TSG-RAN WG1 meeting #15 **R1-001033**
Berlin, Germany
August 22nd – 25th, 2000

Agenda item: Release 2000 issues
Source: GBT
Title: GBT's response to Nokia's contribution: R1-00-890
Document for: Discussion (RAN WG1)

Nokia presented a contribution in WG1#14 where they analysed the delay associated with the CLPC-FACH scheme especially when the packet is re-transmitted once. GBT has performed a similar analysis and is providing responses to Nokia's comments and analysis. While the delays are slightly higher with CLPC-FACH, it is much less than the Nokia contribution states. In a nutshell, we would like to highlight the following:

1. Nokia's analysis showed an increase of 130% in delay associated with usage of CLPC-FACH fro packet re-transmissions.
2. Agreeing with Nokia's assumptions, we show this increase to be 60%.
3. Invoking some new assumption (UE protocol processing delay of 20 ms), we show this delay to increase by 35% as compared to OLPC-FACH (delay with one re-transmission)

GBT's comments are embedded in Nokia's contribution and are coloured in yellow.

TSG-RAN Working Group 1 meeting #14 **R1-00-0890**
Oulu, Finland
July 4th to July 7th , 2000

Agenda item: Release 2000 issues
Source: Nokia
Title: Remarks on the proposal for the improved cell RACH/FACH state
Document for: Discussion (RAN WG1), Information (RAN WG2)

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1. Introduction

In the last TSG RAN WG1 meeting Tdoc 678 (WG1 number) was submitted to TSG RAN WG1 and WG2 to clarify the issues. As the document was not covered in the actual meeting but still answered via the WG1 reflector, this provides an update of the documents with remaining issues that would need to discuss. The original questions and their answers are provided in Annex as it is felt that reviewing them will give some more insight what is the proposed method actually..
(The part with the revision marks is the answers provided by GBT to the issues via the reflector)

Some new items or issues needing clarification are pointed out in this paper.

1. The simulation cases:

As discussed in the reflector, for the downlink simulations TX power should be used instead of RX power. Preferable similar assumptions should be used than with TX diversity work to allow cross-checking of the results and later potential comparison with other proposed methods (if such methods emerge).

Agreed. The results are shown as a function of Tx power in contribution number R1-00-1034.

The large interleaving lengths as 80 ms are not going to be very practical as they basically mean that the FACH is reserved for 80 ms for a single UE only (otherwise TPC can not be applied)

This point requires further study. Please see the delay analysis below.

Interesting comparison case is the overhead in the uplink with current RACH/FACH state, assuming e.g. a single acknowledgement in the uplink after each packet (stream) in the downlink.

2. Delay with the operation assuming a single retransmission.

With the TCP/IP traffic model it is worth noting what is the delay for operation before TCP level retransmission is initiated. If the TCP timer value is exceeded then (IP) core network will assume that packet was lost and will resent the packet. If the timers are set very long on the otherhand will deteriorate the end user quality of service. The TCP timers are adaptive and will slowly adapt to the radio characteristics, thus the protocol will work but relative delay is interesting to account in the comparison.

What is then worth comparing is the delay with a single retransmission with the proposed scheme for a small amount of packets that could be sent during a few frames.

The delay will consist then of the following issues:
a) RNC scheduling delay
b) FACH procedure delay (including UE processing and CPCH set up etc.)
c) These both for the retransmission
d) Additionally the Iub delay and BS processing

Lets compare the delay elements between the current FACH/RACH and the proposed FACH/RACH with "FACH paging"

Delay "element"	Current	Proposed
RNC scheduling	Traffic dependant, zero if no other traffic	Requires considering the traffic that has been scheduled a priori with two-step FACH procedure. Let's assume the same value added as is needed for FACH procedure (Advance in the scheduling required)
FACH procedure delay (from the start of the FACH message to the start of the acknowledgement transmission in the uplink)	FACH message duration plus processing at UE	First FACH message duration and UE processing + second FACH message duration + UE processing
Retransmission	As above	As Above
BS processing	Not considered at this point	Not considered at this point (additional memory and processing needed though if Iub delay is not constant)
Iub Delay	Assume 100 ms roundtrip	The currently

With the above table the value for the current method for s single retransmission becomes:

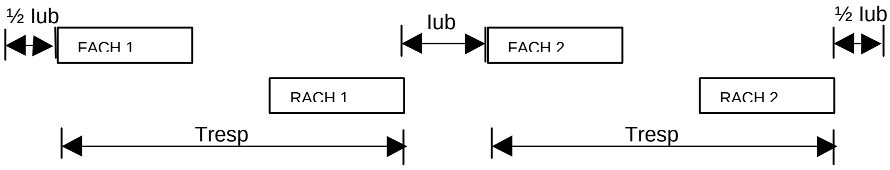
0 ms (assumed traffic equal to the FACH capability, excluding processing)
160 ms (FACH decoding, protocol processing, start up of RACH TX+ RACH procedure)
160 ms (retransmission procedure as above)
100 ms Iub delay (roundtrip) for first TX
100 ms Iub delay for second TX
+--------------------
Total of approximately 500 ms

With the above table the value for the proposed method for s single retransmission becomes:

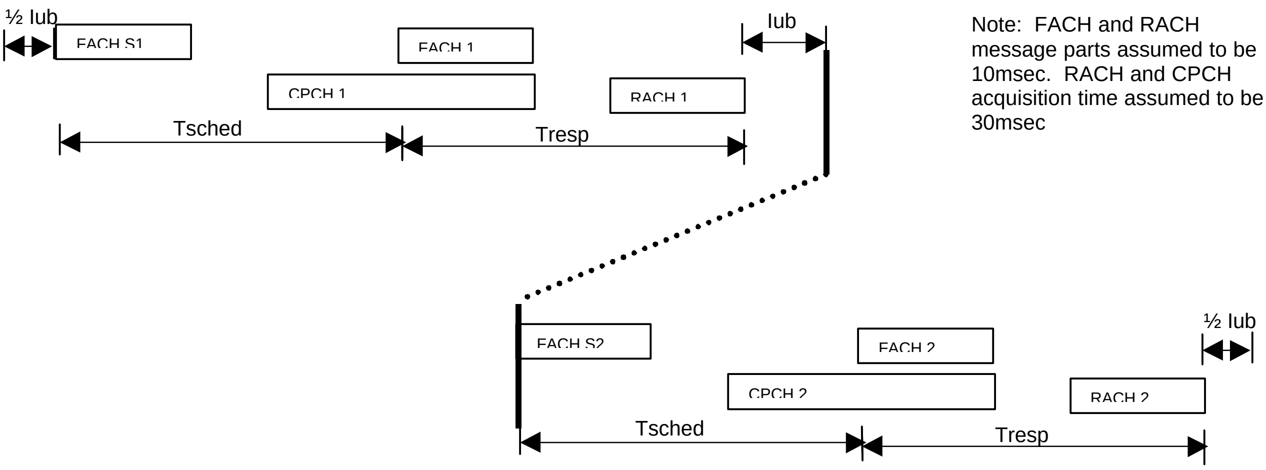
160 ms (assumed traffic equal to the FACH capability, + 160 ms advance scheduling to compensate the UE processing delay, RNC processing excluded)
160 ms (assumed traffic equal to the FACH capability, + 160 ms advance scheduling to compensate the UE processing delay) for scheduling of second retransmission
320 ms (1st FACH decoding, protocol processing, start up of CPCH TX+ procedure, 2nd FACH decoding, protocol processing, RACH or CPCH procedure for acknowledgement)
320 ms (retransmission procedure as above)
100 ms Iub delay (roundtrip) for first TX
100 ms Iub delay for second TX
+--------------------
Total of approximately 1200 ms

With the mentioned assumptions the QoS with proposed method is reduced due to the increased delay. Further if IP based transport is used on the Iub, the delay jitters needs to be compensated with additional buffer for the proposed method since the scheduling message on FACH is tied to the particular SFN.

It seems as if this analysis double counts the scheduling delay with the transmission of the FACH scheduling message. As a result the 1200 ms delay value is not valid for this comparison. The correct value seems to be 840 msec under Nokia's assumptions. The below figures clarify and correct the above tabular analysis. However, under GBT's assumptions, the correct delay value is 460 ms.



Current Case: Total_C = 2x(Iub + Tresp)



Proposed Case: Total_P = 2x(Iub + Tsched + Tresp)

In the above figures,FACH1 is the first transmission of the message, FACH2 is the retransmission of the same message, FACH Sn is the FACH scheduling message for CLPC of FACH n, which follows. RACH 1 is the RLC Nack to FACH1, while RACH 2 is the RLC Ack to FACH2.

Using this corrected analysis with the original delay assumptions: if Iub = 100 msec and Tsched = Tresp = 160, then Total_C = 520msec, while Total_P = 840 msec (60% increase), *NOT* 1200 msec (130% increase) as suggested above.

Moreover, GBT feels that the suggested values for Tsched and Tresp may be improved. Tresp consists of FACH message part (10msec), UE processing time (20msec?), RACH acquisition time (30msec) and RACH message part (10 msec) for a total Tresp = 70 msec. [The estimates for RACH and CPCH acquisition times are detailed below in response (5).] Tsched consists of FACH message part (10msec), UE processing time (20msec?), CPCH acquisition time (30msec), for a total Tsched = 60 msec. Using these revised delay estimates: if Iub = 100 msec and Tresp = 70msec, and Tsched = 60msec, then Total_C = 340msec, while Total_P = 460 msec. These improved delay estimates indicate an increased response time of only 35% using the proposed method for CLPC on FACH with FACH scheduling.

Tresp (10 ms load)=	Tsche=	Tresp (80 ms load)=
FACH message part = 10 ms	FACH message part = 10 ms	FACH message part = 80 ms
UE proc time = 20 ms	UE proc time = 20 ms	UE proc time = 20 ms
RACH acquisition time = 30 ms	CPCH acq time = 30 ms	RACH acquisition time = 30 ms
RACH message time = 10 ms	Total = 60 ms	RACH message time = 10 ms
Total = 70 ms		Total = 140 ms
C = 2x(Iub + Tresp) = 340 ms		**C = 2x(Iub + Tresp) = 480 ms**
P = 2x(Iub + Tsched + Tresp) = 460 ms		**P = 2x(Iub + Tsched + Tresp) = 600 ms**

Finally note that since Iub is the time for a round trip from Node_B to the RLC buffer (which is in SRNC, not in CRNC), the value of Iub actually includes both Iub and Iur round trip delays. Based on recent delay estimates in RAN3, 100msec seems reasonable.

The resulting delay values are not the full story as the IP network itself has varying delay characteristics that add to the total delay in addition to the one generated by the radio interface operation.

Thus if there is gain it comes at cost as well. It is then worth noting that Release –99 terminals will have better QoS in cell RACH/FACH state compared to Release 2000 terminals having support for this feature.

Interesting comparison aspect is then what is the difference to a dedicated channel set up delay when comparing to this and then what are the achieved benefits actually when compared to the dedicated channel operation.

Conclusions:

Conclusions are to be drawn of ther the discussion of this and other items raised on the reflector. It is woth noting that some decision is needed at the WG1 meeting #15 at the latest. It is to be noted that TSG RAN WG2 is also the leaving WG on the issue and outcome needs to be coordinated together with TSG RAN WG2.

Annex 1: The Comments to the Questions in R1-00-0678 (Revised comments from GBT are indicated with revision marks)

2. Comments on the fast power control benefits and simulation results.

a) Fast power control seems to be evaluated against non-power controlled case with continuous operation. As this is not the case with FACH, the results as such are of no relevance.

(1) The more correct model for analysing benefits on the FACH is a bursty model, with radio frames addressed to different UE's multiplexed and broadcast on a continuous FACH channel. The new results with bursty case are presented in R2-001246. Note that using CPCH for CLPC, provides a 5 ms power control preamble that provides closed loop power level convergence before the beginning of the FACH frame which is to use CLPC.

For a single packet (frame) on FACH, comparison needs to be made with total required signalling with and without fast power control, In this case single packet is better without fast power control as with fast power control there needs first to be a transmission with "paging" type of information (without fast power control to initiate CPCH operation in the uplink. For this:

- What is the interference generated in the uplink only for this? (as only downlink is simulated)

(2) One reserved PCPCH channel operating at the lowest SF [256]. So the total generated interference is either 15 kbps for a FACH operating at a very high rate.
This uplink CPCH is used only during those FACH segments selected for CLPC.
If, for instance an average FACH would have 20% of its downlink traffic addressed to individual UEs and selected for CLPC, then the UL interference for the CPCH providing CLPC would be 15 kbps x .2 = 3 kbps average. The PCPCH only lasts during the FACH CLPC segment downlink transmission .

- What is the cut of "difference" for total number of frames on FACH before closed loop power control bring gains? It should be obvious that a single frame FACH is better without power control when considering all the overhead coming from: FACH "paging", CPCH (both uplink and downlink), channels needed to support extra CPCHs (CSICH etc,)

(3) The gain for 10 ms, 20 ms, 40 ms and 80 ms bursts are shown in R2-001246. Even at 10 ms and 64 kbps, there is a close to 2 dB gain at BER of .005. Again, the CPCH overhead in DL and UL is only 15 kbps (DL) and 15 kbps? (UL) used only during transmission of the CLPC FACH.

The downlink scheduling for CLPC FACH would require approximately 20 bits for each message which schedules a single CLPC FACH segment. Each CLPC FACH segment may use multiple contiguous frames, but the worst case for overhead computation is to assume a CLPC page message for each frame. In this case the CLPC paging messages will require 2kbps. So the total overhead can be calculated:

DL: 15 kbps (CPCH) + 2 kbps (paging) = 17 kbps
UL: 15 kbps (CPCH)

These figures would be multiplied by the percentage of the FACH channel which would use CLPC. For example:

10% of FACH using CLPC:
1.7 kbps overhead in DL, 1.5 kbps overhead in UL.

100% of FACH using CLPC:
17kbps overhead in DL, 15 kbps overhead in UL.

The DL capacity gain for continuous operation depends on FACH channel rate.
For a 2 db capacity gain (20 msec, 5 Hz), the increased DL capacity is:

30 kbps FACH: 27 kbps (data) x 2 db = 15.8 kbps increased capacity
(assuming TFCI)
60 kbps FACH: 57 kbps x 2 db = 33.3 kbps increased capacity

120 kbps FACH: 108 kbps x 2 db = 63.2 kbps increased capacity
240 kbps FACH: 228 kbps x 2 db = 133.4 kbps increased capacity
…..etc…

Thus for 30 kbps FACH the overhead to support CLPC exceeds the capacity gain. For 60 kbps FACH the net gain is marginal. For FACH rates at 120 kbps or higher, there are clearly large net capacity gains.

Given the above, there should be a 64 kbps cut-off for CLPC on FACH.

It is also worth noting as mentioned in last WG1 that some generic assumption like power control dynamic range correspond (60 dB?) to the uplink case rather than the downlink case.

(4) The new results for 40 dB and 20 dB dynamic ranges are presented in R2-001246.

3. Questions on the proposal itself:

b) What is the minimum and max delay required between FACH "paging" and actual packet on the FACH? What does the calculated delay consist of (UE processing, CPCH procedure, Node B-RNC delay etc.)? Are CPCH procedure error events included?

(5) The scheduling delay, $\tau_{CLPC,}$ is deterministic and includes

1. UE processing (fixed)
2. CPCH Access Ramp up (variable, Nap_retrans_max dependant)
3. CD phase (fixed)
4. pre-data power control (fixed)

Note that 1 or two PCPCH channels are reserved for CLPC and there is no contention for this PCPCH. CPCH procedure errors events are considered in this protocol and if they occur, OLPC of FACH (normal operation) is used on the FACH segment. See answer (9), below.

τ_{CLPC} = (Nap_retrans_max + 1)$\tau_{next\ slot}$ + 5.28msec,
where τ_{next_slot} = Time to next available access slot, between Access Preambles.
= 3.75ms + 1.25ms X Tcpch (CPCH timing parameter)

Note that this is equivalent to:
τ_{CLPC} = [max period from first AP to start of PCP] + [8 slot length PCP]

Figure 1 below shows an overview of the CLPC FACH timing between the Node B and the UEs.

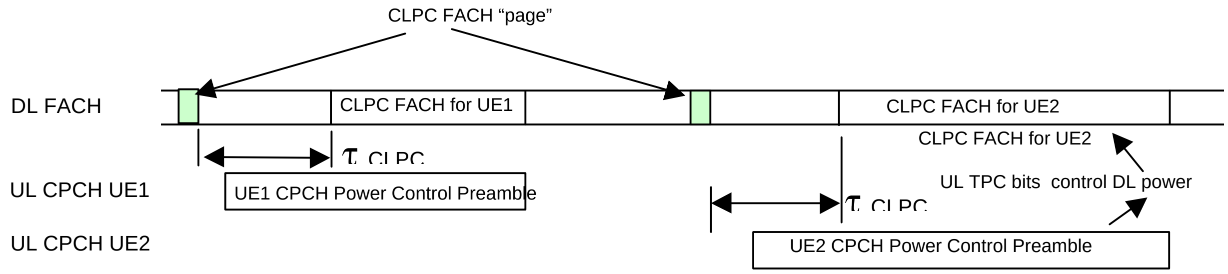


FIGURE 1. CLPC FACH Timing.

For example if Tnext slot = 3.75 msec, and if Nap_retrans_max= 10,
τ_{CLPC} = (10 + 1)*3.75 + 5.28 msec = 46.5 msec (approximately 5 frames).
If Tnext slot = 3.75 msec, and if Nap_retrans_max= 5,
τ_{CLPC} = (5 + 1)*3.75 + 5.28 msec = 27.8 msec (approximately 3 frames).

c) Where are the packets buffered in the meantime and what is the buffer size needed?

(6) It is proposed to buffer the packets in Node B.
Buffer size is dependant on τ_{CLPC} , as shown above. If τ_{CLPC} is 5 frames, as shown in the above example, then the required buffer is approximately 200 bytes for 60 kbps FACH, 400 bytes for 120 kbps FACH, etc.

d) If in the RNC, is then the uplink CPCH maintained over (100 ms?) just for a single 10 ms packet?

NA

e) What is the amount of bits needed to tell UE the necessary parameters for closed loop FACH reception?

(7) The UE scheduling message includes the following:

1) the UE ID (e.g. CRNTI) to use the next CLPC FACH, e.g.16 bits
2) Identification of the PCPCH to be used for the next segment 4bits

Upon receipt of the CLPC scheduling message, the addressed UE begins to access the reserved PCPCH channel indicated in the message, while continuing to monitor the FACH DL. When the CLPC FACH segment begins, the UE maintains the PCPCH channel. If no FACH segment is addressed to the UE within τ_{CLPC} of initial access attempt, the UE releases the reserved PCPCH. The UE maintains the reserved PCPCH channel until the first frame in which there is no FACH message directed to that UE. At that point the UE releases the PCPCH used for CLPC. In this way the protocol does not require explicit signalling of SFN number for onset of CLPC segment or signalling of CLPC segment length.

4. Questions on System issues:

a) Does there need to be PCPCH always reserved for FACH with closed loop power control? Or multiple ones? If more than one then how many? How many extra receivers are needed for CPCH in Node B for a single FACH with CPCH? (With and without existing CPCH traffic)?

(8) It is required to have a minimum of one PCPCH transceiver in the Base Node for this purpose ONLY (with or without CPCH traffic) which is reserved for CLPC of the Downlink FACH transmission. It is worthwhile to do so if the capacity gain in the downlink is by a factor of 1.4-2 and the FACH transmission is rates 60 kbps or higher. At the lower rates there is no net gain.

If the CLPC FACH traffic is interleaved with normal FACH, then only one PCPCH is needed. UTRAN schedules the CLPC portions of the FACH with the constraint that each CLPC FACH segment must be separated by a minimum period equal to τ CLPC if there is only one associated PCPCH. This period permits the UE which is to receive the following segment to access the associated CPCH channel in order to establish closed loop power control with the Node B. If there is more than one associated PCPCH, then UTRAN alternates use of these PCPCHs so that CLPC FACH segments may be transmitted contiguously.

b) If uplink is congested, does this prevent FACH transmission on the downlink (when CPCH procedure fails due (to) interference peak in the uplink)

(9) As mentioned above one PCPCH access resource is reserved for this purpose only. So, there is no congestion or contention for this resource.

If the uplink interference is so high that the access preamble is not heard at all after maximum number of ramp-ups, then the cell is overloaded. In that case the FACH transmission would continue normally using OLPC methods. If the Base Node does not hear the preamble [confirmation from the UE],or if, for any reason, the reserved PCPCH DPCCHs for CLPC are not established at the time the CLPC FACH segment is to begin, Node B will not attempt CLPC and will revert to normal FACH broadcast for that segment. Access error events cause the Node B to abort CLPC protocol for that FACH segment. The FACH segment is still transmitted and received, but at the higher broadcast power level.

c) Are there impacts for the functional split between RNC and Node B? The earlier raised issue was where are the packets stored before CPCH procedure has success?

See above.

d) If RNC controls the FACH usage (message contents), how does RNC know when CPCH has been released or whether it was free when FACH message was generated in RNC? (if the same CPCH resource pool is shared for CPCH operation)

(10) NA. The resource should be reserved for this purpose.

e) What is the impact for PCH/FACH scheduling?

(11) May need further clarification on this question.

For UEs in the PCH state, UTRAN shall transmit paging messages to alert UEs of forthcoming DL FACH messages which may use CLPC FACH. Upon receipt of an alert for a forthcoming DL FACH message, the UE shall transition to Cell-FACH state and use the procedure described here for receipt of CLPC FACH. The UTRAN must schedule the paging alert for CLPC FACH sufficiently early to permit the UE time to transition to Cell-FACH state, receive the CLPC FACH schedule, and access the associated PCPCH channel before the beginning of the scheduled CLPC FACH segment.

f) Release –99 UE expects FACH to be non-power controlled. When on the RACH/FACH state, does the power controlling of FACH cause problems for their quality monitoring of FACH reception and in-band identification of UEs ? Mainly are there impacts to WG4 requirements due (to) this change?

(12) Preliminary comments:

1. It is our understanding that currently slow power control and OLPC on FACH is possible. So this should not be a new issue.
2. It is also our understanding that several S-CCPCH could be used in a single cell, so segregation of UEs by capability (UE release) is possible.
3. Even if the R'99 UE is not power-controlled, there is a possibility of error on FACH reception, possible errors induced by CLPC would be no different than other errors handled in R'99.
4. It is also possible not to interleave the packet data traffic on FACH#1 and open another FACH #2 for the downlink packet data ONLY.

5. **Conclusions:**

This contribution is intended to point out the issues where further clarifications would be needed before some evaluation of the benefits of the proposed modification for UTRA FDD cell RACH/FACH state could be done. It is to be noted that most of the issues are of the responsibility of RAN WG1 but it was felt useful to have visibility of the raised questions to RAN WG2 as well. Thus this paper is submitted to both RAN WG1 and RAN WG2 with the expectation that (most of) the discussion is to take place in RAN WG1.