Presentation of Specification to TSG or WG

Presentation to: TSG RAN Meeting #23

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Abstract of document:

During TSG RAN Meeting #19, a new study item called “Low Output Powers for General Purpose FDD BS” was created (the study item description is in Tdoc RP-030198: "Low output power FDD Base Station"). The purpose of the TR 25.807 is to record all the information related to this study item, and trace its history and status

Changes since last presentation to TSG RAN Meeting #22:

Two possible solutions are descibed in the TR:

Solution#1 requires the introduction of a new IE to TS 25.433.

Solution#2 is O&M based and makes Base Stations provide Low Output Powers (LOP). This solution is the one agreed by RAN3, as it has a minimum impact on the current specifications, i.e. no changes to the current specifications are needed.
R3-040128 introduced a clarification to understand the use of both uplink and downlink gains of the distribution system connected after the Base Station.

Outstanding Issues:

No outstanding issues, level of completion is 100%

Contentious Issues:

No changes to current specifications needed

3GPP TR 25.807 V1.0.0 (2004-03)

Technical Report

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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

During TSG RAN plenary meeting #19, a new study item called "Low Output Powers for General Purpose FDD BS" was created (the study item description is in [1]). The purpose of the present document is to record all the information related to this study item, and trace its history and status.

1 Scope

Some companies have shown their interest in the feasibility of a low output power FDD base station, because it would offer the following advantages:

1. It would not be necessary to use an expensive high power amplifier when a distribution system is connected after the node B. Distribution systems require low input powers. If a high power amplifier is used, the BS output signal must be attenuated before it is fed into the distribution system, thus the high power amplifier is not needed at all. Power consumption would be reduced, and this would also have positive environmental effects.

2. It would facilitate the sharing of infrastructures among operators, especially in locations where it is difficult to find sites, or where operators are forced by regulators to share infrastructures. A common distribution system could be connected to the low output power BS's from each operator.

3. It would increase the flexibility in radio network deployment, because it would allow the placement of one or several base stations in a centralised position with separate RF power amplifiers distributed closer to the subscriber positions. This would also reduce network interference.

A study item called "Low Output Powers for General Purpose FDD BSs" was created during TSG RAN plenary meeting #19, in order to study the feasibility of the low output power FDD base station. The main objectives of this study item are:

1. Identify the range of output powers to be considered. This SI must assess what must be understood as low output power.

2. Once the range of output powers to be considered has been delimited, it must be studied how the RAN specifications can be changed in order to allow that range of output powers.

This technical report will collect the results of the study item. It must be clearly understood that the purpose of this SI is not to create a new interface within the base station. Its purpose is just to enlarge the output power range of the current base station, in order to allow lower output power values. It must also be stated that a BS doesn't have necessarily to comply with the whole allowed output power range. A BS will only fulfil a subrange of the allowed output power range. The manufacturer must declare the maximum output power of the base station, and the power range supported by it. The only requirements for the BS output power range are those imposed by the dynamic range requirements in [2].

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] Tdoc RP-030198: "Low output power FDD Base Station".

[2] 3GPP TS 25.104 v6.1.0: "BS Radio transmission and reception (FDD)".

[3] Tdoc R4-030744, "New approach to low output power", Telefonica

[4] Tdoc R3-040128, "Clarification on the use of the downlink and uplink gain", Telefonica

[5] Tdoc R3-040137, "Solutions for LOP", Telefonica

3 Abbreviations

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

3G	Third Generation
3GPP	Third Generation Partnership Project
BS	Base Station
CPICH	Common Pilot Channel
DL	Downlink
DPCH	Dedicated Physical Channel
IE	Information Element
FDD	Frequency Division Duplex
NBAP	Node B Application Part
P-CCPCH	Primary-Common Control Physical Channel
Pmax	Maximum Output Power
PRACH	Physical Random Access Channel
RAN	Radio Access Network
RF	Radio Frequency
RNC	Radio Network Controller
SI	Study Item
TR	Technical Report
TSG	Technical Specification Group
UE	User Equipment
UL	Uplink
WG	Working Group

4 Definition of low output power

Maximum output power, Pmax, of the base station is the mean power level per carrier measured at the antenna connector in specified reference conditions, as defined in [2], section 6.2.1. The lowest maximum output power that can be set for a base station with the current specifications is 0 dBm. The individual channel codes in a carrier are assigned portions of the carrier maximum output power. The lowest output power that can be allocated to an individual channel code with the current specifications is –15 dBm (for the P-CCPCH) and –10 dBm (for all channels but for P-CCPCH).

After consulting several distributed systems manufacturers, they have quoted –20 to +10 dBm as a useful range for the "maximum power" of the input signal to their equipments. Therefore, this range of output powers was initially taken as a definition of "low output power". If Pmax equals –20 dBm, this implies that an individual DPCH code can be radiated with down to –48 dBm (the dynamic power range for a DPCH, according to [2], section 6.4.2, is –3 dB to –28 dB). Some companies have argued that this power level could be below or near the noise level. Another company has argued that there are serious implementation problems if the codes are to be transmitted with powers of down to –48dBm.

Because of these problems, the definition of low output power has been relaxed to 0 dBm. Let's analyse what requirements this imposes on the power of the individual codes.

According to [2], section 6.4.2, the power control dynamic range for a code channel is –3 dB to –28 dB. This implies that the power of a DPCH can range between –3 dBm and –28 dBm (assuming that the "maximum output power" of the carrier has been set to 0 dBm). According to [2], section 6.4.3, the total power dynamic range for a base station is 0 dB to –18 dB. This implies that the power of the CPICH can range between –3 dBm (this is the maximum allowed power for a single code channel) and –18 dBm (assuming a Pmax of 0 dBm). Finally, the power range for the P-CCPCH must be set. The current specifications allow a P-CCPCH power of down to –15 dBm. We think that this is more than enough for a realistic situation, because it allows transmitting the P-CCPCH with at least –15 dB relative to the maximum output power.

According to the previous reasoning, the next table summarises what must be understood as low output power:

Table 4.1: Definition of low output power

Power definition	Power range or value
Maximum output power (Pmax)	0 dBm
DPCH power	-3 dBm to –28 dBm
CPICH power	-3 dBm to –18 dBm
P-CCPCH power	-3 dBm to –15 dBm

Only the DPCH and CPICH power ranges are not allowed by the current specifications. So this study item must analyse what must be changed in order to allow these power ranges.

5 Solutions for getting low output power

5.1 Solution #1

The first solution for getting low output power is described in Annex B. As it can be seen in this annex, this solution implies only one change to the current specifications, which is the following:

- TS 25.433 (NBAP protocol specification). A new IE must be created, containing the following information:
  - External_Gain_DL: This is the DL gain of the external distribution system. This parameter also includes the losses of the coupling system between the low output power base station and the distribution system.
  - External_Gain_UL: This is the UL gain of the external distribution system. It comprises all the way from the distribution system remote antenna connector and the low output power base station antenna connector.

The main advantages of this solution are the following:

- It minimises the changes to the specifications.
- There are not backwards compatibility problems with the node B and/or the UE.

From the TSG RAN WG4 point of view, this is a feasible solution for getting low output power, but due to the fact that all the changes that this solution implies affect to RAN specifications under TSG RAN WG3 control, the feasibility of this solution is conditioned to TSG RAN WG3 review.

5.2 Solution #2

Another way of getting low output power would be to introduce these two parameters, as described in Solution #1, DL and UL gain of the distribution system, into the O&M system.

By doing this, the base station would be aware of the presence of this equipment and could therefore adjust its output power, so as to provide the expected power at the antenna port, that is, at the Uu interface.

To provide this information, two possibilities could be foreseen:

a) These two parameters could be stored into the local database of the base station.

b) It could also be possible to include these parameters in the network manager database, though this seems to be indeed more complex, because this information would have to be sent to the base station via the itf-N interface.

Comparing both alternatives, option a) seems to be much simpler than option b), as it would minimise the impact to the specifications. Besides, it would not be needed to involve TSG SA WG5, responsible for the standardisation of the itf-N interface.Therefore, option a) would be the one chosen when referring to Solution #2.

6 Conclusions

TSG RAN WG3 has reviewed solution #1 and concluded that, although this could be a feasible solution, it does not seem to be the optimal one.

Therefore, a second solution, solution #2, was proposed trying to minimize the changes to the current specifications.

As option a) of solution #2 seems to be the simplest solution, TSG RAN WG3 agrees to adopt this alternative to provide low output power.

Annex A: Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**

Annex B: Description of solution #1 for getting low output power

The first solution that one can think of for getting low output power is to change the Iub signalling information elements, so that the RNC can order the node B to transmit the desired power. So this was the first approach taken to obtain low output power. But this solution leads to several problems:

- The changes in the Iub signalling affect not only to the node B, but to the UE [3]. The CPICH power value sent to the UE by the RNC does not correspond to the CPICH power at the distribution system antenna connector. This can lead to problems with some RNC functionality like admission control or the adjustment of the initial power of the PRACH.
- The changes to the Iub signalling are not backwards compatible. A node B or a UE that is not Release 6 compatible would not understand the changes done to the signalling [3].

Because of this, a more feasible solution has been considered. With this solution, current information elements are not changed. The node B and the RNC are the ones that perform the necessary corrections to obtain the low output power. Figure B.1.1 shows an example of this solution.

In this example, we want a Pmax at the distribution system antenna interface of +30 dBm. The gain of the feeder between the node B and the distribution system, plus the distribution system gain, is 30 dB. Therefore, the node B should be ordered to transmit with a Pmax of 0 dBm. But the RNC orders the node B to transmit 30 dBm, which should be the maximum output power at the distribution system antenna interface. The order is sent by using a non changed Release 99 IE. According to this, the node B should transmit with a Pmax of 30 dBm at its antenna interface. But the RNC sends to the node B a new IE, which tells the node B that there is a distribution system connected to its antenna interface. This new IE contains the UL and DL gain of the distribution system. Then the node B is able to correct its output power, and therefore, it transmits with a Pmax of 0 dBm, so that the Pmax at the remote antenna interface is 30 dBm. In order that the RNC can send to the node B the gain of the external distribution system, it is necessary to add two parameters to the RNC, operator configurable, which contain the UL and DL gain of the external distribution system.

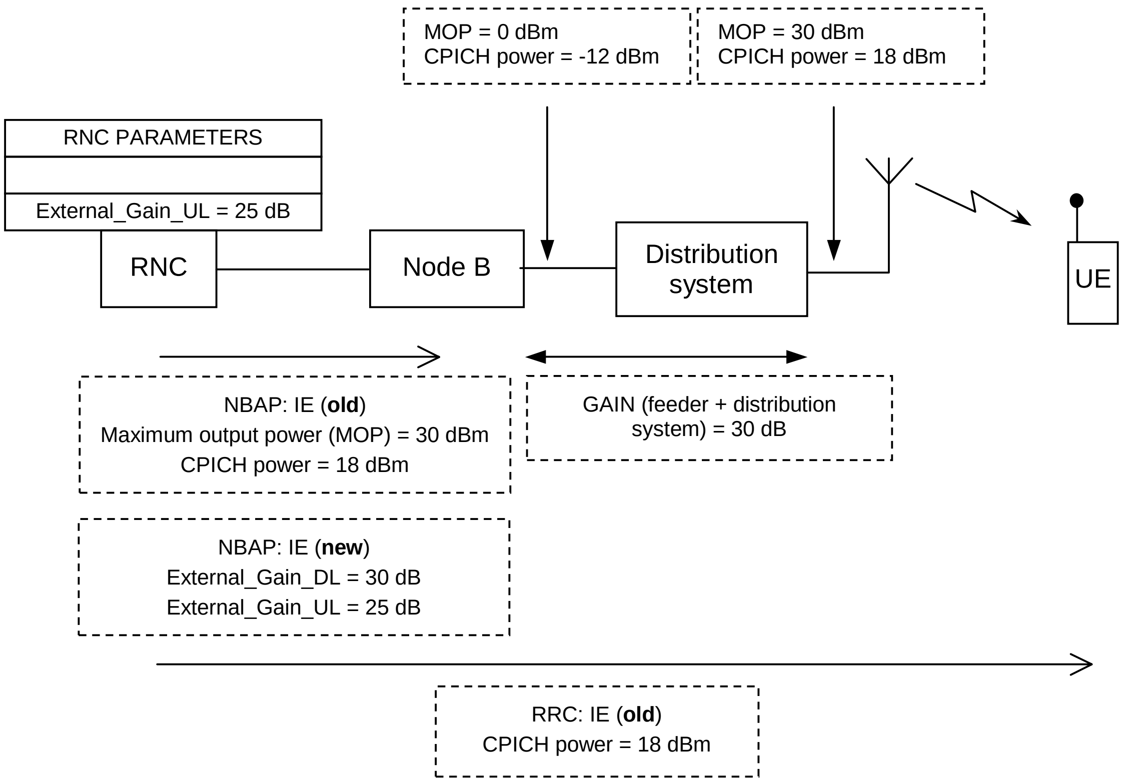

Figure B.1: Solution #1 for getting low output power

On the other hand, the CPICH power value sent to the UE by the RNC is 18 dBm, which is the CPICH transmit power at the distribution system antenna interface. With this solution, the correct CPICH power value is sent to the UE, and there are not backwards compatibility problems with the UE's. The only change to the specifications is the new IE in the NBAP protocol, containing the UL and DL gain of the distribution system. There would be no changes in the RRC protocol, and there would be no backward compatibility problems with the NBAP IE's.

In the previous explanation of the approach, no mention has been made of the possible use of the distribution system UL gain for the node B and/or the RNC. It could be useful for correcting the measurement reports received from the node B, because if these reports are not relative to the distribution system antenna connector (the point at which the CPICH power value is given), it could lead to problems with some RNC functionality.

It should also be pointed out that if the or distribution system connected to the node B has several antenna ends, all of them should be configured to transmit the same output power. If not, it would be impossible for the node B to correct its transmit power so that the correct output power is transmitted at all antenna ends. This comment should be included in the relevant documents, for instance in the WDS technical report.

This solution is not fully closed yet. Subsequent modifications or additions to this solution can be incorporated into this TR by means of TSG RAN WG's contributions.

Annex C: Use of the downlink and uplink gain

To clarify the use of both parameters, downlink and uplink gain of any distributed antenna system connected after the base station, the following structure is to be considered:

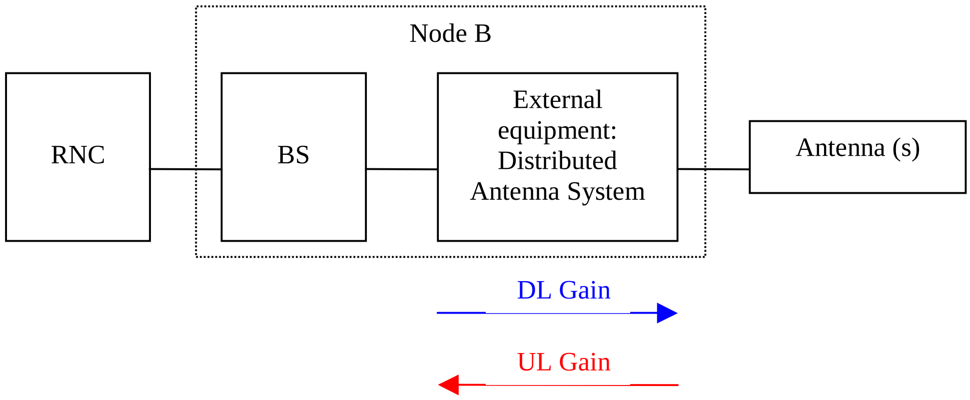

Figure C.1: General topology in case of Low Output Power

First of all, it seems clear that, indisputably, the downlink gain of the distributed antenna system connected at the output of the base station will be a value needed by the base station, in order to be able to adjust its output power accordingly. By doing this, the Primary CPICH power at the antenna connector can be correct, as indicated on the BCH.

On the other hand, the purpose of the uplink gain could be less obvious, although it is also important, for this parameter will be used to compensate any dissymmetry between both, uplink and downlink, so as to receive an exact - as accurate as possible - initial power for the PRACH preambles. To clarify this point, it would be useful to analyse in detail how the calculation of this power is performed by the UE.

The formula the UE uses to estimate the power of the initial preamble for the PRACH, Preamble_Initial_Power, is given in 3GPP TS 25.331 as follows:

Preamble_Initial_Power = *Primary CPICH TX power IE* – CPICH_RSCP

+ *UL Interference IE*

+ *Constant Value IE*

Where:

- The *Primary CPICH TX power IE* is the transmitted Primary CPICH power sent to the UE on the Uu interface. This IE is indicated on the BCH in the System Information Block, SIB, type 6 (or SIB 5, if SIB 6 is not being broadcasted).
- The CPICH_RSCP is measured by the UE as the received value of the Primary CPICH.
- The *UL Interference IE* is the estimated uplink interference already existing in the cell. This IE is present on the BCH in SIB7.
- The *Constant Value IE* is a constant chosen by the RNC. This IE is radiated to the UE on the BCH in SIB 6 (or SIB 5, if SIB 6 is not being broadcasted).

In fact, the first two terms represent the estimation of the downlink path loss. Of course, it can only be correct if the Primary CPICH power at the antenna connector is equal to the *Primary CPICH TX power IE*. So, this is obviously the reason why the base station needs to be aware of the presence of the external element connected at its output before the antenna itself, adjusting its output power in accordance.

Additionally, a constant value is chosen so as to enable RRC connection establishment without delay and without creating too much uplink interference.

Finally, in order to take into account the presence of other UEs in the cell, the *UL interference IE* is included. This estimation will only be correct if the base station is aware of the UL gain of the external element connected.

As it could be noticed, this formula does not explicitly contain uplink and downlink path losses, but on the contrary, symmetry between both links is implied. This means that the UE assumes that uplink and downlink path losses are almost the same. This hypothesis is usually valid at the antenna connector reference point, that is, immediately after (or before) any external element connected at the output (input) of the base station on the downlink (on the uplink). It is important to maintain this symmetry up to the base station itself, so that the initial power of the preambles would be correct enough.

If either uplink or downlink is not compensated correctly, then the Preamble_Initial_Power may not be accurate enough:

- Being too low, the RRC connection establishment might be delayed or even impossible.

- Being too high, too much uplink interference will be created in the cell.