3GPP TSG-RAN WG2 Meeting #59 **R2-073254**
Athens, Greece, 20th – 24th of August 2007

Agenda item: **7.6**

Source: **NSN, Nokia**

Title: **Further discussion on enhanced CELL_FACH in REL8**

Document for: **Discussion**

1 Introduction

The objective of the REL7 WI "Enhanced CELL_FACH state in FDD" was to reduce uplink and downlink delays in CELL_FACH, CELL_PCH and URA_PCH state [1]. Reduced downlink signalling delays and higher downlink bit rate were achieved by introducing downlink optimisations of the radio together with Node B based scheduling using HSDPA.

However the target to reduce uplink and downlink signalling delays has not been fully addressed if packet optimised radio together with Node B based scheduling also for uplink direction has been thoroughly investigated as the benefits of downlink enhancements cannot be fully exploited when the uplink feedback over RACH is limiting the overall data performance for the Rel-7 UEs in CELL_FACH state.

This document analyses the current state of uplink data transmissions in CELL_FACH, CELL_PCH and URA_PCH and outlines a proposal for a way forward for improved UL for CELL_FACH state allowing a direct UE access to both HSDPA and HSUPA by combining the random access procedure with the E-DCH concept.

2 Thoughts for an enhanced random access

The reasons to improve the uplink common channel RACH are:

- The REL99 random access procedure capacity is general limited to a RACH message part of e.g. TBS 320 bits (TTI = 20; min. SF=64). If a higher data volume than 40 bytes needs to be transmitted then either a state transition to CELL_DCH is necessary or the RACH procedure has to be started multiple times, both approaches introducing additional delays. Rel-7 further significantly increases the DL/UL imbalance.

- Sending an HTTP request takes roughly 500 bytes, but moving the UE to the CELL_DCH state before sending any uplink messages introduces significant delay before the actual data download can start. Today's RACH effective bit rate is below 10 kbps with 16 kbps RACH and preambles. It has been observed that is requires about ten REL99 random accesses to transmit a complete HTTP request which is too much to be in any way practical.

- Enhanced CELL_FACH significantly increases the downlink common channel performance, allowing a throughput of more than 100 kbps, but a comparably high data rate solution in uplink is not available thus limiting the performance of any service requiring uplink feedback still to CELL_DCH only.

Thus, current RACH is lacking of data transmission capability with fast power control or HARQ. Therefore providing means for wider UL data transmission in other states than in CELL_DCH is not really possible without significant improvements to CELL_FACH state uplink. Services and applications which can benefit from such an enhancement are e.g.:

- Internet browsing (no need to move to CELL_DCH for sending HTTP request, web page downloading can start while the UE is still in CELL_FACH)

- Always-on applications sending frequent keep-alive messages such as VoIP clients, email clients etc. (more system than service benefit, no need to move significant number of terminals periodically to CELL_DCH for small packet transmission)

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- call setup (reduced delay due faster and more robust uplink RRC signalling)

3 Proposed solution for enhanced RACH

Rel-7 Enhanced CELL_FACH achieved reduced RRC signalling delays and higher bit rates by utilizing HS-DSCH for downlink transmission. A natural complement of enhanced CELL_FACH is to apply E-DCH channels for an enhanced CELL_FACH for uplink transmissions. This would provide HARQ and power control for the CELL_FACH state uplink transmissions enabling significantly larger data amounts to be delivered in CELL_FACH state with high reliability from the UE to the network.

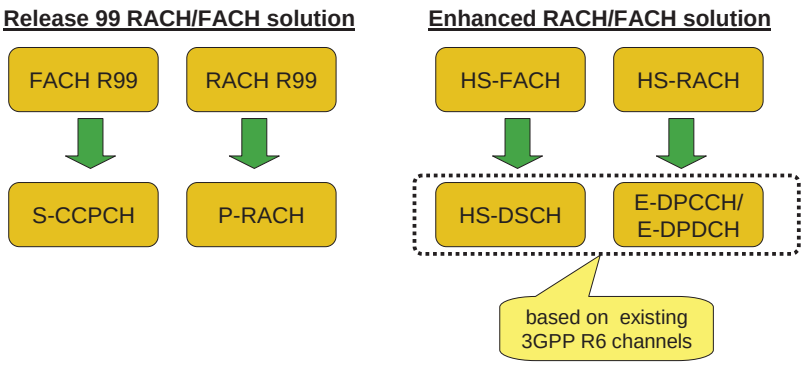
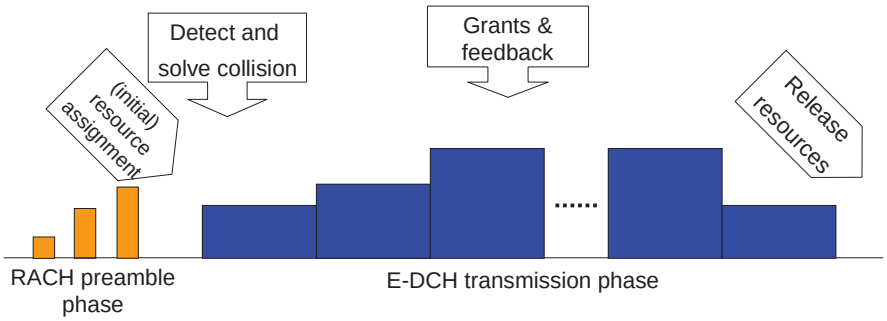


Figure 1: An illustration of data transmission in Rel'99 and Rel-8 CELL_FACH states

The uplink access can be initiated as in Rel’99 by PRACH preamble/AICH acknowledgement procedure, but after receiving the acquisition indication, instead of transmitting the message part over a PRACH channel specifically designed for this sole purpose the UE can be granted with a direct access to E-DCH channels for the payload delivery. Naturally corresponding DL feedback (TPC, ACK/NACK, data rate control) needs to be included. Additionally some kind of a collision detection method for the early phase of data transmission could be introduced, if seen needed. Such a scheme could be coupled with an efficient uplink feedback mechanism for the downlink transmissions on enhanced CELL_FACH and could enable seamless transition from CELL_FACH to CELL_DCH for both downlink and uplink.



Using EDCH principles for data transmission for extending the random access procedure allows

- UL interference reduction by fast power control,
- fast retransmission by exploiting the HARQ functionality,
- fast and dynamic UL resource allocation using scheduling grants, thus
- allowing variable and in comparison to REL99 RACH higher data rates

- EDCH resource co-ordination for dedicated and common users can be co-ordinated within the Node B
- HSDPA feedback (ACK/NACK and CQI) for the enhanced CELL_FACH feature becomes possible, if the EDCH resources are allocated to a UE for several 10ms to several 100 ms.

4 Conclusions

The target is to further reduce signalling delays and increase uplink data bit rates for a packet optimised radio together with Node B based scheduling, which has not been addressed for uplink with the WI "enhanced CELL_FACH for FDD" in Rel-7. An enhanced random access procedure was proposed, where E-DCH principles for data transmission replace the REL99 message part. The potentials of enhanced RACH vs REL99 RACH are listed in the table below:

	REL99 RACH	**enhanced RACH**
fast retransmissions	no	yes
fast power control	no	yes
delay to start data transmission	very low	very low
resource allocation period	one TTI period (10 or 20 ms)	up to hundreds of ms (until feasible to change to CELL_DCH)
Delivered payload per procedure	40 bytes	Kilobytes
data rate	low	comparable with EDCH
method to mitigate fast fading	interleaving	fast power control, HARQ

It is proposed to discuss proposed solution for enhancing the random access, including possibilities to capture the section 3.2 to TR25.815 and the introduction of the enhancement justifies a separate WI.

References

[1] RP-060619, Enhanced CELL_FACH state in FDD, Work Item description, Nokia