TSG-RAN meeting #18 RP-020679
New Orleans, US 3-6 December 2002

TSG-RAN Working Group 1 meeting No. 29 R1-02-1457
Shanghai, China, 5th-8th November 2002

Title: **LS on HS-DPCCH performance**
Release: **R'5**
Source: **RAN1**
To: **RAN2, RAN3**
CC: **RAN**

Contact Person:
Name: **Tim Moulsley**
Tel. Number: +44 1293 815717
E-mail Address: tim.moulsley@philips.com

Attachments:

[1] R1-02-1334, **"Scheme for meeting HS-DPCCH performance requirements for Rel-5", Philips**

[2] R1-02-1335, **"Simulation results on scheme for meeting HS-DPCCH performance requirements for Rel-5", Philips**

[3] R1-02-1422 **CR25.214-295r2 (Rel-5) Correction of DTX transmission in ACK/NACK field**

CR25.212-161r1 (Rel-5) Correction of coding of HARQ-ACK

---

1. Overall Description:

RAN1 understands the performance requirements for reception of HS-DPCCH previously stated by RAN2 to be as follows:

- The probability of the Node B decoding an ACK when a transport block has been correctly received by the UE on HS-DSCH:- > 0.99
- The probability of the Node B decoding an ACK when the CRC has failed for a transport block on the HS-DSCH:- < 0.0001 (0.001 for difficult radio conditions)
- The probability of the Node B decoding an ACK when the HS-SCCH is not detected by the UE:- < 0.01 (0.1 for difficult radio conditions)

The last requirement applies under the assumption that the probability of the UE failing to detect the HS-SCCH is less than 0.01.

Meeting these requirements with the current Rel5 specifications in difficult radio conditions (e.g. Soft Handover, particularly with unfavourable radio link imbalance) requires raising the DPCCH power (which would reduce uplink capacity using R99 channels) and/or using ACK/NACK repetitions (potentially limiting the peak bit rate and reducing the throughput achievable with HSDPA for certain UE categories with minimum inter TTI interval equal to one).

Although RAN1 is not in full agreement whether there is a need to change the current specifications to meet the relaxed performance requirementsRAN1 has for some time been studying proposals to improve the reliability of ACK/NACK signalling. Simulation results for one of these proposals indicated worthwhile improvements in performance in some cases (see [1] and [2]), and possible suitability for inclusion in R'5. However, some companies requested more time to fully evaluate the performance of the proposed scheme and investigate concerns about possible erroneous operation and increased complexity of Node B receiving process. Therefore RAN1 has reviewed the attached CR's in [3] and although not fully approving them has endorsed them as "a technically correct specification of the scheme" and as such, they can be submitted to RAN#18 in December for final approval (providing the further studies confirm satisfactory performance). The CR's are indicated as sourced by the proposing companies.

In order to assist in the timely completion of R'5 in the event of approval by RAN, RAN1 would like to inform RAN2 and RAN3 of the following clarifications:

(1) The proposed scheme introduces two additional physical layer signals to be conveyed via HS-DPCCH in the slot allocated to uplink ACK/NACK transmission. These take the form of two additional codewords representing a PRE (preamble) and a POST (postamble) respectively. RAN1 has not reached agreement on whether these additional signals can be processed entirely within the physical layer or whether they would need to be visible to higher layers.

(2) The existing performance requirements are unchanged for (a) the probability of correctly decoding an ACK transmission and (b) erroneously decoding ACK's when one was not transmitted. RAN1 has not concluded whether additional performance requirements are needed.

(3) It is suggested that the proposed scheme would be enabled/disabled by a higher layer parameter ("DTX_mode") signalled to each UE and which may take values 0 or 1. Furthermore, in order for the Node B to implement appropriate decoding of the HS-DPCCH, it should be aware of the value of DTX_mode for each UE. Therefore it seems necessary to be able to signal this value via the NBAP/RNSAP.

RAN1 is not yet in full agreement whether this proposed change to the specification is sufficient to satisfactorily meet the performance requirements under some important conditions (e.g. Soft handover, particularly with unfavourable radio link imbalance, as indicated by some contributions presented to RAN1). Some companies have also expressed concern over the reliability of CQI under the same conditions, and both these issues could be addressed at the same time if additional proposals are studied. However, in this case, the expected completion date of the further necessary work, based on contributions so far discussed by RAN1, would not be before RAN#18 but would be in time for approval at RAN#19.

2. Actions:

To RAN WG2

ACTION: RAN1 kindly requests RAN2 to check whether the additional PRE and POST signals have any impact on the HARQ functionality or if they can be processed entirely within the physical layer and therefore would not be required to be visible to higher layers. RAN1 also requests RAN2 to check whether additional performance requirements are needed for PRE and POST reception.

RAN1 also kindly requests RAN2 to prepare the relevant CR for addition of the proposed scheme in R5 25.331 and 25.321 if judged necessary.

To RAN WG3

ACTION: RAN1 kindly requests RAN3 to prepare the relevant CR(s) for addition of the proposed scheme to the R5 NBAP/RNSAP.

3. Date of Next RAN1 Meetings:

RAN WG1 #30	2003	January	7-10	San Diego, CA, USA
RAN WG1 #31	2003	February	18-21	Tokyo, Japan

3GPP TSG RAN WG1#29 **Tdoc R1-02-1334**

Shanghai, China, 5th – 8th November, 2002

Agenda Item: 6.1

Source: Philips

Title: Scheme for meeting HS-DPCCH performance requirements for Rel-5

Document for: Decision

---

1. Introduction

Note: A draft version of this document was circulated on the RAN WG1 email reflector on 15th October 2002.

In [1] we presented a scheme for reducing the power requirement for the HSDPA hybrid ARQ ACK/NACK transmissions on the HS-DPCCH and helping to ensure that the error rate requirements are met. Further simulation results were presented in [2], and some small improvements were made in [3] following some helpful comments.

In this document we present a further small improvement to this scheme in the light of comments raised during the email discussion, and we provide a detailed summary of the scheme.

2. Further improvement following email discussion

According to the original scheme, some extra NACKs are transmitted on the HS-DPCCH in sub-frames which would not otherwise contain an ACK or NACK, in order to avoid the Node B having to distinguish between DTX and ACK in a single slot. This reduces the detection threshold offset which is required at the Node B, and results in a significant reduction in the required HS-DPCCH power.

During the email reflector discussion, some concerns were raised as follows:

1. For the case of consecutive packet transmission, the original scheme did not allow the Node B to distinguish between the UE having failed to detect the HS-SCCH signalling and the UE having detected the HS-SCCH signalling but failed to decode the HS-DSCH packet. It was suggested that this could increase the packet energy required with full IR where only the first transmission is self-decodable (although in the case of so-called partial IR, where at least one of the subsequent retransmissions also contains the systematic bits, or in the case of Chase combining, this should not be a problem).
2. For certain specific sequences of packet transmission, the full gain of the scheme was not achievable.

In order to solve these two potential problems, we propose that the “preamble” NACK, which is transmitted when the UE detects HS-SCCH control information, and the “postamble” NACK, which is transmitted after a hybrid ACK/NACK if a packet is not detected in the next subframe, should be modified to enable them to be distinguished from normal NACKs, as follows:

ACK:	+1 +1 +1 +1 +1 +1 +1 +1 +1 +1
NACK:	-1 -1 –1 –1 -1 –1 -1 -1 –1 -1
PREAMBLE (”POST”):	-1 -1 +1 –1 -1 +1 -1 -1 +1 -1
POSTAMBLE (”PRE”):	-1 +1 –1 –1 +1 –1 -1 +1 –1 –1

According to this modification, a much greater Euclidian distance is still maintained between the preamble/postamble and ACK (total distance 14) than between DTX and ACK. This enables most of the benefit from Node B threshold reduction to be maintained. In addition to this, there is now a distance 12 between the preamble and the postamble, and a distance of 6 between the preamble/postamble and NACK.

This means that it is now possible to use this scheme with full IR and distinguish between failure to detect the HS-SCCH and failure to decode the HS-DSCH packet.

In addition, the CQI can be used to improve the reliability of identifying whether the UE has detected the HS-SCCH: if a high CQI value is reported, it is likely that the HS-SCCH was detected, but if a low CQI value is reported, it may be more likely that the HS-SCCH was not detected.

If NACK is wrongly received as POST or PRE, the only potential side-effect if "full" IR is used is that the previous redundancy version would be retransmitted instead of transmitting a new redundancy version. The effect of this should be very small, as, unlike with the original scheme, no systematic bits would be lost.

For those cases where this scheme is not needed (e.g. very slow speeds in non-SHO), this scheme can be disabled by higher layers (using the parameter "DTX_mode"). This will minimise uplink interference.

3. Detailed summary of improved scheme

a) With single ACK/NACK transmission (i.e. N_acknack_transmit = 1)

For simplicity, we begin by considering the case when N_acknack_transmit = 1, as shown in Figure 1.

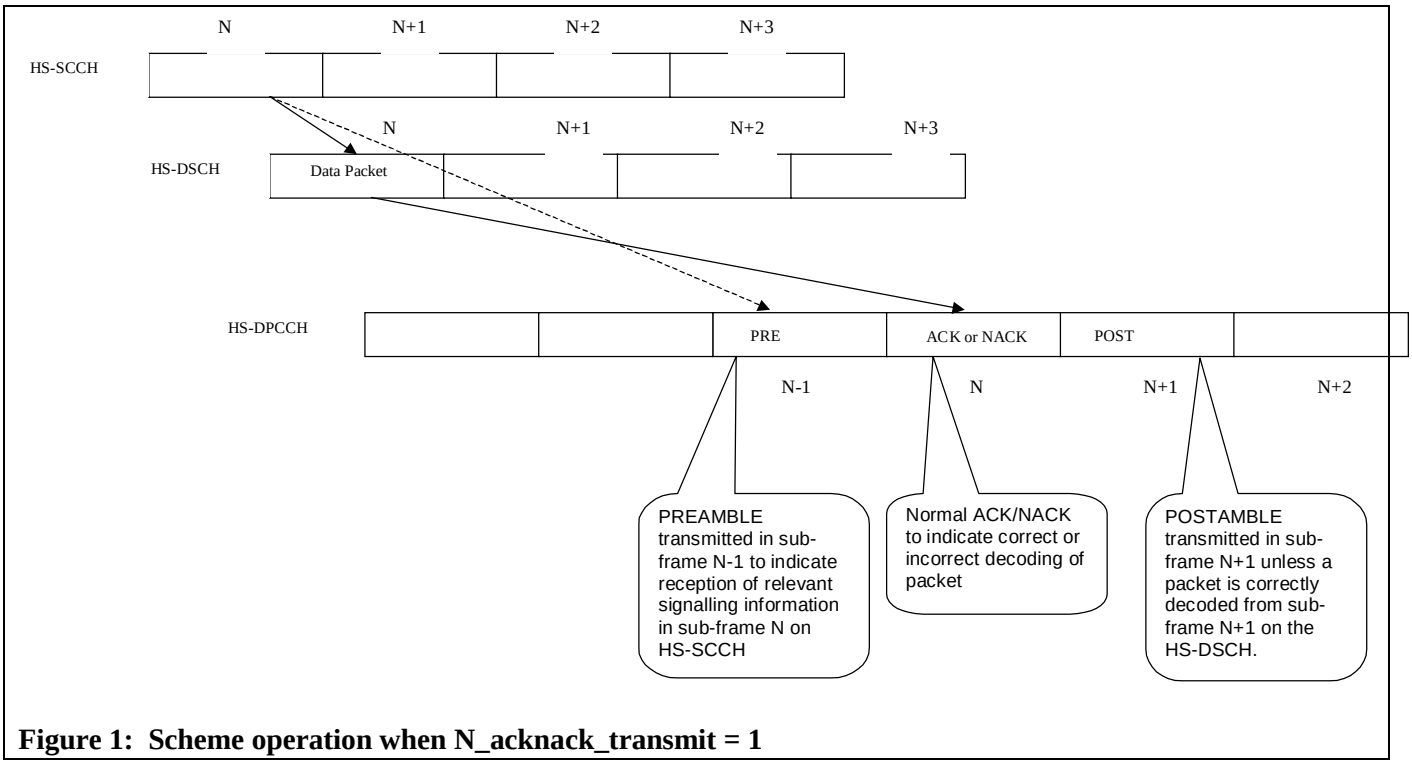


Figure 1: Scheme operation when N_acknack_transmit = 1

The two parts of this scheme are as follows:

- When the UE detects control information for it in sub-frame N on the HS-SCCH, the UE transmits a preamble (PRE) in sub-frame N-1 on the HS-DPCCH (unless an ACK/NACK/POST is to be transmitted in sub-frame N-1 as a result of a packet in an earlier sub-frame on the HS-DSCH);

- After decoding the HS-DSCH packet and transmitting the hybrid ARQ ACK/NACK in sub-frame N on the HS-DPCCH, if the UE's InterTTI capability is 1 the UE transmits a postamble (POST) in sub-frame N+1 on the HS-DPCCH (unless a packet is detected in sub-frame N+1 on the HS-DSCH, in which case ACK/NACK is sent, or HS-SCCH control information is detected in subframe N+2, in which case PRE is sent).

  (Note that if the UE's InterTTI capability is > 1, there is no need to transmit the POST in sub-frame N+1, because an HS-DSCH packet could not be received in sub-frame N+1 on the HS-DSCH.)

In sub-frames N+2 onwards on the HS-DPCCH, the UE goes back to using DTX in the ACK/NACK field (unless new relevant control information is detected on the HS-SCCH).

To help understanding, an alternative view of the operation of the scheme, describing the same functionality, is given in the State Diagram in Figure 2. The labels on the arrows show the signal which is sent when the given state transition occurs.

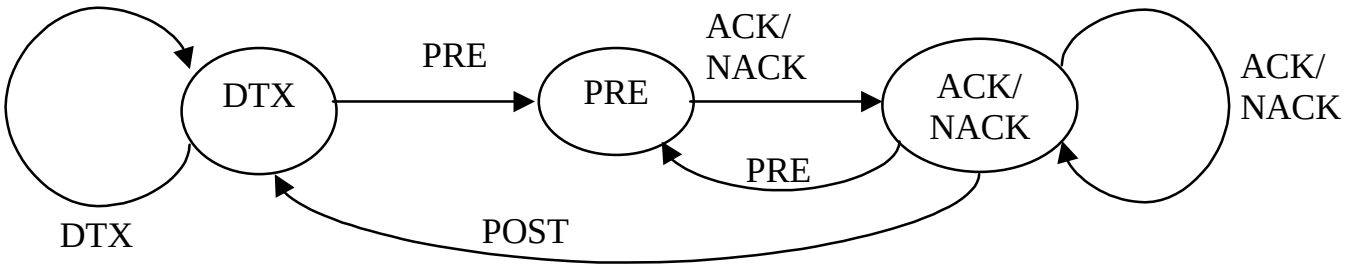


Figure 2: State Diagram of improved scheme for reducing UL signalling power requirement

b) With repetition of ACK/NACKs (i.e. when N_acknack_transmit > 1)

Now we consider the case when N_acknack_transmit > 1, as shown in Figure 3 for the example of N_acknack_transmit = 3.

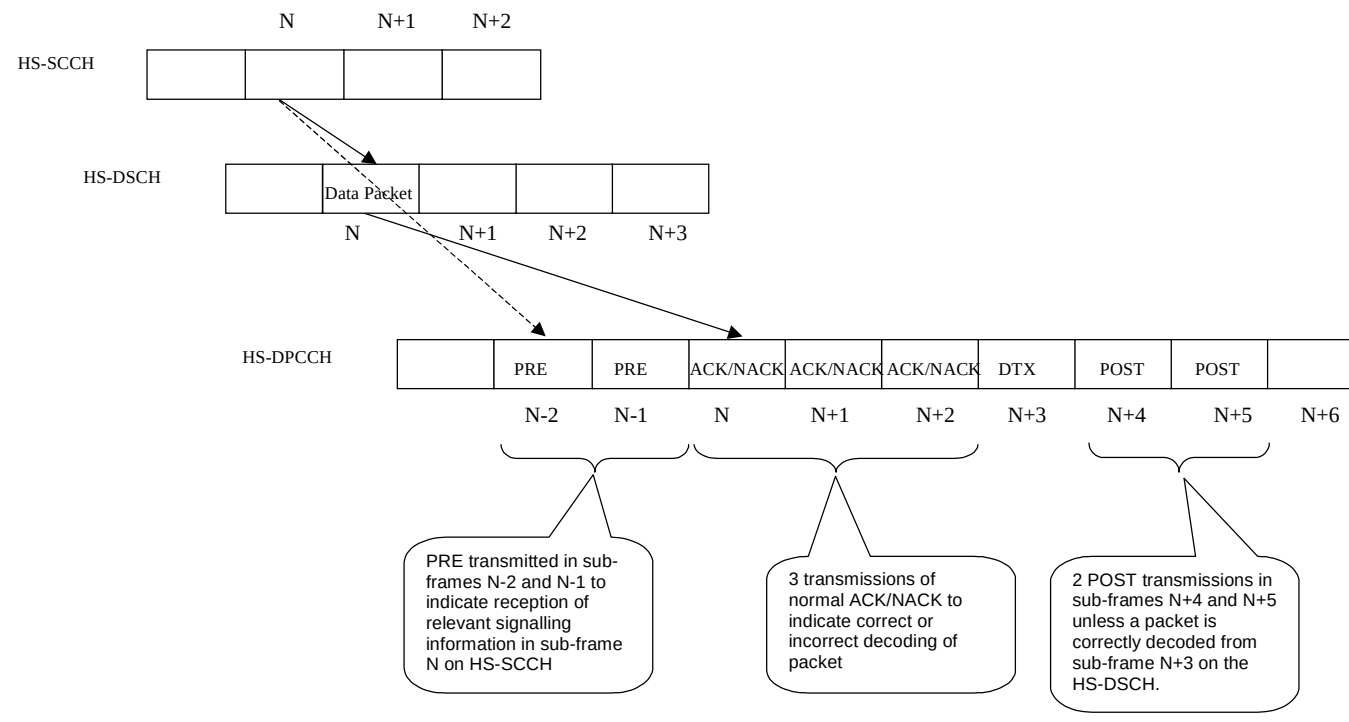


Figure 3: Scheme operation when N_acknack_transmit > 1 (3 in this example)

Two slight modifications are made compared from the behaviour when N_acknack_transmit = 1:

- When the UE detects control information for it in sub-frame N on the HS-SCCH, the UE transmits a PRE in sub-frame N-2 as well as sub-frame N-1 on the HS-DPCCH (unless an ACK/NACK is transmitted in these sub-frames as a result of an earlier packet on the HS-DSCH);

  (Note that the UE never transmits a PRE earlier than sub-frame N-2 in response to detecting control information on the HS-SCCH even if N_acknack_transmit = 3 or 4).

- After decoding the HS-DSCH packet the UE transmits the hybrid ARQ ACK/NACK in sub-frames N to N+N_ack_transmit-1 on the HS-DPCCH (as currently specified).
- If the UE's InterTTI capability is ≤ N_acknack_transmit then the UE does the following:
    - transmit a HARQ Postamble (POST) in the slot allocated to HARQ-ACK in HS-DPCCH subframe $n + 2*N\_acknack\_transmit - 1$, unless an ACK, NACK or PRE is to be transmitted in this subframe, and
    - if $N\_acknack\_transmit > 1$, transmit a HARQ Postamble (POST) in the slot allocated to HARQ-ACK in HS-DPCCH subframe $n + 2*N\_acknack\_transmit - 2$, unless an ACK, NACK or PRE is to be transmitted in this subframe.

Note that no more than two POST's may be transmitted following detection of control information on the HS-SCCH, DTX being used in when there is nothing to send in the intervening sub-frames, as shown in the example in Figure 3.

In sub-frames N+2*N_acknack_transmit onwards on the HS-DPCCH, the UE goes back to using DTX in the ACK/NACK field (unless new relevant control information is detected on the HS-SCCH).

In Annex A, we provide some specific examples to illustrate the operation of the improved scheme and to show that potential concerns over previously-identified "problem" packet sequences are now avoided.

In Annex B we show the proposed transmission sequences for some examples in the cases of N_acknack_transmit = 2 and 3.

Simulation results for the improved scheme are presented in [4].

4. Conclusions

In this paper we have presented an improvement to the proposed scheme for improving the HS-DPCCH performance using preamble and postamble transmissions. This solves the potential issues which had been raised during then email reflector discussions regarding full IR and certain specific packet sequences. We have also explained the operation of the scheme in detail.

Draft CRs for this scheme are included with this document in the zip file.

The CR for TS25.212 also covers an issue raised separately on the email reflector, that the mapping between ACK/NACK and the physical layer signals is not defined anywhere at present.

The CR for TS25.214 is based on the current structure of section 6A.1.1 and has 3 main parts:

1. A new first paragraph is added in subclause 6A.1.1 to clarify the referencing of the different subframes on the HS-DSCH, HS-SCCH and HS-DPCCH (this change is not directly related to the scheme proposed in this paper, but it aims to reduce ambiguity in the whole subclause).
2. In the third paragraph, some sentences are added to describe the transmission of the HARQ preamble on detecting control information on the HS-SCCH.
3. Near the end of the subclause, a new paragraph is added to describe the transmission of the HARQ postamble after a hybrid ARQ ACK/NACK has been sent if a control information is not detected in the next sub-frame.

In summary, this proposal aims to achieve the right balance between HS-DPCCH performance improvement for Release 5 and simplicity.

Since the transmission of PRE/POST is enabled by higher layer signalling of the parameter DTX_mode, implementation of the scheme is optional at the Node B.

The scheme is also fully compatible with other proposals for the HS-DPCCH.

5. References

[1] R1-02-1085, "Reduction of HS-DPCCH power requirements", Philips
[2] R1-02-1104, " Results for ACK/NACK power reduction in conjunction with repetition ", Philips
[3] R1-02-1163, “Correction of DTX transmission in ACK/NACK field”, Philips
[4] R1-02-1335, “Simulation results on scheme for meeting HS-DPCCH performance requirements for Rel-5”, Philips

Annex A – Examples

We give here some specific examples to illustrate the operation of the improved scheme and to show that potential concerns over previously-identified "problem" packet sequences are now avoided. The main points addressed here are providing the Node B with the means to detect whether HS-SCCH was correctly received while at the same time reducing the peak power needed to reliably detect ACK's.

Example 1:

		Sub-frame 1	Sub-frame 2	Sub-frame 3	Sub-frame 4	Sub-frame 5	Sub-frame 6	Sub-frame 7
Transmitted sequence at Node B		No Packet	No Packet	Packet	No Packet	Packet	No Packet	No Packet
UE transmission	If UE detects both packets	DTX	PRE	ACK/NACK	PRE	ACK/NACK	POST	DTX
	If UE only detects 1st packet	DTX	PRE	ACK/NACK	POST	DTX	DTX	DTX
	If UE only detects 2nd packet	DTX	DTX	DTX	PRE	ACK/NACK	POST	DTX
	If UE detects neither packet	DTX	DTX	DTX	DTX	DTX	DTX	DTX

It can be seen that the Node B never has to detect "HS-SCCH failure" based on one sub-frame alone. We now consider how easy it is to avoid confusing the cases where a packet is not detected with the packet having been correctly received:

If the UE fails to detect the first packet in the above sequence, the Node B can distinguish between DTX+DTX and PRE+ACK much more easily than between just DTX and ACK. If the UE fails to detect the second packet in the above sequence, the Node B can easily distinguish between POST+DTX and PRE+ACK.

This is further illustrated in the following trellis diagram:

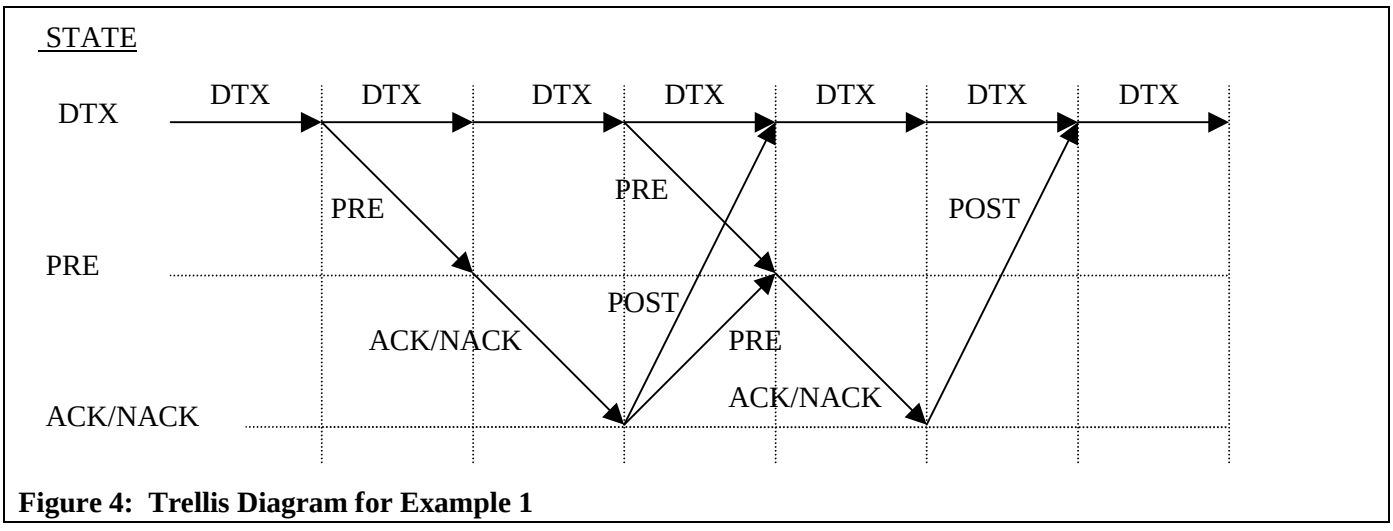


Figure 4: Trellis Diagram for Example 1

Example 2:

		Sub-frame 1	Sub-frame 2	Sub-frame 3	Sub-frame 4	Sub-frame 5	Sub-frame 6	Sub-frame 7
Transmitted sequence		No Packet	No Packet	Packet 1	Packet 2	Packet 3	No Packet	No Packet
A	If UE detects all packets	DTX	PRE	ACK/NACK	ACK/NACK	ACK/NACK	POST	DTX
B	If UE only detects packet 1	DTX	PRE	ACK/NACK	POST	DTX	DTX	DTX
C	If UE only detects packet 2	DTX	DTX	PRE	ACK/NACK	POST	DTX	DTX
D	If UE only detects packets 1,2	DTX	PRE	ACK/NACK	ACK/NACK	POST	DTX	DTX
E	If UE only detects packet 3	DTX	DTX	DTX	PRE	ACK/NACK	POST	DTX
F	If UE only detects packets 1,3	DTX	PRE	ACK/NACK	PRE	ACK/NACK	POST	DTX
G	If UE only detects packets 2,3	DTX	DTX	PRE	ACK/NACK	ACK/NACK	POST	DTX
H	If UE detects no packets	DTX	DTX	DTX	DTX	DTX	DTX	DTX

Again, we now consider how easy it is to avoid confusing the cases where a packet is not detected with the packet having been correctly received:

In case B above, for packet 2 a POST->ACK error rate of 0.01 can be achieved with less power than is required for a DTX->ACK error rate of 0.01 (which would be the case without this scheme). For packet 3, the Node B can easily distinguish between POST+DTX and PRE/ACK/NACK+ACK.

In case C above, for packet 1 the Node B can determine whether HS-SCCH was received by distinguishing between DTX+PRE and PRE+ACK. For packet 3, the Node B can distinguish between POST and ACK as for packet 2 in case B.

In case D above, for packet 3 the Node B can distinguish between POST and ACK as for packet 2 in case B and packet 3 in case C.

In case E above, for packet 1 the Node B can distinguish between DTX+DTX and PRE+ACK, and for packet 2 the Node B can distinguish between DTX+PRE and PRE+ACK.

In case F above, for packet 2 the Node B can distinguish between PRE and ACK in the same way as distinguishing between POST and ACK for packet 2 in case B and packet 3 in case C.

In case G above, for packet 1 the Node B can distinguish between DTX+PRE and PRE+ACK as for packet 2 in case E.

This is further illustrated in the following trellis diagram:

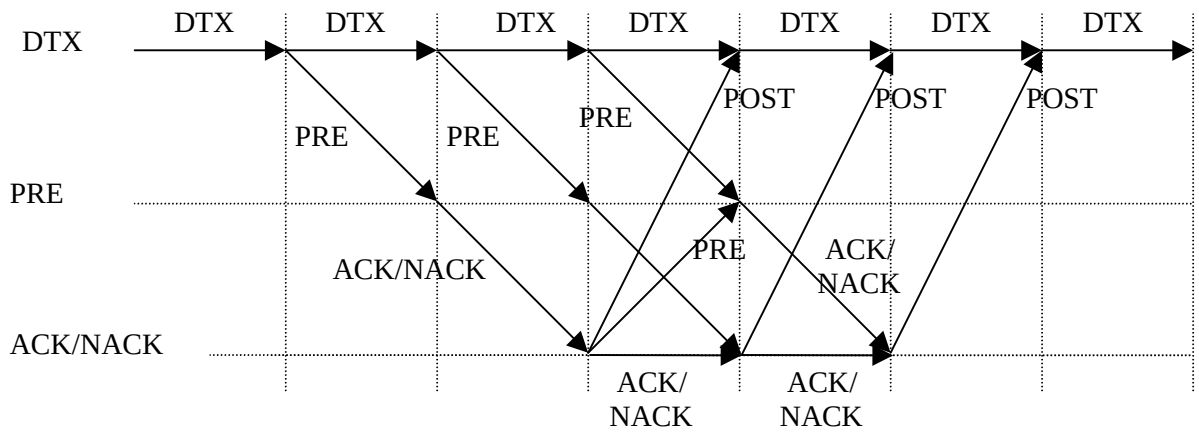


Figure 5: Trellis Diagram for Example 2

Example 3:

		Sub-frame 1	Sub-frame 2	Sub-frame 3	Sub-frame 4	Sub-frame 5	Sub-frame 6	Sub-frame 7
Transmitted sequence		No Packet	Packet 1	Packet 2	Packet 3	Packet 4	No Packet	No Packet
A	If UE detects all packets	PRE	ACK/NACK	ACK/NACK	ACK/NACK	ACK/NACK	POST	DTX
B	If UE only detects packets 1,4	PRE	ACK/NACK	POST	PRE	ACK/NACK	POST	DTX

In case B above, for packet 2 the Node B can distinguish between POST and ACK as for packet 2 in example 2 / case B, and for packet 3 the Node B can distinguish between POST+PRE and PRE+ACK.

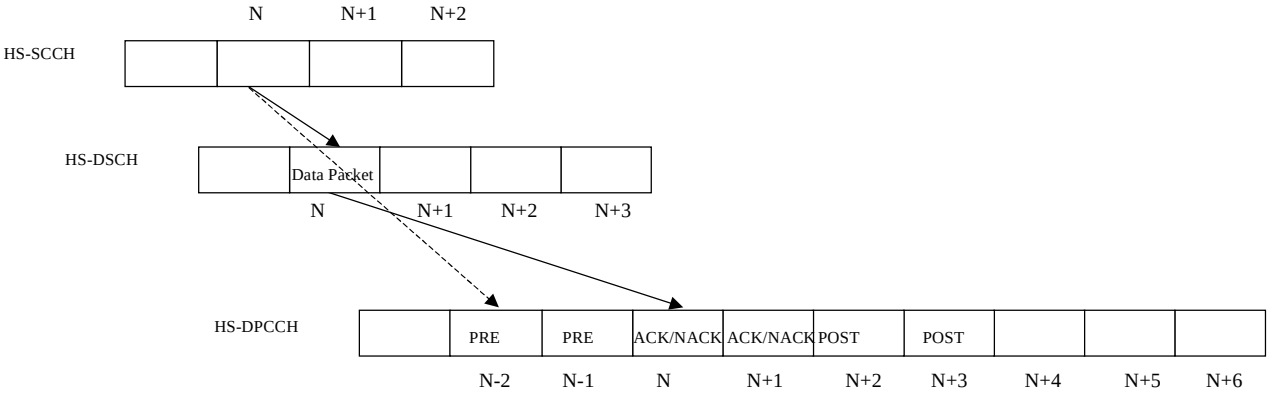
Example 4:

		Sub-frame 1	Sub-frame 2	Sub-frame 3	Sub-frame 4	Sub-frame 5	Sub-frame 6	Sub-frame 7
Transmitted sequence		No Packet	Packet 1	Packet 2	Packet 3	Packet 4	Packet 5	No Packet
A	If UE detects all packets	PRE	ACK/NACK	ACK/NACK	ACK/NACK	ACK/NACK	POST	DTX
B	If UE only detects packets 1,5	PRE	ACK/NACK	POST	DTX	PRE	ACK/NACK	POST

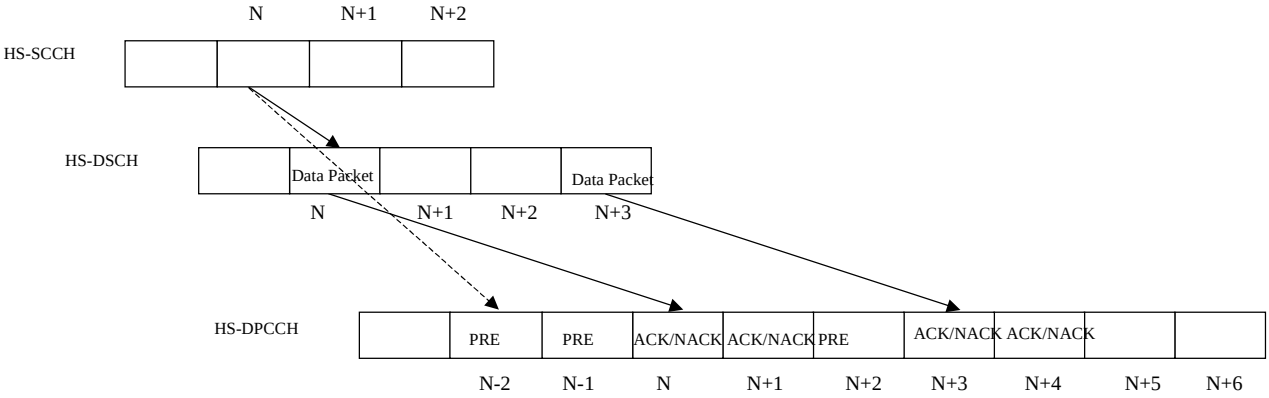
In case B above, for packet 3 the Node B can distinguish between POST+DTX and PRE+ACK.

Annex B – Examples of Transmission Sequences for N_acknack_transmit>1

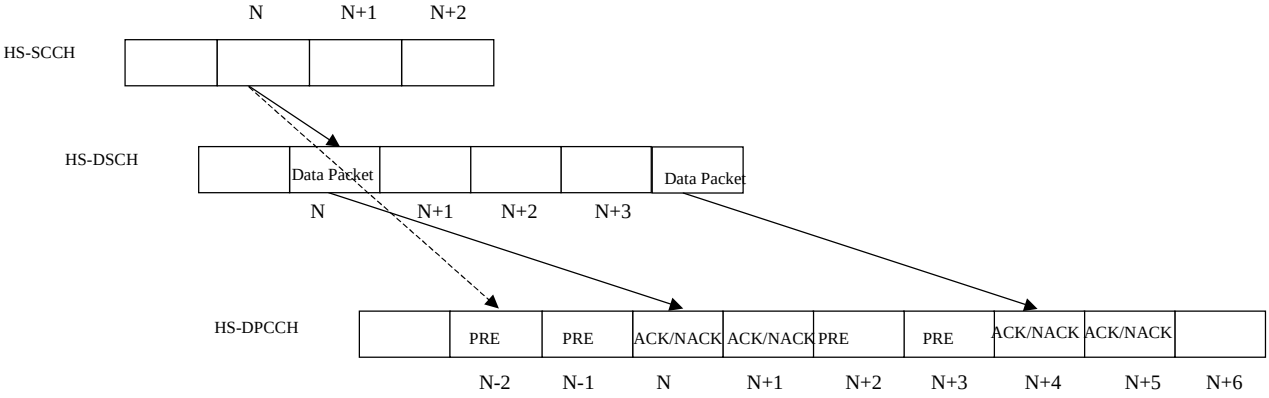
N_acknack_transmit=2, packet detected in subframe N and not N+2 to N+5



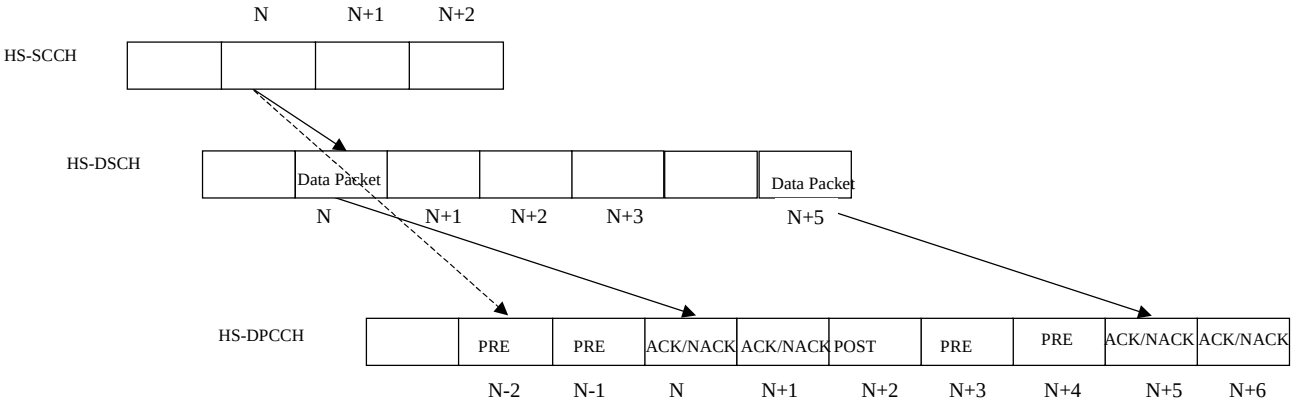
N_acknack_transmit=2, packet detected in subframe N and N+3 (and not N+2)



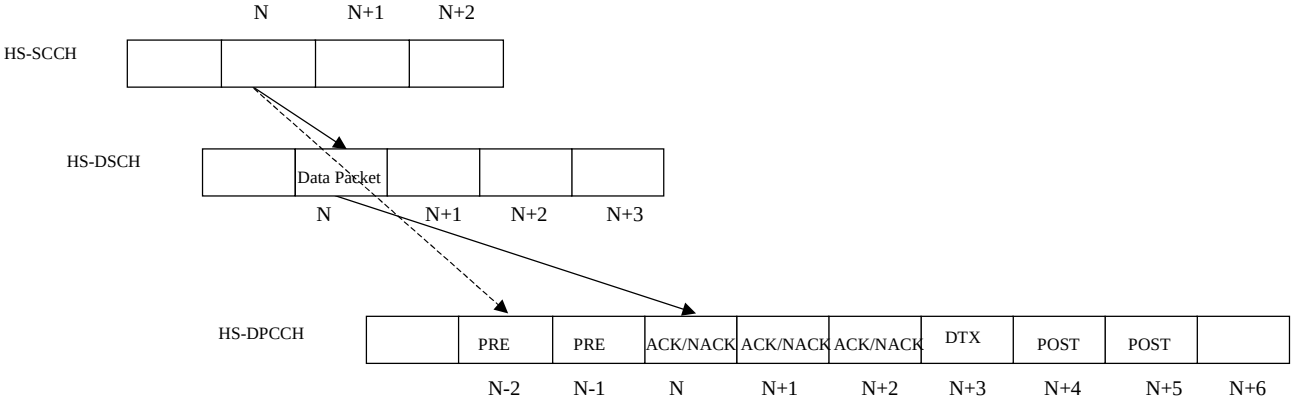
N_acknack_transmit=2, packet detected in subframe N and N+4, not in N+2 or N+3



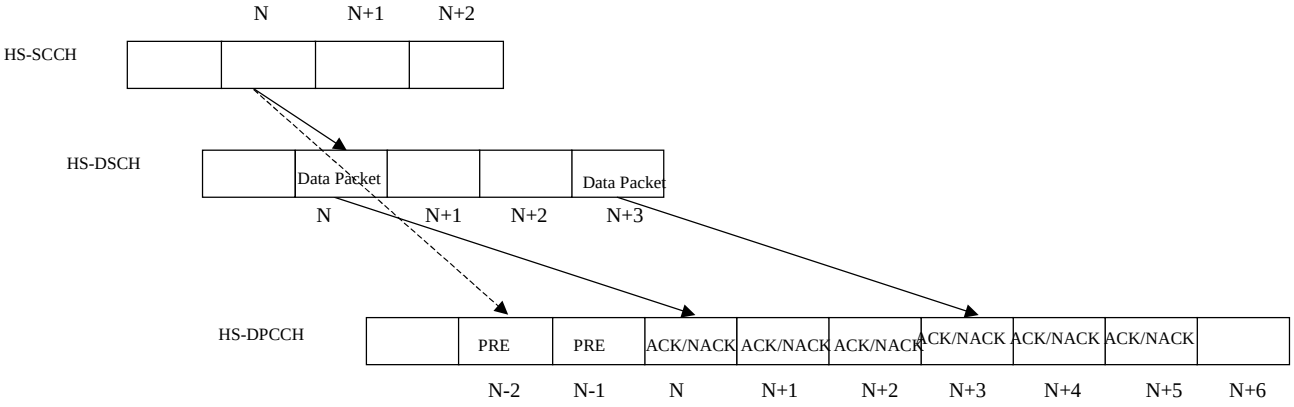
N_acknack_transmit=2, packet detected in subframe N and N+5, not in N+2, N+3, N+4



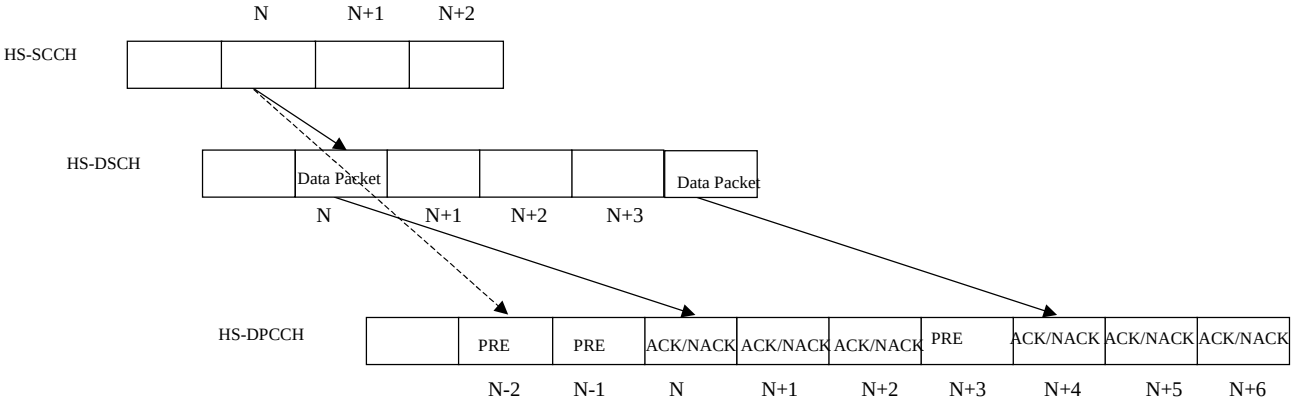
N_acknack_transmit=3, packet detected in subframe N and not N+3, to N+7



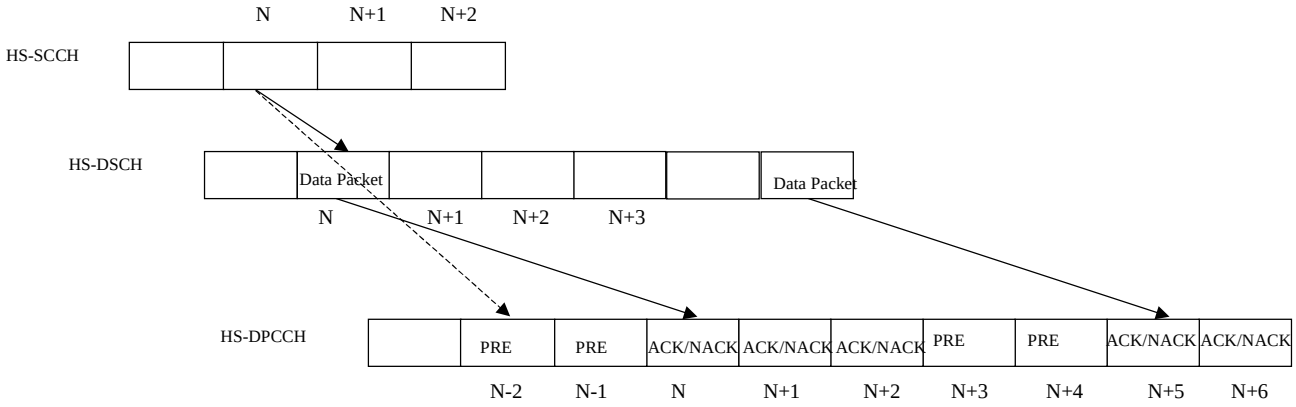
N_acknack_transmit=3, packet detected in subframe N and N+3



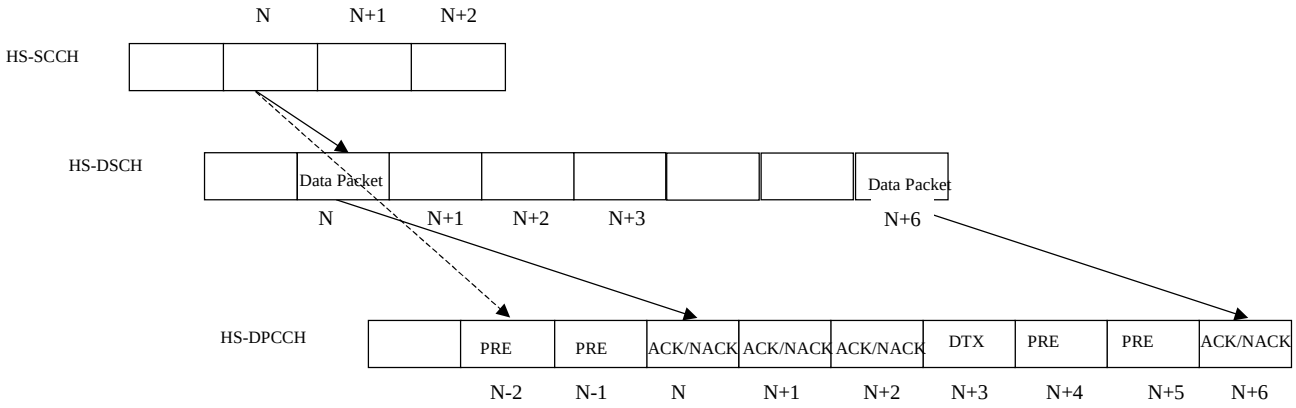
N_acknack_transmit=3, packet detected in subframe N and N+4, (and not in N+3)



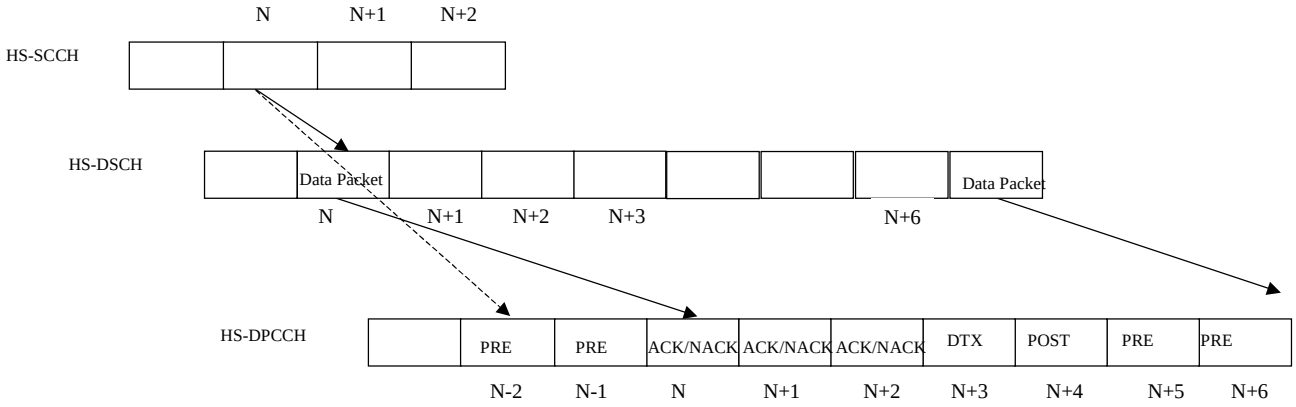
N_acknack_transmit=3, packet detected in subframe N and N+5, (and not in N+3 or N+4)



N**_acknack_transmit=3, packet detected in subframe N and N+6, not in N+3 to N+5**,



N_acknack_transmit=3, packet detected in subframe N and N+7, not in N+3 to N+6,



3GPP TSG RAN WG1#29 **Tdoc R1-02-1335**

Shanghai, China, 5th – 8th November, 2002

Agenda Item: 6.1

Source: Philips

Title: Simulation results on scheme for meeting HS-DPCCH performance requirements for Rel-5

Document for: Information

---

1. Introduction

In [1] we presented the full details of the improved scheme for reducing the power requirement for the HSDPA hybrid ARQ ACK/NACK transmissions on the HS-DPCCH by means of extra NACK/PRE/POST transmissions on the HS-DPCCH, enabling the Node B to use a lower detection threshold.

The improved scheme also enables the Node B to distinguish between the UE having failed to detect the HS-SCCH signalling and the UE having detected the HS-SCCH signalling but failed to decode the HS-DSCH packet.

In this document we present new simulation results for the improved scheme.

2. Simulation Results

General simulation assumptions are given in Annex A. A diagram showing the type of decoding method used for the POST/PRE scheme is shown in Annex B. This includes some small enhancements since the version previously circulated on the RAN WG1 email reflector. Other implementation approaches could be used.

The “original” and “relaxed” performance requirements are summarised in Annex A.

The “relaxed” performance requirements have been considered sufficient for “difficult” radio conditions such as high speeds or SHO.

Figure 1 shows simulation results for SHO with N_acknack_transmit = 2 for the “relaxed” HS-DPCCH performance requirements. For the POST/PRE scheme, two different HS-DSCH traffic loadings (20% and 80%) are shown, as this affects the ratio between packets which are first in a burst and those which are immediately preceded by other packets. The traffic model used specifies the probability of a packet being sent to the UE in any given sub-frame. We assumed no correlation between packet transmissions.

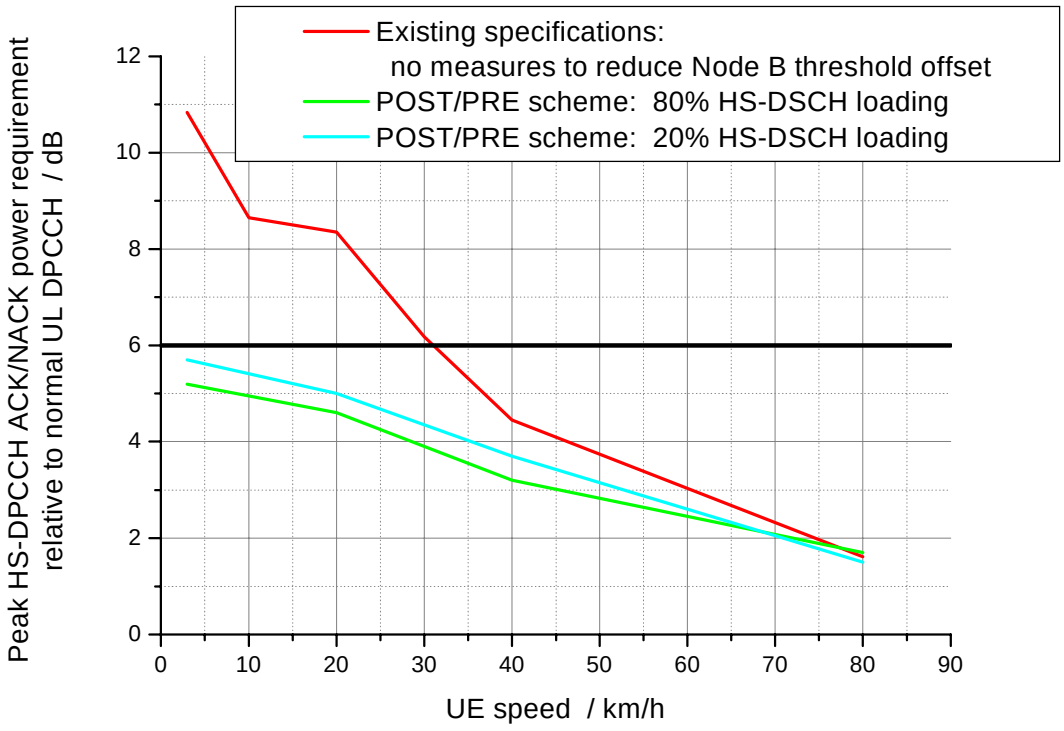


Figure 1: SHO, relaxed performance requirements, N_acknack_transmit = 2

It can be seen from Figure 1 that the POST/PRE scheme meets the performance requirements at all UE speeds and at both high and low loadings, without requiring a larger HS-DPCCH power offset than can be signalled according to the current specifications.

Figure 2 shows the power required to meet the original performance requirements with N_acknack_transmit = 2.

It can be seen from Figure 2 that the POST/PRE scheme can even meet the original requirements in SHO at UE speeds above about 45km/h (where the effect of time-diversity is greater relative to the fading rate), although this is not considered to be necessary.

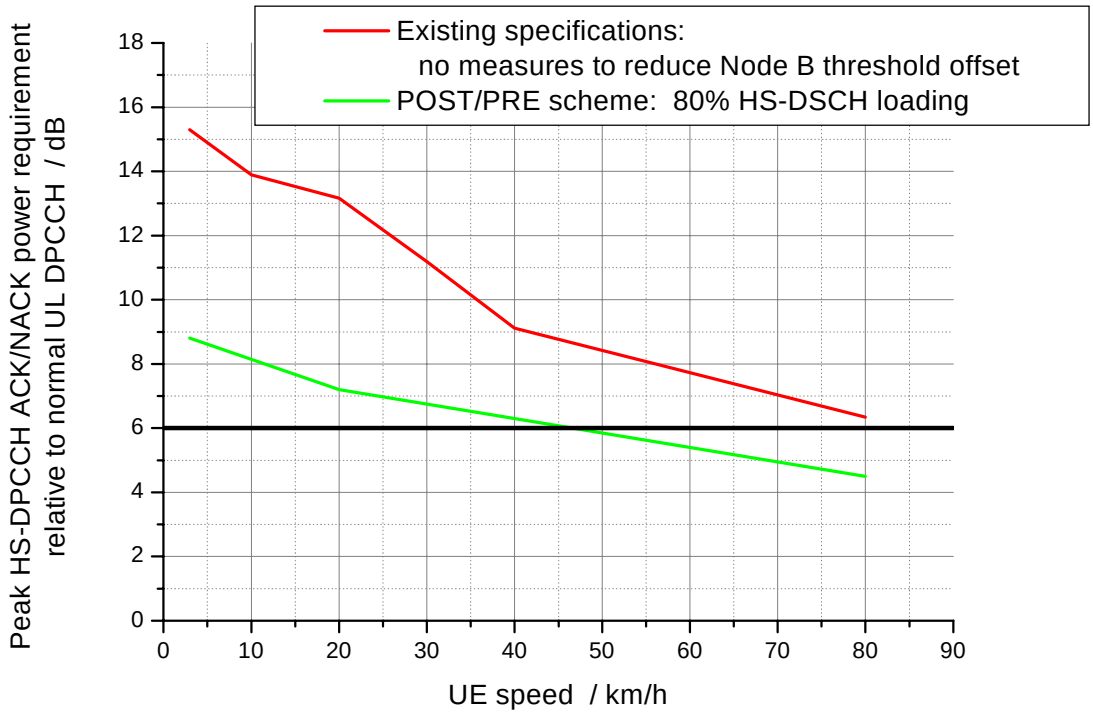


Figure 2: SHO, original performance requirements, N_acknack_transmit = 2

The POST/PRE scheme also gives benefit in non-SHO situations, as shown in Figure 3 for the original performance requirements, with N_acknack_transmit set to 1.

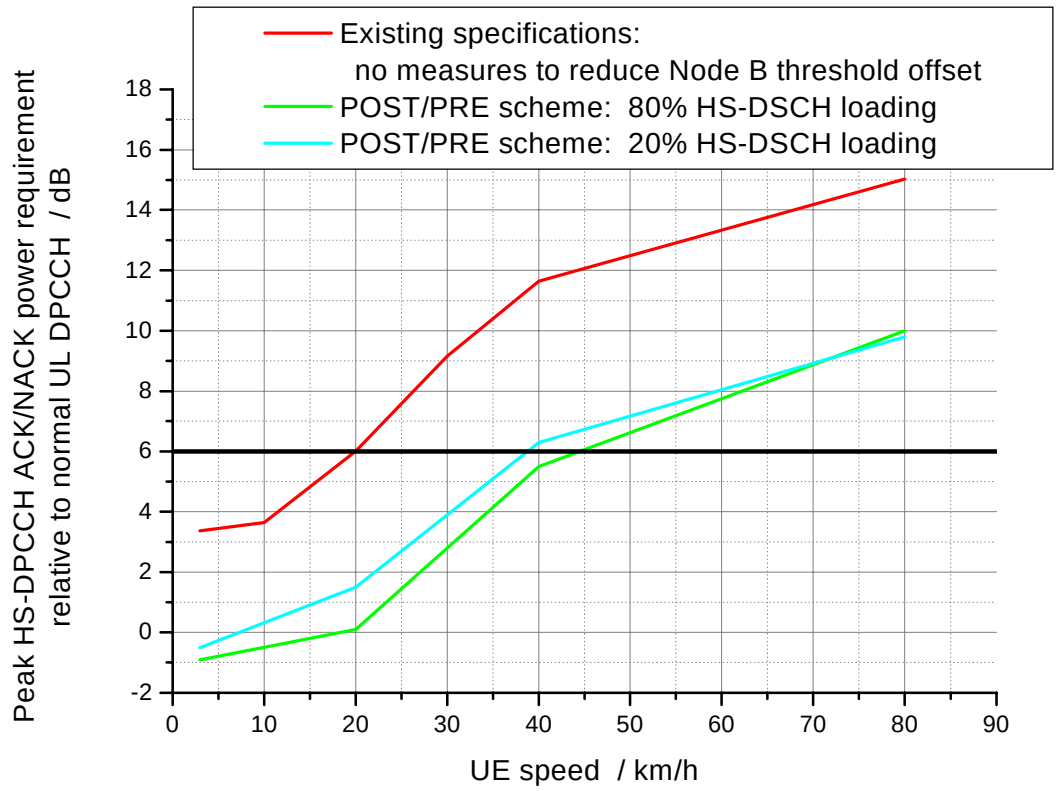


Figure 3: Non-SHO, original performance requirements, N_acknack_transmit = 1

It can be seen from Figure 3 that the POST/PRE scheme enables the original performance requirements to be met at speeds up to 40km/h, instead of only 20km/h with the existing specifications. Clearly 20km/h cannot be considered a “high” speed, as required for the relaxed requirements to be applicable.

Figure 4 shows the power requirements for the relaxed requirements. It can be seen that the POST/PRE scheme enables the relaxed requirements to be met at all UE speeds, without requiring the use of repetition. (By contrast, the existing specifications would need the use of repetitions at UE speeds higher than about 35km/h in order to meet the relaxed requirements).

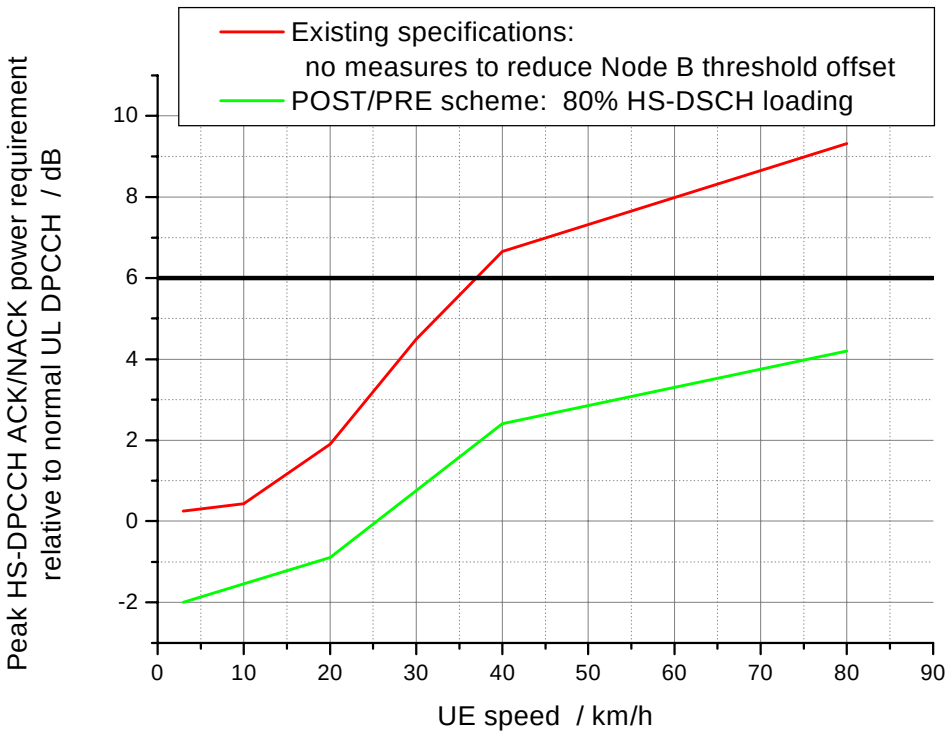


Figure 4: Non-SHO, relaxed performance requirements, N_acknack_transmit = 1

In addition to satisfying the requirements for ACK and NACK errors, the PRE/POST scheme enables the Node B to distinguish between the UE having failed to detect the HS-SCCH signalling and the UE having detected the HS-SCCH signalling but failed to decode the HS-DSCH packet.

If the UE has failed to detect the HS-SCCH signalling, the UE will transmit either POST, or PRE, or DTX in 2 consecutive slots, whereas a NACK (or PRE+NACK for the first packet in a burst) would be transmitted if the UE had detected but failed to decode the packet. If full IR is being used, the error rate between POST/PRE/DTX+DTX and NACK is of interest. In the simulations presented here, a maximum error rate of 0.03 is achieved in all circumstances, both for POST/PRE/DTX+DTX -> NACK and for NACK->POST/PRE/DTX+DTX.

This enables the Node B to select the best redundancy version with a high degree of confidence.

4. Conclusions

Simulation results presented here show that the POST/PRE scheme achieves the following:

- Relaxed requirements met at all UE speeds in SHO, without needing more than 1 ACK/NACK repetition;
- Original requirements met in SHO at UE speeds above 45km/h;
- When not in SHO, original requirements met with no repetitions at all speeds up to 40km/h (compared to only 20km/h with existing specification);
- Relaxed requirements met without repetitions at speeds higher than 40km/h when not in SHO.
- Worst-case error rate of 0.03 achieved for distinguishing between failed HS-SCCH detection and failed HS-DSCH CRC.

This scheme aims to achieve the right balance between HS-DPCCH performance improvement for Release 5 and simplicity.

CRs are provided in [1].

5. References

[1] R1-02-1334, "Scheme for meeting HS-DPCCH performance requirements for Rel-5", Philips

Annex A: Simulation assumptions:

2GHz carrier frequency
Pedestrian A channel – Rayleigh fast fading, classical Doppler spectrum, no shadowing
Rx diversity at Node B: 2 uncorrelated antennas
Channel estimation: 3 slots up to 40km/h, 1 slot at higher speeds
4% error rate (AWGN) on DL TPC commands
UL power control step size 1dB, algorithm 1
UL DPCCH SIR target set to give 4% TPC error rate; same SIR target in SHO as for non-SHO.
Interference in UL modelled as AWGN
Static ACK/NACK decision threshold
Average HS-SCCH failure rate = 0.01.

Original requirements for current specification:
P(ACK->NACK) = 0.01
P(NACK->ACK) = 0.0001
P(DTX->ACK) = 0.01

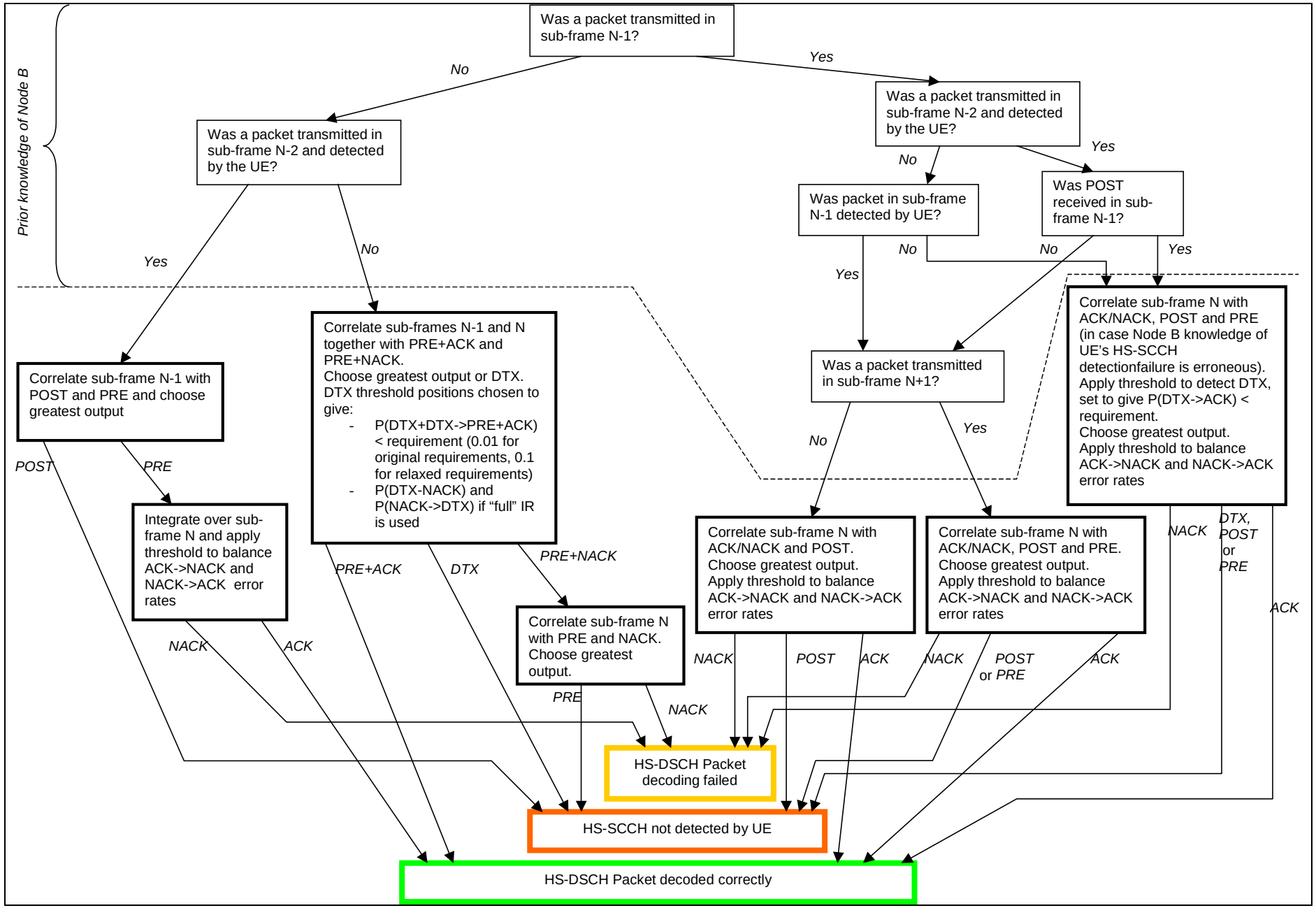
Original requirements for POST/PRE scheme:
P(ACK -> (NACK or PRE or POST)) = 0.01
P(NACK -> ACK) = 0.0001
P((PRE or POST or DTX) -> ACK) = 0.01

Relaxed requirements for current specification:
P(ACK->NACK) = 0.01
P(NACK->ACK) = 0.001
P(DTX->ACK) = 0.1

Relaxed requirements for POST/PRE scheme:
P(ACK -> (NACK or PRE or POST)) = 0.01
P(NACK -> ACK) = 0.001
P((PRE or POST or DTX) -> ACK) = 0.1

Annex B: Decoding diagram for HS-DPCCH sub-frame N

The following diagram shows the type of decoding mechanism which can be employed in the Node B for the POST/PRE scheme.



3GPP TSG-RAN WG1 Meeting #29 **R1-02-1422**
Shanghai, China, 5th – 8th November 2002

CR-Form-v7

CHANGE REQUEST

⌘ **25.212** **CR** **161** ⌘ **rev** **1** ⌘ Current version: **5.2.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: UICC apps⌘ [ ] ME [X] Radio Access Network [X] Core Network [ ]

Title:	⌘	Correction of coding of HARQ-ACK
Source:	⌘	Philips, Nokia
Work item code:	⌘	HSDPA-Phys
Date:	⌘	07/11/2002
Category:	⌘	**F**
Release:	⌘	Rel-5

Use one of the following categories:
F *(correction)*
A *(corresponds to a correction in an earlier release)*
B *(addition of feature),*
C *(functional modification of feature)*
D *(editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

Use one of the following releases:
2 (GSM Phase 2)
R96 (Release 1996)
R97 (Release 1997)
R98 (Release 1998)
R99 (Release 1999)
Rel-4 (Release 4)
Rel-5 (Release 5)
Rel-6 (Release 6)

Reason for change:	⌘	The mapping between higher-layer HARQ acknowledgements and physical layer signals is not defined. Also the physical layer coding of the HARQ preambles and postambles needs to be defined in order to meet the HS-DPCCH error requirements.
Summary of change:	⌘	A table is inserted describing the mapping of HARQ-ACK messages to physcial layer coding.
Consequences if not approved:	⌘	

Clauses affected:	⌘	4.7

Other specs Affected:	⌘	Y	N		⌘
		X		Other core specifications	TS25.214
			X	Test specifications	
			X	O&M Specifications	

Other comments:	⌘	If this CR is accepted, it should supercede CR 25.212-164, which contains some of the same changes.

How to create CRs using this form:
Comprehensive information and tips about how to create CRs can be found at http://www.3gpp.org/specs/CR.htm.
Below is a brief summary:

1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.

2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be

downloaded from the 3GPP server under ftp://ftp.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2001-03 contains the specifications resulting from the March 2001 TSG meetings.

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

4.7 Coding for HS-DPCCH

Data arrives to the coding unit in form of indicators for measurement indication and HARQ acknowledgement.

The following coding/multiplexing steps can be identified:

- channel coding (see subclause 4.7.1);
- mapping to physical channels (see subclause 4.7.2).

The general coding flow is shown in the figure below. This is done in parallel for the HARQ-ACK and CQI as the flows are not directly multiplexed but are transmitted at different times.

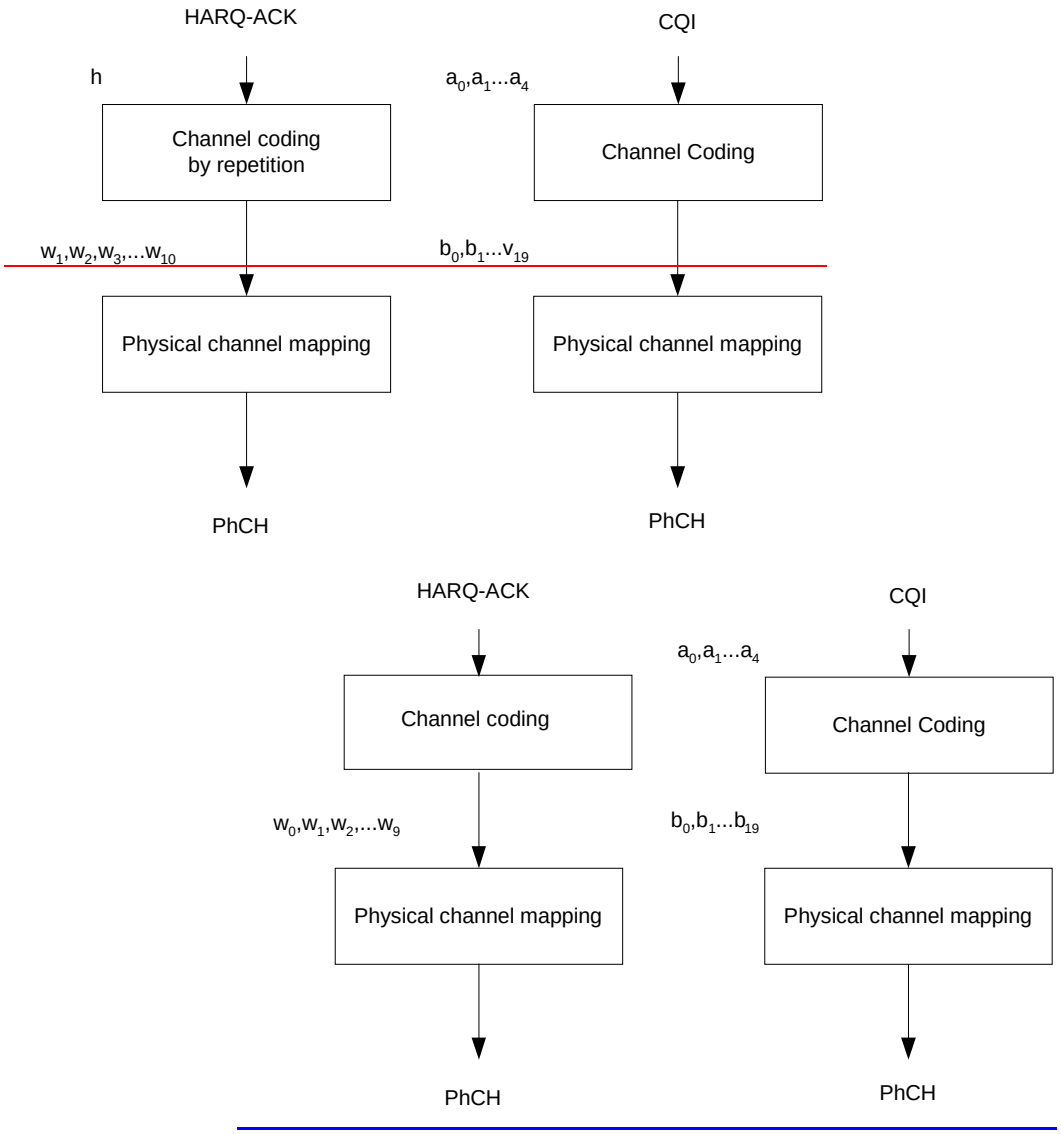


Figure 20: Coding for HS-DPCCH

4.7.1 Channel coding for HS-DPCCH

Two forms of channel coding are used, one for the channel quality information (CQI) and another for HARQ-ACK (acknowledgement).

4.7.1.1 Channel coding for HS-DPCCH HARQ-ACK

The ~~1 bit~~ HARQ acknowledgement message to be transmitted, as defined in [4], shall be ~~repetition~~ coded to 10 bits as shown in Table 13A. The output is denoted $w_{~~1~~0}$, $w_{1~~2~~}$,…$w_{~~10~~9}$.

Table 13A: Channel coding of HARQ-ACK

HARQ-ACK message to be transmitted	w_0	w_1	w_2	w_3	w_4	w_5	w_6	w_7	w_8	w_9
ACK	1	1	1	1	1	1	1	1	1	1
NACK	0	0	0	0	0	0	0	0	0	0
Preamble	0	0	1	0	0	1	0	0	1	0
Postamble	0	1	0	0	1	0	0	1	0	0

3GPP TSG-RAN WG1 Meeting #29 **R1-02-1422**
Shanghai, China, 5th – 8th November 2002

CR-Form-v7

CHANGE REQUEST

⌘ **25.214** **CR** **295** ⌘ **rev** **2** ⌘ Current version: **5.2.0** ⌘

*For **HELP** on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: UICC apps⌘ [ ] ME [X] Radio Access Network [X] Core Network [ ]

Title:	⌘	Correction of DTX transmission in ACK/NACK field
Source:	⌘	Philips, Nokia
Work item code:	⌘	HSDPA-Phys
Date:	⌘	07/11/2002
Category:	⌘	**F**
Release:	⌘	Rel-5

Use one of the following categories:
F *(correction)*
A *(corresponds to a correction in an earlier release)*
B *(addition of feature),*
C *(functional modification of feature)*
D *(editorial modification)*
Detailed explanations of the above categories can be found in 3GPP TR 21.900.

Use one of the following releases:

2	*(GSM Phase 2)*
R96	*(Release 1996)*
R97	*(Release 1997)*
R98	*(Release 1998)*
R99	*(Release 1999)*
Rel-4	*(Release 4)*
Rel-5	*(Release 5)*
Rel-6	*(Release 6)*

Reason for change:	⌘	The performance requirements for the Hybrid ARQ ACK/NACK signalling cannot be met satisfactorily.
Summary of change:	⌘	When the UE receives signalling information directed to it on the HS-SCCH, the UE transmits a preamble in the sub-frame before the one allocated to the hybrid ARQ ACK/NACK. In addition, if the UE's InterTTI is less than or equal to N_acknack_transmit, it transmits a postamble in the sub-frame following the hybrid ARQ ACK/NACK. This avoids the Node B having to detect DTX as NACK in the hybrid ARQ ACK/NACK sub-frame, giving a substantial reduction in the required ACK power.
Consequences if not approved:	⌘	

Clauses affected:	⌘	5.1.2.5A, 6A.1, 6A.1.1

Other specs affected: ⌘	Y	N		
	X		Other core specifications	⌘ TS25.212
		X	Test specifications	
		X	O&M Specifications	

Other comments:	⌘	

How to create CRs using this form:
Comprehensive information and tips about how to create CRs can be found at http://www.3gpp.org/specs/CR.htm.
Below is a brief summary:

1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.

2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be downloaded from the 3GPP server under ftp://ftp.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2001-03 contains the specifications resulting from the March 2001 TSG meetings.

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

5.1.2.5A Setting of the uplink DPCCH/HS-DPCCH power difference

When an HS-DPCCH is active, the relative power offset $\Delta_{HS\text{-}DPCCH}$ between the DPCCH and the HS-DPCCH for each HS-DPCCH slot shall be set as follows.

For HS-DPCCH slots carrying HARQ Acknowledgement :

$\Delta_{HS\text{-}DPCCH} = \Delta_{ACK}$ if the corresponding HARQ-ACK message is ACK ~~Acknowledgement is equal to 1~~

$\Delta_{HS\text{-}DPCCH} = \Delta_{NACK}$ if the corresponding HARQ-ACK message is NACK. ~~Acknowledgement is equal to 0~~

$\Delta_{HS\text{-}DPCCH}$ is the greatest of Δ_{ACK} and Δ_{NACK} if the corresponding HARQ-ACK message is PRE or POST.

For HS-DPCCH slots carrying CQI :

$\Delta_{HS\text{-}DPCCH} = \Delta_{CQI}$

The values for Δ_{ACK}, Δ_{NACK} and Δ_{CQI} are set by higher layers.

The setting of the power difference between DPCCH and HS-DPCCH is independent of the inner loop power control.

Then, in non-compressed frames β_{HS}, which is the gain factor defined in [3] subclause 4.2.1, is calculated according to

$$\beta_{HS} = \beta_c \cdot 10^{\left(\frac{\Delta_{HS-DPCCH}}{20}\right)},$$

where β_c value is signalled by higher-layer or calculated as described in subclause 5.1.2.5.3 or 5.1.2.5.4.

When HS-DPCCH is transmitted in compressed frames, β_{HS} is calculated according to

$$\beta_{HS} = \beta_c \cdot 10^{\left(\frac{\Delta_{HS-DPCCH}}{20}\right)} \cdot \sqrt{\frac{N_{pilot,N}}{N_{pilot,C}}},$$

where $N_{pilot,C}$ is the number of pilot bits per slot on the DPCCH in compressed frames, and $N_{pilot,N}$ is the number of pilot bits per slot in non-compressed frames.

The gain factor β_{HS} may vary on slot basis depending on the current power offset $\Delta_{HS\text{-}DPCCH}$ and whether the compressed mode is used or not in UL DPCH. When the HS-DPCCH and the DPCCH are not slot aligned, the reference DPCCH power shall be the one used in the DPCCH slot being transmitted at the beginning i.e. slot boundary of the HS-DPCCH slot.

6A HS-DSCH-related procedures

6A .1 General procedure

Scheduling and transport format selection is controlled by the MAC-hs sublayer in the Node B [9].

The following physical layer parameters are signalled to the UE and the Node B from higher layers:

1) HS-SCCH set to be monitored
2) Repetition factor of ACK/NACK: N_acknack_transmit
3) Channel Quality Indicator (CQI) feedback cycle *k*.
4) Repetition factor of CQI: N_cqi_transmit
5) Measurement power offset Γ
6) Status of preamble/postamble transmission: DTX_mode

6A .1.1 UE procedure for receiving HS-DSCH

In this sub-clause, sub-frame *n* on the HS-SCCHs refers to the sub-frame which is associated with sub-frame *n* on the HS-PDSCH as defined in [1], and sub-frame *n* on the HS-DPCCH refers to the sub-frame which is related to sub-frame *n* on the HS-PDSCH as defined in [1].

If the UE did not detect control information intended for this UE on any of the HS-SCCHs in the HS-SCCH set in the ~~previous~~ subframe *n* – 1, the UE shall monitor all HS-SCCHs in the HS-SCCH set in sub-frame *n*. If the UE did detect control information intended for this UE in ~~the previous~~ subframe *n* – 1, it is sufficient in sub-frame *n* to only monitor the same HS-SCCH used in ~~the previous~~ subframe *n* – 1.

If a UE detects that one of the monitored HS-SCCHs in sub-frame *n* carries control information intended for this UE, the UE shall start receiving the HS-PDSCHs indicated by this control information, and, if DTX_mode = 1, the UE shall transmit a HARQ Preamble (PRE) in the slot allocated to HARQ-ACK in HS-DPCCH sub-frame *n* – 1. In addition, if N_acknack_transmit > 1 and DTX_mode = 1, the UE shall transmit a HARQ Preamble in the slot allocated to HARQ-ACK in HS-DPCCH sub-frame *n* – 2. However, these HARQ Preambles in sub-frames *n* – 2 and *n* – 1 shall not be transmitted if an ACK or NACK is to be transmitted in the respective sub-frames as a result of an HS-DSCH transmission earlier than sub-frame *n* on the HS-PDSCH.

After decoding the HS-PDSCH data, the UE shall transmit an hybrid ARQ ACK or NACK as determined by the MAC-hs based on the CRC check. The UE shall repeat the transmission of the ACK/NACK information over *N_acknack_transmit* consecutive HS-DPCCH sub-frames, in the slots allocated to the HARQ-ACK as defined in [1]. When *N_ acknack_transmit* is greater than one, the UE shall not attempt to receive nor decode transport blocks from the HS-PDSCH in HS-DSCH sub-frames *n + 1* to *n + (N_acknack _transmit - 1)* ~~where *n* is the number of the last HS-DSCH sub-frame in which a transport block has been received~~.

If DTX_mode = 1 and UE InterTTI ≤ *N_acknack_transmit*, then the UE shall:

- transmit a HARQ Postamble (POST) in the slot allocated to HARQ-ACK in HS-DPCCH subframe *n* + 2**N_acknack_transmit* – 1, unless an ACK, NACK or PRE is to be transmitted in this subframe, and
- if *N_acknack_transmit* > 1, transmit a HARQ Postamble (POST) in the slot allocated to HARQ-ACK in HS-DPCCH subframe *n* + 2**N_acknack_transmit* – 2, unless an ACK, NACK or PRE is to be transmitted in this subframe.

Apart from the above provisions, ~~I~~if control information is not detected on any of the HS-SCCHs in the HS-SCCH set, ~~neither ACK, nor NACK,~~DTX shall be ~~transmitted~~ used in the corresponding subframe.

6A .1.2 UE procedure for reporting channel quality indication (CQI)