dBm
	(6dB sensitivity degradation)

5.4.3.2 Adjacent Channel Selectivity (ACS)

Based on the figures collected in section 2.1 for blocking inband, the requirement for the ACS shall be also hardened by 17dB. The current requirement in TS 25.104 specifies a wanted signal of –115dBm (6dB sensitivity degradation) and an interfering signal of level (–52dBm). Therefore, the interfering signal in the ACS requirement should be changed from –52dBm to –35dBm for micro class (keeping the same sensitivity degradation 6dB).

5.4.3.3 Intermodulation Characteristics

Based also on the figures collected in section 2.1 for blocking inband, the requirement for the Intermodulation Characteristics shall be also hardened by 17dB. The current requirement in TS 25.104 specifies a wanted signal of –115dBm (6dB sensitivity degradation) and an interfering signal of level (–48dBm). Therefore, the interfering signal in the Intermodulation Characteristics requirement should be changed from –48dBm to –31dBm for micro class (keeping the same sensitivity degradation, 6dB).

A specific scenario needs further investigation: considering the case of a multi-operator scenario with operator1-macro and operator2-micro, two uncoordinated UE's of the operator1 can be operating in close proximity to the micro BS, transmitting both at full power. These two UE's could produce IM3 within the RX band of the BS micro, and cause the blocking of the receiver.

5.4.3.4 Reference Sensitivity Level

The difference between the average coupling losses in macro and microcell environments is assumed to be the same as between the values of MCL for macro and microcells scenarios (17dB). The expected UE adjacent channel power is –50dBm according to TS 25.101. Based on this figure, the noise floor at the BS FDD antenna will be, when the MCL=53dB, –102dBm, 6dB higher than specified. Due to this fact, the proposed relaxation of the Reference Sensitivity level would be in the order of 10dB.

NOTE: In TS 25.101, the requirements for the Adjacent Channel Leakage power Ratio and the Spurious Emission from the MS TX are specified in such a way that it is not easy to know which is the Spurious Emission requirement. This issue should be pointed out.

5.4.3.5 Adjacent Channel Leakage Ratio (ACLR)

It needs further investigations.

5.4.4 Summary

Based on the results presented here, a micro class is necessary.

For the microcell scenario (BS to UE coupling losses $\geq$53dB) the blocking requirement, intermodulation characteristics and the ACS should be hardened by 17dB. Additionally, the Reference Sensitivity Level could be relaxed.

6 Base station classes

This section describes how the base station classes are defined.

6.1 Base station class criteria

Different sets of requirements are derived from calculations based on Minimum Coupling Loss between BS and UE. Each set of requirements corresponds to a base station class is used as criteria for classification. Two classes are defined: Wide Area BS class and Local Area BS class.

Wide Area BS class assumes relatively high MCL, as is typically found in outdoor macro and outdoor micro environments, where the BS antennas are located in masts, roof tops or high above street level. Existing requirements are used, as they are in [1], for the Wide Area BS class.

Local Area BS class assumes relatively low MCL, as is typically found indoors (offices, subway stations etc) where antennas are located on the ceilings or walls or possibly built-in in the BS on the wall. Low-CL can also be found outdoors on hot spot areas like market place, high street or railway station. New requirements, as defined in this TR, are set for the Local Area BS class.

6.1.1 Text proposal for 4.2 Base station classes

The requirements in this specification apply to both Wide Area Base Stations and Local Area Base Stations, unless otherwise stated.

Wide Area Base Stations are characterised by requirements based on BS to UE coupling losses equal to or higher than 53dB.

Local Area Base Stations are characterised by requirements based on BS to UE coupling losses less than 53dB

7 Changes with respect to Release 99

7.1 Changes in 25.104

This section describes the considered changes to requirements on BS minimum RF characteristics, with respect to Release 1999 requirements in TS25.104.

7.1.1 Frequency error

7.1.1.1 New requirement

In the present system the mobile has to be designed to work with a Doppler shift caused by speeds up to 250 km/h at 2100 MHz. This corresponds to a frequency offset of

[Doppler shift, Hz] = [UE velocity, m/s] * [Carrier frequency, Hz] / [speed of light, m/s]

= (250 * 1000/3600) * 2.1 * 10^9 / (3 *10^8) Hz

≈ 486 Hz

At present, the BS requirement is 0.05 ppm, corresponding to 105 Hz at 2100 MHz.

In this case, the mobile must be able to successfully decode signals with offset of

[present UE decode offset, Hz] = [frequency error, Hz] + [max. Doppler shift, Hz]

= 486 Hz + 105 Hz

= 591 Hz

The frequency error requirement for local area BS class is proposed to be relaxed to 0.1ppm.

[frequency error, ppm] = 0.1 ppm

This corresponds to a maximum UE speed of 155km/h.

[max. new Doppler shift] = [present UE decode offset] - [frequency error, Hz]

= 591 Hz – 210 Hz

= 301 Hz

[UE velocity, km/h] = [speed of light, km/h] * [Doppler shift, Hz] / [Carrier frequency, Hz]

= (3 *10^8 * 301 * 3600) / (2.1 * 10^9 * 1000)

= 155 km/h

7.1.1.2 Text proposal for 6.3.1 Minimum requirement

The modulated carrier frequency is observed over a period of one power control group (timeslot).

Table 6.n: Frequency error minimum requirement

BS class	accuracy
wide area BS	±0.05 ppm
local area BS	±0.1 ppm

7.1.2 Adjacent Channel Leakage power Ratio (ACLR)

7.1.3 Reference sensitivity level

7.1.4 Spectrum emission mask

7.1.5 Adjacent Channel Selectivity (ACS)

7.1.6 Blocking characteristics

7.1.7 Intermodulation characteristics

7.1.8 Demodulation in static propagation conditions

7.1.9 Demodulation of DCH in multipath fading conditions

7.1.10 Demodulation of DCH in moving propagation conditions

7.1.11 Demodulation of DCH in birth/death propagation conditions

7.2 Changes in 25.133

This section describes the considered changes to requirements on UTRAN measurements, with respect to Release 1999 requirements in TS25.133.

7.3 Changes in 25.141

This section describes the considered changes to base station conformance testing, with respect to Release 1999 requirements in TS25.141.

8 Impacts to other WGs

8.1 WG1

8.2 WG2

8.3 WG3

9 Backward Compatibility

History

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Date	**Version**	**Comment**
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06 July 2001	1.1.0	Update based on TSG RAN WG4 meeting#17 approved input documents R4-010597 and R4-010598

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