**3GPP TSG RAN WG1** **TSGR1#17(00)1369**
**Meeting #17**
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**Stockholm, Sweden**



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| **Agenda item:** | **7** |
| **Source:** | Nokia |
| **Title:** | Text proposal on HARQ for HSDPA TR |
| **Document for:** | Discussion and approval |

**Summary:**

Technical Report (TR) 25.848 collects the RAN WG1 results for High Speed Downlink Packet Access (HSDPA) study item. Hybrid ARQ (HARQ) has been proposed as one of the possible techniques to enhance the system performance. In this contribution, a text proposal to TR 25.848 on HARQ is made considering mainly the physical layer aspects.

## 1. INTRODUCTION

Technical Report (TR) 25.848 collects the RAN WG1 results for High Speed Downlink Packet Access (HSDPA) study item. Hybrid ARQ (HARQ) has been proposed as one of the possible techniques to enhance the system performance. In the following, a text proposal to TR 25.848 on HARQ is made considering mainly the physical layer aspects.

## 2. HARQ FOR HSDPA

The following text is proposed to be added to TR 25.848:

**---------------------------------------- Start text proposal --------------------------------------------**

### 6.2 Hybrid ARQ (H-ARQ)

In order to reduce receiver buffering requirements a HARQ scheme based on dual channel stop-and-wait protocol has been proposed. Key principle of the solution is illustrated in the Figure 1 which shows an example sequence of events when packets $P_1$-$P_6$ are being transmitted. Packets are transmitted using two parallel ARQ processes, each using stop-and-wait principle. Each packet is acknowledged during the transmission of the next packet so that the downlink channel can be kept occupied all the time if there are packets to transmit.

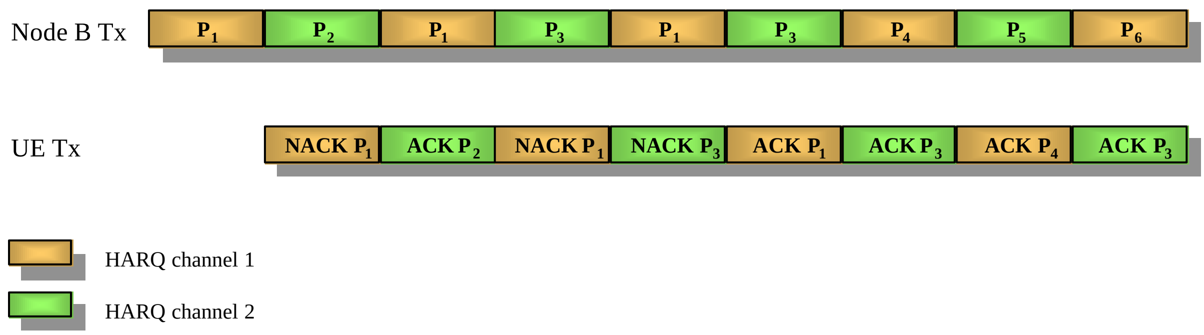


*Figure 1. Principle of dual channel stop-and-wait HARQ.*

The dual channel principle can be generalized to N channels in which case there are N parallel ARQ processes each using stop-and-wait protocol.

There are a number of issues that need to be studied and specified if N channel HARQ will be used including:

?? Downlink signaling requirements

?? Uplink signaling requirements

?? Coding solution

?? UE and Node B processing requirements

?? Max number of parallel ARQ processes

?? Max number of retransmissions

?? Interaction with AMC and FCS

For each HSDPA TTI, receiver needs to know which HARQ process the transport block(s) of that TTI belong to. That could be explicitly signaled requiring $log_2(N)$ bits per HSDPA TTI. Alternatively, deterministic mapping between the ARQ processes and e.g. CFN could be defined allowing the receiver to distinguish which one of the N channels is being received in a given HSDPA TTI.

It could also be useful to signal in downlink the redundancy version of the transport block(s) received during a HSDPA TTI. In most simple case this could be just a indication of a start of a new packet (i.e. RLC PDU). This would aid the receiver to perform the combining and decoding of the transport block(s) properly in case of signaling errors in uplink. If incremental redundancy schemes are used even the redundancy version could be signaled to the UE requiring at least $log_2$(# of redundancy versions) bits per HSDPA TTI.

In the uplink direction acknowledgements of the received RLC PDUs are sent. In a straightforward solution this would require 1 bit per received HSDPA TTI to be transmitted from UE to Node B. If there are more than one transport block in a HSDPA TTI, they could be acknowledged individually resulting in higher uplink signaling load but possible better link performance.

An important issue is the encoding solution of the HARQ, i.e. if Type II or Type III HARQ will be used. A simple solution is to use Type III with single redundancy version meaning that received code blocks are simply soft combined before decoding. In case of Type II or Type III with multiple redundancy versions, additional redundancy bits are sent during each retransmission yielding potentially more coding gain than simple Type III with single redundancy version. Which scheme will be adopted should be based on performance improvement and complexity considerations.

Due to strict timing requirements of N channel stop-and-wait HARQ scheme the processing time requirements both in UE and Node B should be carefully studied. At UE side there should be sufficient time left for all the processing after the reception of the transport blocks of a HSDPA TTI until the transmission of acknowledgement in uplink. Similarly, sufficient time should be left for Node B to react to the received acknowledgement message before the next transmission time interval for the given HARQ process.

Figure 2 shows an example of a feedback timing of a dual channel stop-and-wait HARQ. In this case 5 slot HSDPA TTI has been assumed. HARQ feedback is transmitted over three uplink slots leaving 1 slot time for processing both in UE and Node B (excluding propagation delays).

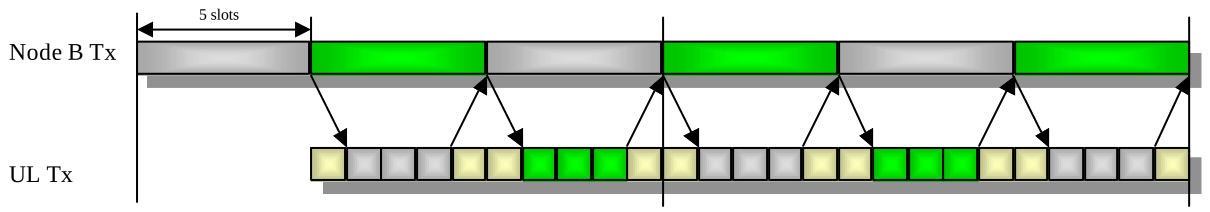


*Figure 2. Example of HARQ feedback timing in case of dual channel stop-and-wait protocol.*

For a fixed HSDPA TTI length, increasing the number (N) of parallel HARQ processes will improve the time diversity per process and could result in longer available processing times both at UE and Node B. Downside include the increased buffering requirements at UE, longer delay per process and higher uplink signaling load in case the HARQ state information need to be communicated to new Node B while doing FCS. These factors should be taken into account when defining the maximum for N. Note that for very short (< 3 slots) HSDPA TTI it could be beneficial to have N always greater than 2 because then, for example, the processing time requirements would not be too demanding.

Maximum number of retransmissions could be fixed to a constant value or it could be a parameter whose value can be set based on various criteria. Defining it as a parameter would mean a bit more flexibility in controlling the delay characteristics over the air interface. Note that if some indication of the start of a new RLC PDU is send to UE it is not absolutely necessary for UE to know what is the maximum allowed number of retransmissions. Yet, due to signaling errors it is probably beneficial to negotiate that information between the network and UE in order to recover faster from erroneous situations.

When N channel HARQ is used in addition to other proposed performance enhancement techniques like AMC and FCS there are certain interactions between them that need to be considered. One issue that needs to be addressed is the possibility to change the MCS while doing retransmissions. A simple approach is to impose a restriction on the AMC control so that MCS can be changed only when the transmissions of a new RLC PDU starts. By proper coding design of HARQ it could be possible to remove that restriction. The eventual selection of a solution should be based on complexity and performance considerations.

When FCS is applied it is probable that HARQ state information needs to be communicated to a new Node B. In order to minimize this signaling load in the uplink number of parallel HARQ processes should be kept small. This should be taken into consideration when defining the maximum value of N.

**---------------------------------------- End text proposal -------------------------------------------**