TSG-RAN Working Group 1 meeting No. 18 **_TSGR1-01-0007_**
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Agenda Item: **AH24**

Source: **Nokia**

Title: **Considerations on HSDPA HARQ concepts**

Document for: **Discussion**

Introduction

In RAN WG1 meeting #17 in Stockholm there was a discussion paper on HARQ aspects addressing quite a few issues of interest [1]. This contribution continues the discussion on these concepts and also brings out some new points to consider.

Discussion

Processing Time

Processing time considerations are discussed in [2].

Multiple transport blocks per TTI

It was suggested in [1] that Ack/Nack per transport block would allow specific retransmission. There is a benefit from individual acknowledgement of transport blocks if the block errors are uncorrelated from one TB to another. However, it is expected that there is a high correlation between errors in transport blocks that are transmitted during one HSDPA TTI [3], i.e. probably 1 – 5 ms. Acknowledging each transport block separately would only unnecessarily increase feedback signaling.

Furthermore, it seems best to consider the HSDPA TTI length as fixed. Flexibility in the TTI length during HSDPA transmission would complicate scheduling. There has been some concern that at lower bit rates the short HSDPA TTI would provide too few bits for efficient turbo encoding. Table 1 shows the amount of bits in HSDPA TTIs of several lengths for a number of spreading factors. These sizes are calculated for QPSK modulation with single code channel, i.e. the lowest bit rate with HSDPA. CRC bits are included in the figures. Shaded part shows the cases when there are (roughly) at least 300 bits before Turbo encoding.

Table 1. Maximum number of bits in a smallest allocation unit as a function of the HSDPA TTI length (in slots). QPSK modulation with Turbo coding rates of 1/4, 1/2, 3/4 and 1 in a), b), c) and d), respectively

		Max # of bits			
Ndata	SF	1	3	5	15
160	32	40	120	200	600
320	16	80	240	400	1200
640	8	160	480	800	2400
1280	4	320	960	1600	4800

a)

		Max # of bits			
Ndata	SF	1	3	5	15
160	32	80	240	400	1200

320	16	160	480	800	2400
640	8	320	960	1600	4800
1280	4	640	1920	3200	9600

b)

		Max # of bits			
Ndata	SF	1	3	5	15
160	32	120	360	600	1800
320	16	240	720	1200	3600
640	8	480	1440	2400	7200
1280	4	960	2880	4800	14400

c)

		Max # of bits			
Ndata	SF	1	3	5	15
160	32	160	480	800	2400
320	16	320	960	1600	4800
640	8	640	1920	3200	9600
1280	4	1280	3840	6400	19200

d)

It can be seen that for practical spreading factors for HSDPA (32 or shorter) TTI lengths of 3 and longer do not introduce really small bit allocations for turbo encoding. Encoding rate of ¼ for QPSK may not be feasible in the first place as suggested in [4]. It is also not likely that only one code channel is activated for a user. Multiple code channels increase the minimum allocation of bits from those depicted in table 1. Extra decoding performance from extending a TTI length during transmission has to be big enough to validate the added scheduling complexity in order to be acceptable.

Multiplexing of users in time

In [1] there was a concern whether it is possible to send blocks from user B if there are blocks pending positive acknowledgement from user A in the scheduler. As a matter of fact, N-channel stop-and-wait HARQ does support asynchronous transmission: different users can be scheduled freely without waiting completion of a given transmission. The transmission for a given user is assumed to continue when the channel is again allocated. There are two different methods for N-channel HARQ[5]:

a) either signal the subchannel number explicitely, or

b) tie the subchannel number to e.g. frame timing.

The asynchronous feature of N-channel HARQ is shown in Figure 1 for method a): after four packets to UE1, a packet is transmitted to UE2 and the transmission to UE1 is delayed by one TTI. Also, there are 5 packets to UE1 between packets to UE2.

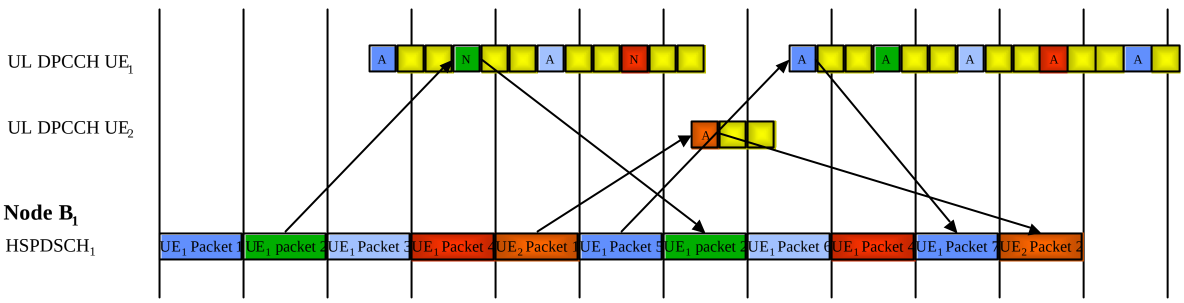

Figure 1. Principle of N-channel stop-and-wait HARQ (N=4). [5]

In other words, the N-channel HARQ processes for UE1 and UE2 are independent but the scheduler allocated the resources such that continuous utilization of the HSDPA channel is possible. The transmissions for UE1 in HARQ subchannel m do not have to be repeated exactly in every N^{th} HSDPA TTI. This flexibility can be supported with a UE indicator and subchannel number for each HSDPA TTI.

Method b) would restrict the positions of retransmissions such that the retransmissions can only happen at positions $m+k*N$, where m is the position (TTI) of the first transmission of a given packet and $k = 1,2,…$. The retransmissions could still be delayed if the channel is allocated to other users in between.

References

[1] Discussion on ARQ aspects for High Speed Downlink Packet Access, R1-00-1442, Nortel

[2] Text proposal to TR25.848 on HARQ complexity, R1-01-0006, Nokia

[3] Relationship between frame error rate and TrCH block error rate, R1-01-0008, Nokia

[4] HS-DSCH simulation results, R1-00-1377, Sony

[5] Text proposal on HARQ for HSDPA TR, R1-01-0005, Nokia