TSG-RAN Working Group 4 (Radio) meeting #7 **TSGW4#7(99)NTC**
Makuhari 7 – 10 Sep 1999

Agenda Item: AH06 and 8.4

Source: Nokia

Title: DL dynamic range and DL power control range

Document for: Discussion and decision

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1. Introduction

In RAN4 AdHoc 06 e-mail discussions it has been pointed out that the current requirements in TS 25.104 in *'6.4.3 Power control dynamic range'*, *'6.4.4. Minimum transmit power'*, *'6.4.5 Total power dynamic range'* and *'6.4.7. Perch channel power'* are not defined clearly. It has even been proposed to completely remove these requirements.

This contribution tries to clarify the need for *Power control dynamic range* requirement and to explain why the current requirement value should be kept unchanged. It also tries to clarify why *Minimum transmit power* or *Total power dynamic range* requirement is needed and to justify the current requirement value (it has already been agreed that one or the other should be removed, as they are redundant).

It must be emphasised that the values proposed in this contribution are for 'general purpose' base station and are based on the assumption of 20W / 43dBm output power. As for most of the requirements in 25.104, these requirements should be checked if base station classes are defined.

2. Background

Before 3GPP ETSI document XX.06 [1] had a requirement for *'Dynamic range'* which was defined as "*difference between the maximum and the minimum transmit output power for a specified reference condition*". Values 80dB for uplink and 30dB for downlink were given, but it was not defined whether this requirement is for one code channel or for total output power. ARIB document [2] had a requirement for *Closed loop power control range*, among other power control requirements. Minimum requirement was not defined, but 20dB was mentioned during SWG5 meetings.

In 3GPP 25.104 *Power control dynamic range* is specified for a code channel whereas the *Total power dynamic range* is specified for transmitter output power. These two requirements are independent and address different radio characteristics.

Unlike UE, base station is not expected to be transmitting only one code channel at any time. At minimum, BS would need to transmit pilot channel (CPICH), synchronisation channel (SCH) and PCCPCH for BCH. As these common channels need to cover the whole cell/sector, it can be assumed that the minimum output power of a base station is the total power allocated to these common channels. This minimum output power together with maximum output power defines also the *'Total power dynamic range'*.
In practice, the minimum transmit power of a downlink DPCH should be lower than the power allocated to common channels as not all users are at the cell edge. Therefore there is no need to set the same minimum transmit power requirement for a code channel and for the whole base station.

3. Maximum, minimum or no requirement?

Both *Power control dynamic range* and *Total power dynamic range* are related to downlink capacity and the latter also for modulation accuracy. *Perch channel power* is related to uplink capacity, RACH procedure and call set-up time. As with all other requirements in 25.104, these requirements have been included to guarantee reasonable network performance. There should be no reason to remove these requirements from 25.104, even though this has been proposed in AH06.

To guarantee network performance, a minimum requirement has been set for *Power control dynamic range* and *Total power dynamic range*. When related to dynamic range, minimum requirement means that at least the defined dynamic range shall be supported. However, it does not prohibit from implementing or supporting larger dynamic range.

However, currently *'6.4.4. Minimum transmit power'* is ambiguous and should be either removed or rewritten.

4. 6.4.5 Total Power Dynamic Range

The *Total power dynamic range* is defined as the difference between the maximum and the minimum total transmit output power. This requirement is related to that of modulation accuracy, which shall be met over the whole *Total power dynamic range*. The current requirement has been defined to provide sufficiently low output powers for the common channels of a 'general purpose' base station, but so that it does not set stringent requirements on power amplifier design.

As an example: CPICH is transmitted at minimum transmit power 43 – 18dB = 25dBm / 316mW, which leaves 98% of maximum total power for high capacity situation.

The total power dynamic range could be tested so that, for example,

- there are 5 equal power code channels.
- power is raised on all channels so that maximum total output power is reached and modulation accuracy is monitored.
- power is lowered on all channels so that total output power is 18dB less and modulation accuracy is monitored.

This way it is verified that BS can transmit correctly with relatively low powers.

5. 6.4.3 Power Control Dynamic Range

Downlink closed loop power control is the BS ability to adjust code channel power in response to a power control message from a mobile station. Downlink power control range is defined as the possible power range for the individual code channels, regardless of code channel symbol rates or spreading factors.

By implementing closed loop power control in downlink, capacity can be improved by compensating fading - taking away power from users with a good SIR and distributing that among users in need of a better SIR. With reasonable power control range, good gain can be achieved with limited increase in implementation complexity.

Value of 25dB was proposed as a compromise (30dB in ETSI vs. 20dB in ARIB) in TDoc R4-99047 [3] in Turin. This was accepted and has been the working assumption since February both in WG1 and WG4. There have been no simulation or measurement reports that would call for higher Power control dynamic range nor has Nokia found any difficulties in implementing this range.

Power control dynamic range could be tested so that there is, for example,

- one code channel at power (Pmax - 3dB), for which the power is kept constant
- one code channel, for which the power is changed from (Pmax - 3dB) to (Pmax - 28dB) and modulation accuracy is monitored

This way the power control dynamic range of a code channel is verified without tough requirements on PA.

6. 6.4.7. Perch channel power

This requirement is a remnant from ARIB Volume 5. The intention of this requirement is to guarantee that the actual power of Perch channel is close enough to that announced on broadcast channel.

In 3GPP, UE measures the received power of Primary CPICH and reads the transmission power of Primary CPICH. These can be used to estimate path loss from BS to UE, which can then be used for open loop power control e.g. for RACH.

In case 25.101 includes a requirement for the UE for the received power measurement, there probably should be an accuracy requirement for the BS for Primary CPICH power.

7. Conclusion

Definitions and requirements for Power Control Dynamic Range (25dB) and Total Power Dynamic Range (18dB) have been proposed. Related text proposal for 25.104 is included in Annex A.

8. References

[1] UMTS XX.06V0.5.0 (1999-01) UTRA FDD; Radio transmission and reception
[2] Volume 5 Specification of Base Station for 3G Mobile System, version 1.0 – 0.1
[3] Tdoc R4-99047, DL dynamic range and DL power control range, Nokia

6.4.3 Power control dynamic range

The power control dynamic range is difference between the maximum and the minimum transmit output power of a ~~traffic~~ code channel for a specified reference condition.

6.4.3.1 Minimum requirement~~s~~

Down link (DL) power control dynamic range: 25 dB, from max output power –3dB to max_output_power –28dB

~~6.4.4 Minimum transmit power~~

~~The minimum controlled output power of the BS is when the power control setting is set to a minimum value. This is when the power control indicates a minimum transmit output power is required~~

~~6.4.4.1 Minimum requirement~~

~~Down link (DL) minimum transmit power Maximum output power – 18 dB~~

6.4.5 Total power dynamic range

The ~~power control~~ total power dynamic range is difference between the maximum and the minimum total transmit output power for a specified reference condition

6.4.5.1 Minimum requirement

Down link (DL) total power dynamic range 18 dB
~~<This requirement is redundant, since 6.4.4 defines the same dynamic range by a minimum transmit power.>~~

6.4.6 Power control cycles per second

The maximum rate of change for the DL transmitter power control step.

The Down link (DL) rate of power control steps is 1.6 kHz.

6.4.7 ~~Perch channel~~ Primary CPICH power

Primary CPICH power is the transmission power of Common Pilot Channel averaged over one frame.
Primary CPICH power setting is indicated on BCH.
~~The perch channel power, sum of the 1st and 2nd perch channel power, to total power ratio is the power attributed perch channel divided by the total power, and is expressed in dB. The 2nd perch channel power is the averaged power during one frame.~~
<Details of the path loss estimation method is under study in WG1>

6.4.7.1 ~~Minimum r~~Requirement

CPICH power shall be within ±**TBD** dB of the indicated value.
~~Each perch channel power to total power ratio is shall be within ±**TBD** dB of the configured value.~~