TSG-RAN Working Group 1 meeting #20 Tdoc R1-01-0472
May 21 – 25, Busan, Korea

Agenda item : AH24: HSDPA

Source: Texas Instruments

Title: Performance comparison of bit level and symbol level Chase combining

Document for: Discussion

1. Bit level and symbol level Chase combining

This document provides information about the performance of Chase combining scheme for HARQ when the combining is done at the symbol level before demodulation or when it is done at the bit level after demodulation. A block diagram of the receiver doing Chase combining is shown in figure 1 below:

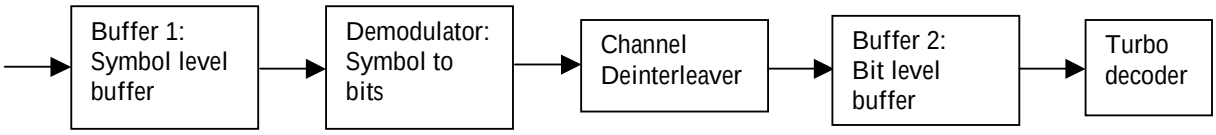

Figure 1: Block diagram of the receiver doing Chase combining is shown

For symbol level Chase combining the receiver accumulates the received soft decisions in Buffer 1. For an N = 4 in N-channel Stop and Wait (SAW) HARQ using Chase combining and using a transmission time interval (TTI) of 5 slots the buffer size is given by [1] and reproduced in table 1 for information.

Table 1. Buffer at symbol level soft combining stage for 10 code channels, HSDPA TTI = 5 slots

	Maximum buffer size for N-channel SAW HARQ, N=4, 3.33 ms frame, modulation symbols (I,Q pairs) buffered (Ksymbols)			
SF	QPSK	8-PSK	16-QAM	64-QAM
16, 10 code channels or 32, 20 code channels	64 Kbytes	64 Kbytes	64 Kbytes	64 Kbytes

Another smaller Buffer 2 at the input of the Turbo decoder is needed for the Turbo decoder, depending upon the Turbo decoder requirement.

For a bit level Chase combining the receiver accumulates the received soft decisions in Buffer 1. For an N = 4 in N-channel Stop and Wait (SAW) HARQ using Chase combining and using a transmission time interval (TTI) of 5 slots the buffer size is given by [1];

Table2. Buffer for bit level Chase combining at the input of turbo decoder for 10 code channels, HSDPA TTI = 5 slots

	Maximum buffer size for N-channel SAW HARQ, N=4, 3.33 ms frame, baseband symbols buffered (Ksymbols)			
SF	QPSK	8-PSK	16-QAM	64-QAM
16, 10 code channel or 32, 20 code channels	64 Kbytes	96 Kbytes	128 Kbytes	192 Kbytes

For QPSK transmission, there is no difference in performance whether a symbol level or a bit level Chase combining is done. For 8-PSK, 16-QAM and 64-QAM there is difference in performance of bit level and symbol level Chase combining. The performance comparison of the two for AWGN, 16 QAM, rate ½ coding is shown in figures 1, 2 for frame size of 1-Slot and 5-Slot respectively.

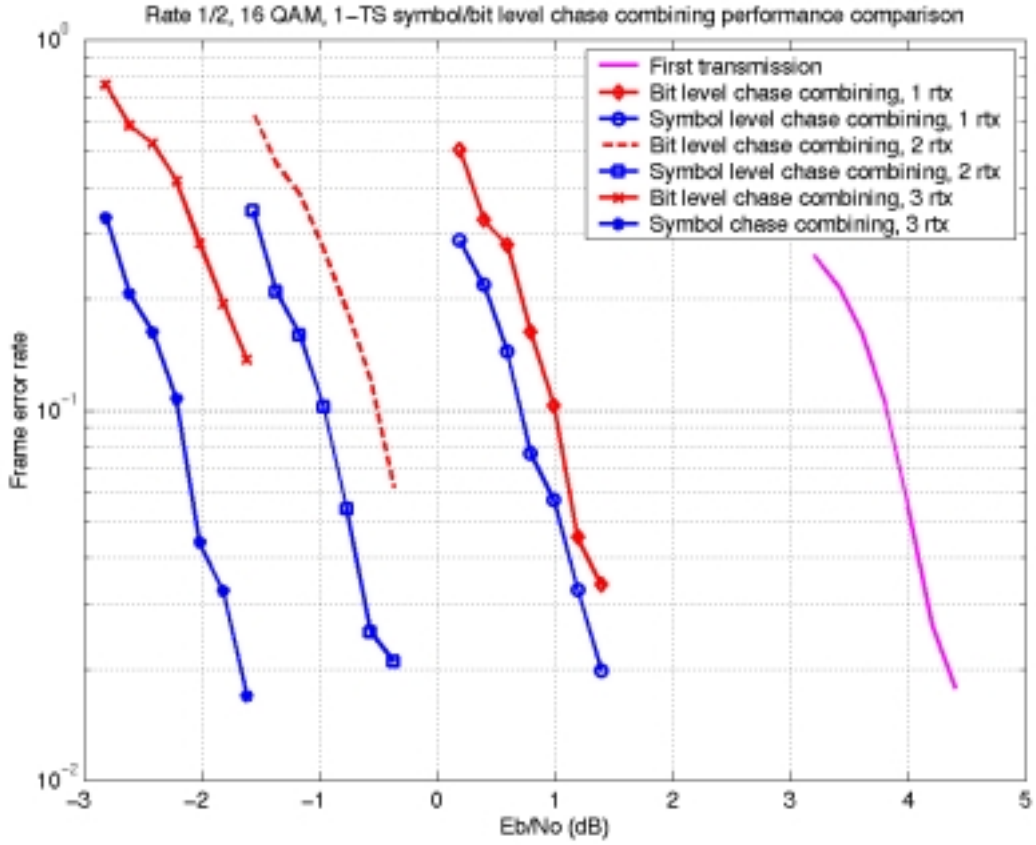

Figure 1: Performance comparison for bit level and symbol level Chase combining for AWGN, 16 QAM, rate ½, frame size 1-TS is shown.

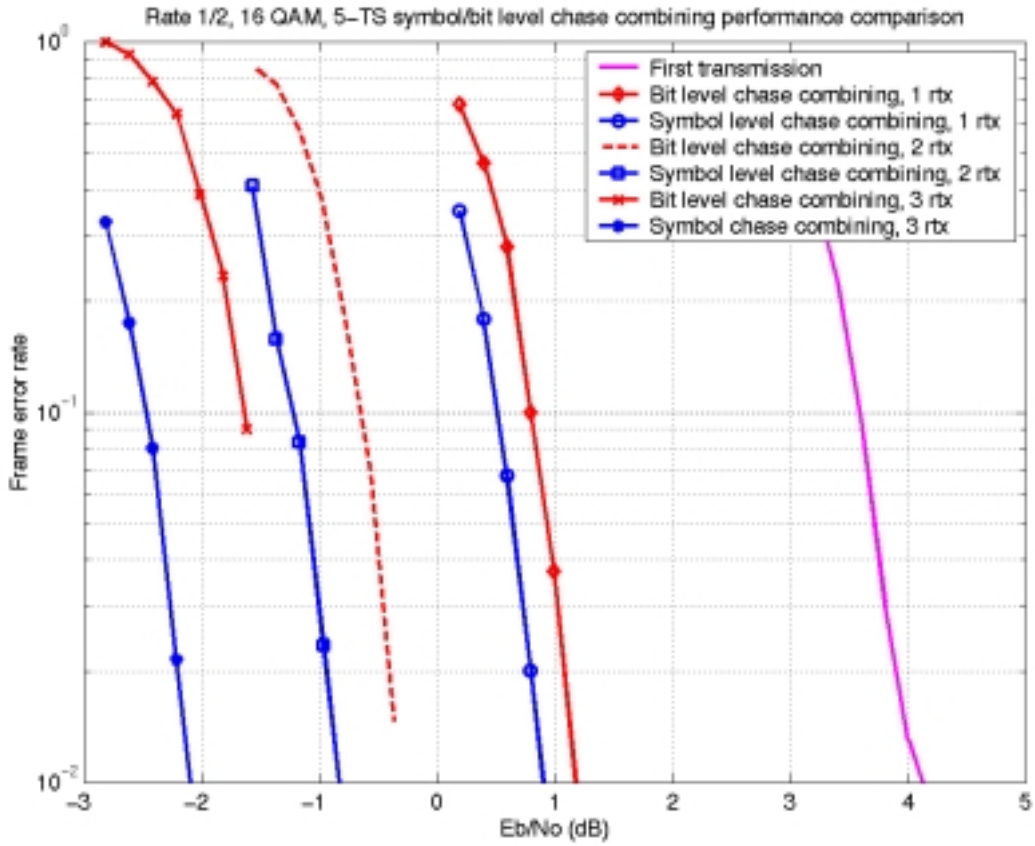

Figure 2: Performance comparison for bit level and symbol level Chase combining for AWGN, 16 QAM, rate ½, frame size 5-TS is shown.

2. Conclusions

Table 3 below summarizes the performance loss by employing a bit level Chase combining versus a symbol level Chase combining:

Table 3: Performance loss for bit level Chase combining versus symbol level Chase combining for 16 QAM, rate ½, frame size = 1-TS

Frame size = 1-TS	
Retransmission number	Performance loss of bit level versus symbol level Chase combining
1	0.2 dB
2	0.4 dB
3	0.7 dB

Table 4: Performance loss for bit level Chase combining versus symbol level Chase combining for 16 QAM, rate ½, frame size = 5-TS

Frame size = 5-TS	
Retransmission number	Performance loss of bit level versus symbol level Chase combining
1	0.3 dB
2	0.5 dB
3	0.8 dB

Thus, symbol level Chase combining has better performance while requiring smaller buffer size at the receiver.

References

[1] 3Gpp Technical Specification for Physical Layer Aspects of UTRA High Speed Downlink Packet Access, 3G TR 25.848 V0.6.0.