TSG-RAN Working Group 1 meeting #3 **TSGR1#5(99) 643**

Shin Yokohama (Japan), 18th-20th April 99

Agenda Item : 6

Source : ad-hoc 9 Chairman[1]

Title : ad-hoc 9 report on ad-hoc 9 activities until WG1#5

Document for : Approval

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1. Introduction

This document reports on the discussions that have taken place on the RAN WG1 reflector in the framework of ad-hoc 9 (Closed loop power control for FDD) between 3GPP RAN WG1#4 and 3GPP RAN WG1#5 meeting.

The discussion on the reflector dealt with the following topics :

1) Power control step sizes for uplink and downlink power control
2) Power control in compressed mode
3) Power control for multi-code in conjunction with ad-hoc 4.
4) Slow power control
5) Power control for inter-frequency handover
6) Open loop power control

Apart for the power control in multi-code no conclusion was reached. Discussion on the reflector have been very intensive though.

2. Power control step size at the UE and BTS

2.1 Minimum power control step sizes

There has not been any firm conclusion on the minimum power control step size, neither for the UE and for the BTS

2.1.1. Minimum PC step size for the UE.

The following approaches were discussed for the UE

1. A 1 dB minimum power control step size mandatory at the UE, no smaller PC step allowed for release 99 even in an optional manner, but the signalling at high layers should allow the introduction of smaller step sizes for future releases, if we feel that this is needed.
2. A 1dB minimum power control step size mandatory at the UE, smaller PC step sizes such 0.5 dB allowed but optional in release 99. The support of smaller step sizes by the UE can be indicated to the network as part of the classmark so that this is taken into account for the PC. UEs not supporting PC step smaller than 1dB are not impacted.
3. 1 dB should be supported but smaller step sizes such 0.5 dB should also be supported in a mandatory manner.

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[1] Evelyne Le Strat, Nortel Networks

The arguments for going for allowing smaller step sizes that 1 dB from release 99, but not making them mandatory were the following :

- Performance at very low and high velocities bring some performance improvement compared to 1 dB step size, as shown in the Nortel Networks contributions R1-99461, in particular on the variance of the power control error (difference between the target SIR and the achieved one). This was confirmed by simulation results from the Philips contribution "Implementation of small power control steps", R1-99553. Nortel also indicated that the loss for 1dB at high speed might need further investigation in particular taking into account PC delay.
- Although the penetration of UE supporting small step sizes is not known, it is expected that some system capacity can be expect in particular considering co-existence of Ue of different releases. For example, considering one or two years after commercial service, we may face a situation in which we have high portion of UEs from release 2000 supporting small steps (because technology evolves), UEs from UE supporting small steps and UEs supporting only 1 dB. By preventing small steps then we restrict the UEs manufacturer flexibility in choosing what they may want to support.
- Although initial simulation results (R1-99353 from Philips) indicate a small gain from small step sizes, Philips had confirmed that a smaller value gives more flexibility for optimization of Eb/No performance. T-Mobil had expressed the views that as a network operator they were interested in this kind of optimisation. As an operator they wanted to have some flexibility.
- Recognising that the complexity of UEs supporting smaller step sizes might be higher, it should not be prevented though that these small step sizes are optional. It should also be considered that other standards support such small step sizes, the accuracy of the step size though being relaxed for smaller steps (e.g. in CDMA 2000 accuracy is 0.3 dB for 0.5 dB step).

The arguments for preventing the support of smaller step sizes for release 99 were the following :

- The performance increase for smaller step sizes was considered by some companies as not significant
- The penetration of UE supporting small step sizes will be too low to allow significant system capacity and it s not easy to make assumption on the penetration of such UEs
- Complexity of small step sizes is high due to the support of large dynamic range, so it is not expected that UE manufacturer will support such step sizes in release 99.
- Though the small step sizes would be optional, UE manufacturers will most likely be asked by the operators to support these small steps, in which case the steps would become mandatory in practice.

No conclusion could be reached. There was indeed a set of companies supporting approach 1 and others supporting approach 2. Though originally supporting of approach 3, T-Mobil agreed to go for approach 2, which had been supported by Nortel Networks from the start. Nokia, Alcatel, Panasonic and DoCoMo favoured the first option. DoCoMo relying mostly on some publication in IEICE transactions on, July 1998. However it was not clear whether the publication was fully applicable to UTRA.

It should be noted that this discussion on the minimum power control step size, is to be separate from the possibility to go for 0dB step size as suggested by Panasonic in the compressed mode. Also apart from the minimum power control step size, decision is needed on the steps to be supported. Although it is assumed that the step is a multiple of the minimum step size, it should be agreed whether it is limited to e.g. 3 times the minimum PC step size.

2.1.2. Minimum PC step size for the BTS.

The following approaches were discussed for the BTS

1) A 1 dB minimum power control step size mandatory at the BTS, no smaller PC step allowed even in an

optional manner.

2) 1 dB minimum PC step size mandatory at the BTS but other smaller step sizes such as 0.5 and 0.25 dB optional.

However it was recognised that even if only 1 dB step size is was the only step allowed and documented, then the standard allows smaller step sizes in practice since there is no test to verify the smaller step sizes are allowed.

There was no extensive discussion on the downlink. There was a suggestion from Nortel to either specify all steps that can be though of or not to specify any steps since there is no test to verify to test this. There was no comment on that suggestion.

3. Power control in compressed mode

3.1 The different schemes

The two proposals introduced at the previous meeting (R1-99462 and R1-99508) were discussed and further clarification requested.

3.1.1. Discussion on the Panasonic proposal

Concerns were expressed on the Panasonic proposal such as described in R1-99509 on the following points :

- What is the solution when DTX is applied ?
- Accurate estimation of the power offset between the TPC and data field
- Impact on the PAR and compatibility with finite set of output levels at the antenna connector, which prevents from changing the power level of one field versus the other.
- complexity

The Panasonic proposal was updated in order to address some of the problems with the following modification :

- Power offset to signal the step size is between TPC and previous bit on the downlink
- Modified DTX to transmit some bits before the TPC.

3.1.2. Discussion on the Alcatel proposal

Concerns were expressed on the Alcatel proposal by Nortel Networks, since there seems to be a fixed relationship between the steps in normal and compressed mode, the recovery period being fixed. Nortel Networks in particular questioned the gain of the scheme at high speed and small speeds, where small steps should be better. Alcatel agreed to modify their proposal to make the step in compressed mode as well as the recovery periods parametrisable, where such parameters may be provided to the UE together with the other compressed mode parameters.

In general the Alcatel scheme was considered as very simple

3.2 Simulation assumptions

There was an extensive discussion on which should be the simulation assumptions in order to compare the two proposals on a fair basis. Although there has been quite a lot of discussion no consensus was reached and each proponent used its own approach to evaluate the scheme.

Without reporting here every topic a list of items for the simulation assumption discussion is the following :

1) Level of modelling

   a) Two levels of modelling where discussed, one for the chip level one for the “slot” level, the latter one, being a simplified model but assumed to provide relative comparison. The first approach was used by

Alcatel, whereas the second approach was used by Panasonic. Panasonic though agreed later one to provide detailed simulation results.

2) Modelling of TPC errors

   a) The Alcatel approach consists in modelling the error rate in average over the recovery period not taking into account correlation of successive TPC.

   b) It was suggested to do a two way simulation where one way is fully simulated, the other providing only the TPC and being itself power controlled.

   c) Panasonic wanted also to have a simulation model allowing to test “worst” test cases, where one link is upto 7 dB away from the target.

3) Propagation model

   a) Single path and multi-path were somehow agreed for detailed simulation however Panasonic does not model multi-path in the simplified simulations.

   b) It was agreed to go for different velocities

4) Delay in the power control

   a) Nortel Networks insisted on the need to take into account the power control delay which might be larger than 1 slot. Impact of the delay was minimised by other companies.

4. Power control for multi-code

Power control for multi-code was discussed together with ad-hoc 4. The following was concluded :

- In order to improve the PC for multi-code in uplink, then the different DPDCH should have the same SF and same power.
- The base station should be allowed to use measurements on the DPDCH in addition to measurements on the DPCCH, rather than DPCCH only. This is anyway outside the scope of the specification what measurements the network does.
- For multi-code on the downlink, we cannot avoid situations in which there are multiple DPDCH with different SF, different power and potentially not aligned in time. This can happen in the DCH+DSCH on the dl and one DCH on the uplink. In such a case, it can be assumed that the uplink TPC control the dl DCH and the power control for the dl DSCH uses the TPC bits targetted for the DCH but potentially other information.

5. Slow power control

Ericsson and Nortel Networks asked for some clarification on the slow power control that is presently documented in 25.214 and got answers from the originator company on slow power control (NEC). There was no conclusion to remove the scheme or to make modifications on other specifications to allow full support of the scheme.

The following points were discussed

- Problem the scheme addresses-scope of applicability

The scheme aims at minimising the transmission on uplink to save battery live, by applying a slow power control on the downlink. The TPC command , is transmitted on the uplink using all TPC bits within one frame, highly protected , where such a frame is transmitted every N frames. The scheme is therefore targeted for downlink non real time service, the TPC Command on the uplink being transmitted together with acknowledgement.

NEC indicates that the proposal is not intended to be used for Downlink shared channel.

This proposal is not a WG1 issue only but also WG2, WG1 being presently more involved with fast closed loop transmit diversity. Also if TPC is to be transmitted anyway then this can have an impact on the protocol design.

- mandatory in network/UE

The feature is optional both at the network and UE side.

- Performance

SWG2-16-30 that was the background material from ARIB was made available by NEC.

The contribution shows performances of outage probability, Forced termination probability and Pilot quality versus Traffic comparing this function with CIR-based slow transmission power control and no TPC. In all of performance criteria, it is shown that this scheme has better performance than CIR-based slow transmission power control and no TPC.

- impact on channel coding

The slot structure is not changed on the uplink, however there is an additional coding of a slow PC command, relying on RS code, making use of the 32 TPC bits per frame.

- impact on uplink and downlink power control

Given that the UE transmits only one frame every N frames, then the uplink is slowly of not power control at all. The impact of the lack of power control on the uplink was not taken into account in the evaluation. The slot structure on the downlink is not changed though. It is not clear though what is transmitted on the TPC in the dl in between uplink transmission.

- conflict with SSTD, which is also a DL TPC method

This function cannot be activated in parallel with closed loop TPC, neither with SSDT and most probably closed loop Tx diversity due to the lack of FBI sufficient transmission rate.

6. Power control for inter-frequency handover

The contribution from Golden Bridge dealing with the issue was distributed on the reflector and discussion initiated.

It was clarified that the procedure aims at allowing a faster convergence of the power control at the handover, a situation where it is assumed that no RACH is previously transmit, meaning that there is no information on power allowing successful reception of any information from the target cell. The proposal aims at also minimising the loss of frames by compressing the first frame(s).

The procedure consist in having a mutual power control in which the UE and the base station send at a given time some power control command but expected at a higher rate.

This led to the following discussion :

- It is explained that the slot structure to support this 10 ms “preamble” is not modified which means that the higher PC rate of 1.6 kHz, not higher than normal. What is the gain then versus the use of normal PC with DTX?
- It was explain that a handover procedure might rely on the FAUSCH, in which case the power ramping principle is applied. GBT though had concerns about the ability of the FAUSCH to be as fast as their proposal.
- The proposal requires knowledge of timing information at the target cell, since both UE and BTS should start at the same time. Inaccuracy of the timing will have to be taken into account though.

The was no conclusion on this proposal. Discussion should continue.

7. List of contributions for the WG1#5 ad-hoc 9 physical meeting

7.1 On power control steps

- R1-99553, Implementation of small power control steps, Philips
- R1-99667, Discussion on minimum power control step sizes for the UE and the BTS in FDD, Nortel Networks

7.2 Power control in normal mode

- R1-99666, Variable step size for power control over-shot protection based on sequential analysis of power control bits, source Nortel Networks.

7.3 Power control in soft handover

- R1-99657, Change request for text proposal regarding SSDT, NEC
- A new reliability factor for TPC command in soft handover

7.4 On power control in compressed mode

- R1-99542, Additional results for fixed-step closed loop power control algorithm in compressed mode, Alcatel
- R1-99543, Evaluation of average error rate on power control commands in compressed mode, Alcatel
- R1-99544, Parameters setting for fixed-step closed loop power control algorithm in compressed mode, Alcatel
- R1-99585, New power control command for FDD, Panasonic
- R1-99586, Comparative results for power control schemes associated with compressed mode, Panasonic
- R1-99638, Comparison between fixed-step and adaptive-step closed loop power control algorithms in compressed mode, Alcatel
- R1-99639, Text proposal for specifications 25.214 and 25.231 on power control in compressed mode
- R1-99649, Power offset estimation performance in ASPC method, Nokia

7.5 Measurement to support power control

- R1-99631, A Proposal of SIR Estimation for Closed Loop Power Control, CWTS.

7.6 Power control for handover

- Hard Handover, R1-99xxx, Golden Bridge Technology.

7.6.1. Withdrawn contributions

- Effect of slotted mode on the power control algorithm Power control is slotted mode, R1-99459, Nortel Networks,

It was already discussed on the reflector and results used to derived probability of error rates on TPC

- Power Control on Multi-code Channels for the UTRA/FDD Uplink, R1-99460, Nortel Networks

It was discussed over the reflector together by ad-hoc 9 and ad-hoc 4 and clarification brought to the formulas and impact on CCTrch

8. Status of list of items for further study or requiring further work

A list of items requiring further study was presented by the chairman at the last meeting WG1#4. This section givs the status of those items.

Item number	Item	Description of item or identified problem	Status
1	Minimum power control step size at the UE, and set of step sizes	The question is which should be the minimum step size. The minimum step size could be UE specific or different for different release of the specification. Choice of step size should take into account hardware limitations as well as impact on system and link level performance.	Open
2	Minimum power control step sizes at the BTS, and set of BTS step sizes	The question is the same as for the UE. Item 9 is though to be clarified	Open
3	Dynamic selection of step sizes (infinite step size or multiple step size)	The current assumption is that the step size is cell specific. It is neither UE specific or variable in the course of the call. Panasonic proposed in R1-99181 the use of adaptive step sizes, which corresponds to an infinite number of steps, with infinitely small step sizes, where the step size is limited to a maximum value (e.g. 3dB). Robustness needs to be studied due to the "analog" indication of the step. Compatibility with WG4 assumption also to take into consideration. Concept of dynamically selecting step size in a restricted set agreed to be studied.	Proposal from Panasonic withdrawn for normal mode
4	Relationship between DPCCH/DPDCH ratios and power control steps at the UE	Ratio of power between the DPCCH and DPDCH (β) takes a limited set. At rate changes (e.g from DTX to non DTX) the β value is updated in order to take into account rate matching ratio. However output power of the UE (sum of output power of DPCCH and DPDCH) (see WG4 answer) can vary only in steps (down from the maximum power ?). How compatible is this with current description, where the power of DPCCH only is monitored, since the DPCCH absolute power may changed in an autonomous manner as β changes?	No further discussed, still to be clarified
5	Fast closed loop power control in slotted mode	The slotted interrupts the transmission in the downlink for a number of slots and possibly also in the uplink dependent on the co-ordination between uplink and downlink slotted mode	On going
6	Fast closed loop power control for Variable rate	In relation with item 4, β changes at most every frame. If the measurements are based only on DPCCH then it is like 4. If measurements are done in addition on DDPCH then the BTS does not know about the rate change before a frame.	Not discussed

7	Fast closed loop power control for multi-code	The item consists in checking the scheme presently documented which leads to a power control for all DPDCH relying on the DPCCH. The DPCCH is a low rate, low power channel whereas the DPDCH might be a high rate, high power channel. This might lead to a lack of optimality.	
8	Fast closed loop power control in relation with downlink shared channels	Power control for the DSCH when associated with a DCH (itself associated with uplink DCH). Is the DSCH power control based on the power control of the dl DCH (itself controlled by the uplink DCH)? In this case the dl DCH is transmitting continuously. Power control for DCSH when associated with a DSCH control channel and an uplink DCH. In this case the uplink cannot rely on measurements of a power controlled downlink channel, to control the DSCH. Power control for the uplink DCH associated with a DSCH associated with a DSCH control channel. Should the uplink be controlled by the DSCH control channel ? What should be the structure of the DSCH control channel ?	
9	Level of standardisation for downlink power control at the Node B		No discussed in details. Only comment in the framework of minimum PC step sizes.

Table 1: List of items requiring further work