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Title: HARQ signalling and receiver operation for HSDPA

Document for: Discussion and decision

1 Introduction

This paper provides details on signalling and receiver operation for HARQ in HSDPA. The proposals for HARQ [1] in HSDPA use stop-and-wait protocol for simplicity. It is also well understood that the HARQ provides throughput gains when the error rate on the individual HARQ transmissions is high. The signalling channel that enables HARQ operation does not use HARQ itself. Therefore, a higher reliability is needed on the signalling part compared to the data or bearer traffic part. The higher reliability means higher overhead due to signalling. Therefore, it is desirable to limit the signalling overhead on the HARQ signalling channel.

2 Signalling requirements

The control fields needed for HARQ operation are shown in Table 1. For N-channel HARQ operation [3] $\log_2(N)$ bits are needed to identify the stop-and-wait channel being used for transmission. In order to allow different transport block set size for a given data rate on the HS-DSCH, a method to indicate the transport block set size to the receiver is needed. This can be accomplished by a $\log_2(S)$-bit field in the HARQ signalling channel, where S is the number of transport block set sizes (i.e., the number of transport blocks). Note that a large number of transport block sets will provide better frame-fill efficiency at the expense of higher signalling overhead.

Table 1. Control fields for HARQ

Control Field	Number of bits
HARQ N-channel identifier	$\log_2(N)$
Transport block set size	$\log_2(S)$, where S is the possible code block sets
New/Continue Flag	1

For HARQ operation, a NEW/CONTINUE flag can be used to indicate whether a transmitted sub-block is the beginning of a new code block or the continuation (repetition or redundant information) for a previous code sub-block. This helps the receiver to determine code block boundaries in case an ACK/NACK is misinterpreted.

The NEW code block indication also helps the receiver IR engine get in synchronisation with the transmitter if a NEW/CONTINUE flag error occurs. Under error conditions, a receiver may miss a transmission or detect a NEW/CONTINUE flag in error. In either case, the receiver will try to decode the code block by combining wrong (or out-of-order) encoded sub-blocks thus making it difficult or impossible to recover the correct code block. Recovery occurs on the receipt of the next NEW code block indication, when the receiver will discard any previously stored coded sub-blocks and will start to decode the new coded sub-block.

3 Receiver Operation

Figure 1 shows the receiver operation for the HARQ operation. A brief description of the flow chart follows. When the receiver is waiting for a NEW encoded sub-block and receives a NEW encoded sub-block, it attempts to decode it. If the decoding is successful it transmits an ACK and then waits for the next NEW encoded sub-block. If the decoding is unsuccessful, it transmits a NACK, stores the received encoded sub-block for subsequent combining with redundant information, and waits to receive a CONTINUE encoded sub-block. If the receiver receives a CONTINUE encoded sub-block while waiting for one, it attempts decoding by combining the received encoded sub-block with the stored information. If the decoding is successful, it transmits an ACK and waits for the next NEW encoded sub-block, while if decoding is unsuccessful, it transmits a NACK and then waits for the next CONTINUE encoded sub-block.

For the case, when a receiver receives a NEW encoded sub-block while waiting for a CONTINUE, the receiver abandons recovery of the previous code block and moves on to attempt to decode the code block corresponding to the new received encoded sub-block.

When a receiver receives a CONTINUE encoded sub-block while waiting for a NEW, the receiver just discards the received encoded sub-block and continues to wait for a NEW encoded sub-block.

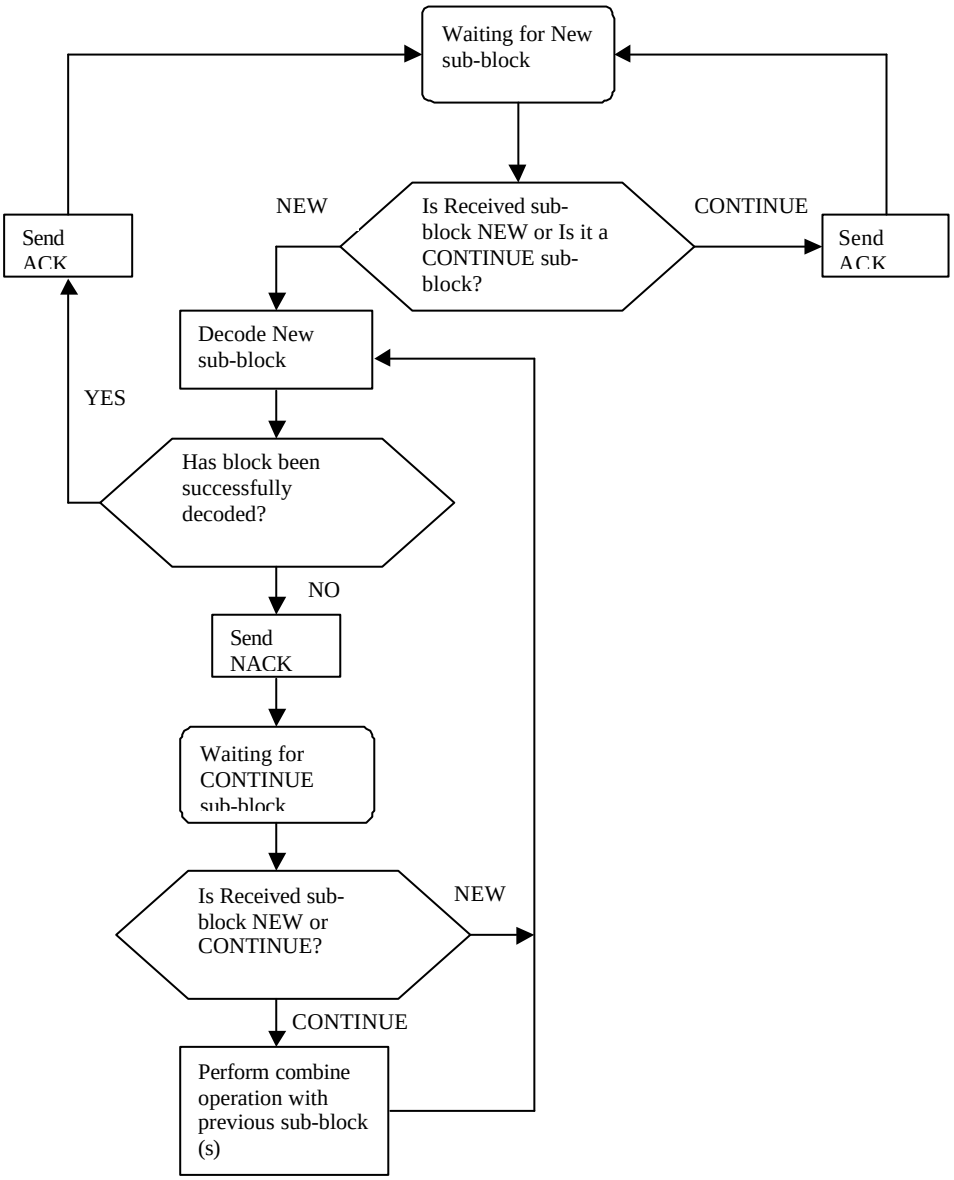

Figure 1. Receiver operation for stop-and-wait HARQ.

4 Conclusion

The signalling and receiver operation required for HARQ operation in HSDPA is discussed.

5 References

[1] "A^2IR - An Asynchronous and Adaptive HARQ scheme for HSDPA", Lucent Technologies, TSG-RAN WG1#18(01) 0080, Boston, USA.

[2] "Variable TTI for HSDPA", TSG-RAN #18(01) 0079, Lucent Technologies.

[3] "Considerations on HSDPA HARQ concepts", TSG-RAN #18(01) 0007, Nokia.