TSG-RAN Working Group 1 meeting #5 **TSGR1#5(99)569**

Cheju, Korea, 1. – 4. June 99

Agenda Item: **Adhoc 1**

Source: **Siemens**

Title: **OL Power Control and Text Proposal for 25.224 and 25.221**

Document for: **Approval**

Introduction:

An advantage of TDD based systems is the reciprocity of uplink and downlink channels. In the UTRA TDD mode this reciprocity is exploited for the open loop power control scheme. The benefits of this scheme are widely acknowledged, however, the performance of this scheme is dependent on the delay between the downlink reference for pathloss measurement and the uplink transmission [see e. g. TSG R1(99)155].

In our contribution we present a proposal, that reduces this delay but retains full flexibility in allocating timeslots for DCA.

Current Status:

In the current version 1.0.0 of 25.224 it is foreseen to use open loop power control for the uplink. The reference power to be used for estimating the pathloss is the transmit power of the CCPCH. This power is signalled on the BCH and is varied on a very slow basis only. The algorithm for uplink open loop power control for the PRACH and also for dedicated channels is:

$$P_{PRACH} = L_{CCPCH} + I_{BTS} + \text{Constant value}$$

where, P_{PRACH} : transmitter power level in dBm,

L_{CCPCH}: measured path loss in dB (transmit power is broadcasted on BCH),

I_{BTS}: interference signal power level at cell's receiver in dBm, which is broadcasted on BCH

Constant value: This value shall be set via Layer 3 message (operator matter).

The problem with this procedure is the delay between the reception of the CCPCH and the uplink transmission. The performance of open loop power control degrades significantly in case of increasing control delay.

One way to overcome this problem is to use multiple timeslots in the downlink for CCPCH transmission to be used as a reference for pathloss measurements. However, this could lead to a decrease in downlink traffic capacity. Furthermore it reduces the flexibility for DCA and still will not avoid control delay completely.

Midamble as reference in all active timeslots

The new proposal is to transmit the midambles of all active downlink timeslots, i. e. of the ones that contain resource units, with the same reference power as the midamble of the CCPCH. In this case all midambles in the downlink can be used as a reference for pathloss measurements. The control delay can be minimised by a clever allocation of timeslots to up- and downlink direction.

The proposed algorithm for uplink open loop power control would then be:

$$P_{TX} = L + I_{BTS} + P_{Service} + P_{Terminal}$$

where,

P_{TX} : transmitter power level in dBm,

L: path loss in dB (estimated by means of midamble power – midamble power is broadcast on BCH),

I_{BTS}: interference signal power level at BTS receiver in dBm, to be broadcasted on BCH

$P_{Service}$: To be set via Layer 3 message (operator matter, e.g. service dependent)

$P_{Terminal}$ To be set via Layer 3 message. It is intended to compensate for terminal hardware inaccuracies

Due to the synchronization of cells in a TDD network the increase in transmit power of the midambles results in interference for midambles of other cells only. This is not critical because of the correlation properties and the processing gain of the midambles used.

Special Extensions for Transmit Diversity/Beamforming
The above proposal is readily extensible to the case where beam forming antennas are implemented in the cell. In this case there is a different channel from the cell for the codes transmitted to each of the UEs. To support this, therefore, it is necessary for the network to transmit a different midamble for each UE.

For the purposes of open loop power control the UE must be informed about the fact of beamforming and then measures the power of the midamble in the particular resource unit addressed to it. Thus, in this case we do not have the flexibility to perform measurements in *any* downlink time slot. Any scheme based on fixed position ‘beacon’ time slots would not work in this case. If, however, as described earlier, the call set up algorithm assigns, wherever possible, downlink and uplink resource units in consecutive slots, the performance of open loop power control will be optimal.

When beam forming antennas are used, it must be possible to perform measurements, for the purposes of handover, on transmissions that are omnidirectional (or uniform over a sector for sectored antennas). The BCCH (part of the CCPCH) must be transmitted to cover the whole cell. Accordingly, its midamble would be appropriate for handover measurements. Unfortunately, the CCPCH also transmits the PCH and the FACH, either or both of which may be directed towards a specific user using a beam. On these occasions, the CCPCH midamble is not suitable for handover measurements. It is proposed, to solve this problem, to transmit an additional omnidirectional midamble on the CCPCH whenever this is not being transmitted to support the BCCH. Thus, in effect, the omnidirectional midamble is transmitted continuously with the CCPCH on a fixed code. When the BCCH is being transmitted, this midamble serves to demodulate. When the PCH or FACH is being transmitted in a beam, an additional midamble is sent on that beam.

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6.3 Transmitter Power Control

6.3.1 General Parameters

Power control is applied for the TDD mode to limit the interference level within the system thus reducing the intercell interference level and to reduce the power consumption in the UE.

Table -1: TPC characteristics

	Uplink	**Downlink**
Dynamic range	80 dB	30 dB
Power control rate	Variable Closed loop: 100-800 cycles/sec. Open loop: 1-7 slots delay ~~(2 slot SCH)~~ ~~1-15 slots delay (1 slot SCH)~~	Variable closed loop: 100-800 cycles/sec.
Step size	[1 ... 3] dB	[1 ... 3] dB
Remarks	All figures are without TPC decoding and received power measurements.	within one timeslot the powers of all active codes may be balanced to within a range of [20] dB

- All codes within one timeslot allocated to the same bearer service use the same transmission power.

- In case of one user with simultaneous RT and NRT bearer service, the closed loop power control is used both for RT and NRT bearer service. However, depending on the current services different power levels are used.

6.3.2 ODMA Power Control

<for further study>

6.3.3 Uplink Power Control

6.3.3.1 Common Physical Channel

The transmitter power of UE for Random Access shall be calculated by the following equation:

$$P_{PRACH} = L_{\cancel{CCPCH}} + I_{BTS} + P_{Service} + P_{Terminal} \cancel{\text{Constant value}}$$

where, P_{PRACH} : transmitter power level in dBm,

~~L_{CCPCH}: measured path loss in dB (transmit power is broadcasted on BCH),~~

I_{BTS}: interference signal power level at cell's receiver in dBm, which is broadcasted on BCH

~~Constant value: This value shall be set via Layer 3 message (operator matter).~~

L: path loss in dB estimated by means of midamble power (transmit power broadcast on BCH)

$P_{Service}$: This value shall be set via Layer 3 message (operator matter, e.g. service dependent).

$P_{Terminal}$ This value shall be set via Layer 3 message. It is intended to compensate for terminal hardware inaccuracies.

In each active downlink timeslot, i. e. a timeslot containing resource units, the midamble is transmitted with the same power as for the CCPCH. Therefore, the midamble of the CCPCH and/or the midamble of any other active downlink timeslot can be used as a reference for the pathloss measurement. This is for the case without transmit diversity. The case of transmit diversity is described in section 6.8.

6.3.3.2 Dedicated Physical Channel

The initial transmission power is decided in a similar manner as PRACH. After the synchronisation between nodeB and UE is established, the UE transits into open-loop or closed-loop transmitter power control (TPC).

UL Open Loop Power Control:
The UE transmit power is set based on the measured path loss in the same way as for the PRACH. In case of transmit diversity or beamforming the UE measures the power of the specific midamble associated with the UE's specific downlink DPCH.

UL Closed Loop Power Control:
Closed-loop TPC is based on SIR, and the TPC processing procedures are the same as the FDD mode. During this power control process, the nodeB periodically makes a comparison between the received SIR measurement value and the target SIR value. When the measured value is higher than the target SIR value, TPC bit = „0„. When this is lower than the target SIR value, TPC bit = „1„. At the UE, soft decision on the TPC bits is performed, and when it is judged as „0„, the mobile transmit power shall be reduced by one power control step, whereas if it is judged as „1„, the mobile transmit power shall be raised by one TPC step. A higher layer outer loop adjusts the target SIR. This scheme allows quality based power control.

When the TPC bit cannot be received due to out-of-synchronisation, the transmission power value shall be kept at a constant value. When SIR measurement cannot be performed for being out-of-synchronisation, the TPC bit shall always be = „1„ during the period of being out-of-synchronisation.

6.3.4 Downlink Power Control

6.3.4.1 Common Physical Channel

The primary CCPCH transmit power can be changed based on network determination on a slow basis. The exact power of CCPCH is signalled on the BCH ~~on a periodic basis~~ .

6.3.4.2 Dedicated Physical Channel

The midamble of the downlink Dedicated Physical Channels is not power controlled but transmitted with the same power as the midamble of the primary CCPCH. One midamble only is used per timeslot. In case of transmit diversity or beamforming an individual midamble with reference power is used for each UE.

The initial transmission power of the data section of the downlink Dedicated Physical Channel is set by the network. After the initial transmission, the nodeB transits for the data section into SIR-based closed-loop TPC as similar to the FDD mode.
The measurement of received SIR shall be carried out periodically at the UE. When the measured value is higher than the target SIR value, TPC bit = „0„. When this is lower than the target SIR value, TPC bit = „1„. At the NodeB, soft decision on the TPC bits is performed, and when it is judged as „0„, the transmission power shall be reduced by one step, whereas if judged as „1„, the transmission power shall be raised by one step.
When the TPC bit cannot be received due to out-of-synchronisation, the transmission power value shall be kept at a constant value. When SIR measurement cannot be performed due to out-of-synchronisation, the TPC bit shall always be = „1„ during the period of being out-of-synchronisation.
A higher layer outer loop adjusts the target SIR.

6.8 Down~~Forward~~ Link Transmit Diversity

Transmit diversity in the ~~forward~~ downlink provides means to achieve similar performance gains as the mobile-station receiver diversity without the complexity of a second mobile-station receiver. Furthermore, transmit diversity improves the SIR and increases the system capacity. Depending on the mobile station's distance to the base station, its speed, and the asymmetry ratio, selective transmit diversity (STD) can be employed.

With STD, the received signal power of ~~reverse~~ uplink is measured for each of the antennas at the BTS over every single reverse link interval (1 slot). The antenna with the highest signal level is used to transmit the forward link information for that link during the next interval over which the carrier is used for the ~~forward~~ downlink (1 or more slots). The basis for the gains from this type of diversity is the availability of information on the channel due to the use of the same frequency for ~~reverse~~ uplink and ~~forward~~ downlink. STD is applied only to dedicated physical channels. STD can be applied if the distance between the different transmit antennas is small enough so that the delay profile from each antenna is almost the same.

In the case of transmit diversity there is a different channel for the transmissions from the network to each of the UEs. To support this, therefore, it is necessary for the network to transmit a different midamble with reference power to every UE.
In case transmit diversity is used for the CCPCH, too, the midamble of the omnidirectional transport channels (BCH, PCH) is transmitted in parallel to the individual midamble for a specific UE.

For the purposes of uplink open loop power control the UE must be informed about the fact that beamforming is used. In this case the antennas or beams that are used by the nodeB in uplink and downlink direction must be identical in order to maintain reciprocity for both directions.

<Editors Note: Other TX diversity schemes such as schemes for common channels and TXAA are ffs>

Text proposal for 25.221

5.2.3.3 Midamble Transmit Power

In the case of the downlink, the midamble of the dedicated channels is transmitted with the same power as the midamble of the CCPCH. One midamble only is used per timeslot. In case of transmit diversity or beamforming an individual midamble with reference power is used for the transmissions to each UE.

In the uplink, the mean power used to transmit a midamble is equal to the transmission power of the data section of a single resource unit attached to it. ~~2K data blocks are transmitted in a burst simultaneously. Also in the uplink, if K' greater than one CDMA code are assigned to a single user, 2K' data blocks are transmitted in a burst simultaneously by this user. This is the so called multi-code uplink situation. In the downlink and the multi-code uplink, the mean power used to transmit the midambles on the one hand and the 2K (or 2K') data blocks on the other hand shall be equal. This shall be achieved by multiplying the midamble codes~~ $\underline{\mathbf{m}}^{(k)}$ ~~, k=1,...,K, with a proper real factor to achieve an attenuation or an amplification~~