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Agenda Item: AH24: High Speed Downlink Packet Access
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Title: Simulation results for Section 13.3.7.1 of TR 25.848
Document for: Simulation result collection

13.3.7 Simulation cases

In order to evaluate the performance of the basic features proposed for HSDPA (AMCS, fast HARQ and FCSS), at least the simulation cases described below should be conducted. In both cases the performance reference is the Rel.-99 system.

13.3.7.1 Case 1

In case 1, adaptive modulation and coding (AMCS) and fast HARQ will be modeled.

The following parameters will be used:

MCS may be selected based on CPICH measurement, e.g. RSCP/ISCP, or power control feedback information

MCS update rate: once per 3.33 ms (5 slots)

CPICH measurement transmission delay: 1 frame

Selected MCS applied with 1 frame delay after receiving measurement report

Std. dev. of CPICH measurement error: 0, 3dB

CPICH measurement rate: once per 3.33 ms

CPICH measurement report error rate: 1 %

Frame length for fast HARQ: 3.33 ms

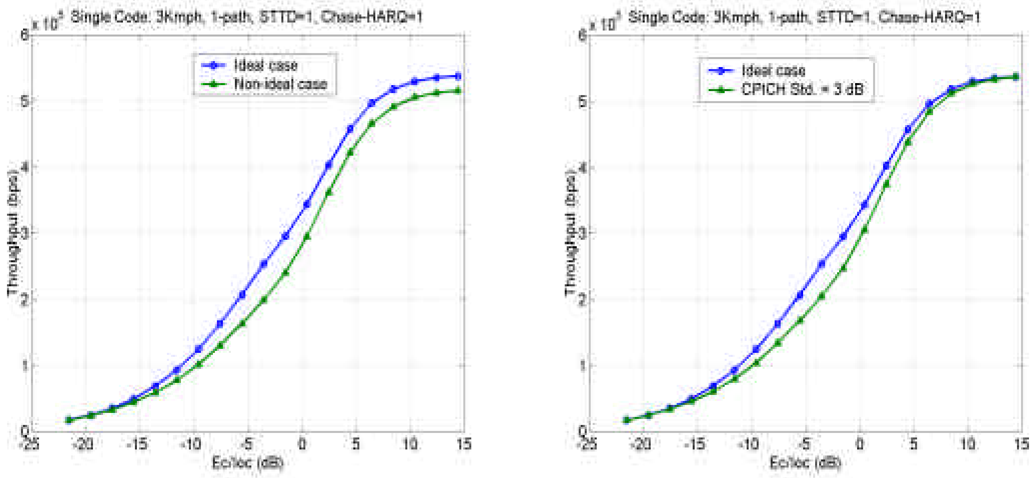
Fast HARQ feedback error rate: 0%, 1% or 4 %.

Effects of non-ideal measurement and feedback situations

The simulation results regarding the effect of channel estimation error on the link level and system level performance of HSDPA showed [1,2] that the link level and system level performance is very sensitive to the channel estimation (used for channel phase and other purposes) and thus the accurate channel estimation is essential, especially in the situation of higher modulation, Turbo code and high vehicle speed. Channel measurement through Long Range Prediction [3,4] is an alternative approach to compensate for the performance loss. This is also noted in [5].

The concept of Long Range Prediction (LRP) of fading signals is an advanced channel quality estimation technology and can improve the performance of HSDPA in terms of system building blocks such as MCS, HARQ,etc., especially at a high vehicle speed.

Figure 27(a) shows the throughput versus Ec/Ioc with a single code for HSDPA in the situations of ideal and non-ideal measurement and feedback. In the simulation, 5 MCS levels are used, which are QPSK 1/2 & 3/4, 16QAM1/2 & 3/4, 64QAM 3/4. In the ideal case, the standard deviation of CPICH measurement error is 0dB, the CPICH measurement report and HARQ feedback are both error free. In the non-ideal case, the standard deviation of CPICH measurement error is 3dB, the error rate of CPICH measurement report and HARQ feedback are 1% and 4% respectively. When the CPICH measurement report error occurs, it is treated as an unknown value and ignored. Thus the MCS selection will be based on the previous CPICH measurement report. Assuming the CRC protection on HARQ ACK/NACK feedback, the HARQ feedback error is treated the same as NACK. It is observed that at slow vehicle speed the performance between the ideal and non-ideal case is about 1 to 2 dB for most Ec/Ioc except very low values (less than –15dB). To further understand this performance difference, we evaluate the effect of different error separately. Figure 27(b) shows the throughput losses due to CPICH measurement error (3dB). Comparing with the ideal case, in the typical range Ec/Ioc (-15dB to 5dB), the performance loss is mainly due to CPICH measurement error and therefore possible unsuitable MCS level. For high Ec/Ioc, the HARQ feedback error (4%) will cause unnecessary retransmission and reduces the throughput [1]. The simulated 1% CPICH measurement report error does not cause any throughput loss due to slow changing channel in this case [1].



(a) (b)

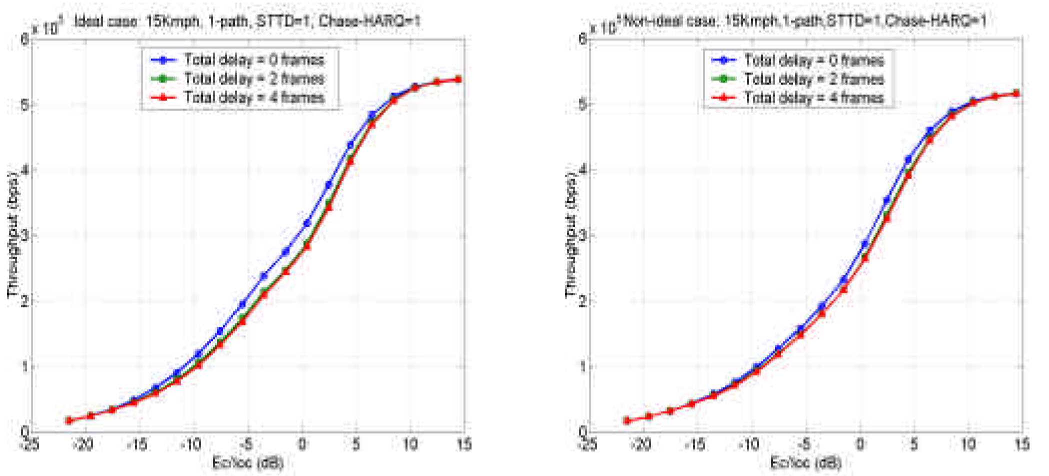
Figure 27. Throughput versus Ec/Ioc for AMCS and HARQ in the non-ideal measurement and feedback situations. 1-path Rayleigh channel, speed = 3kmph, STTD on, HARQ with Chase Combining.
(a) Ideal and non-ideal measurement and feedback cases.
(b) Ideal case and measurement error (3dB) only case.

Summary

We presented the simulation results of AMCS and HARQ for HSDPA in the non-ideal measurement and feedback situations. For the typical value of Ec/Ioc, the channel measurement accuracy has large impact on the throughput. It is observed that at slow vehicle speed the performance between the ideal and non-ideal case is about 1 to 2 dB for most Ec/Ioc except very low values (less than –15dB). It thus suggests that at slow vehicle speed, longer time CPICH average might be necessary for more accurate measurement to improve the throughput. However, at fast vehicle speed, the long time average might fail to track the channel condition closely. Thus, more advanced MCS selection rule might include both long term and short term channel average, Doppler frequency estimation, and long range prediction [3-4] to improve the AMCS and HARQ performance. Further investigation is needed in this topic.

Effect of MCS selection delay on the performance of AMCS and HARQ for HSDPA

Figure 28(a) and 28(b) show the throughput versus Ec/Ioc with a single code for HSDPA for different MCS selection delays in ideal and non-ideal measurement and feedback case respectively. The vehicle speed is 15kmph here. Here the total MCS selection delay means the time difference between the CPICH measurement at UE and MCS selection applied at Node B. The delay may come from the processing time at UE, processing time at Node B, the transmission delay, and the multiplexing and scheduling delay. The zero frame delay is obviously unrealistic and is just used for comparison. Both ideal and non-ideal measurement and feedback cases are considered [1]. Notice that the throughput loss due to MCS selection delay is about 1 dB or 22% throughput loss. If the delay increases further compared with the channel correlation time, the performance loss is expected to be larger. In that case, the technique to predict the channel condition as proposed in contributions [3-4] will help to reduce the performance loss due to MCS selection delay as well as to improve the channel estimation. As shown in [2], at very low vehicle speed (e.g. 3kmph), limited MCS selection delay does not cause significant performance loss due to slow changing channel.



(a) (b)

Figure 1. Throughput versus Ec/Ioc for different MCS selection delay.
1-path Rayleigh channel, STTD on, HARQ with Chase Combining.
(a) Ideal measurement and feedback cases. Speed = 15kmph.
(b) Non-ideal measurement and feedback case. Speed = 15kmph.

Summary

We evaluate the effect of MCS selection delay on the performance of AMCS and HARQ for HSDPA. The perfomance loss due to the MCS delay is not significant at very slow vehicle speed.

However it increases at higher vehicle speeds and larger MCS selection delays. The throughput loss due to MCS selection delay is about 1 dB or 22% throughput loss. Thus the technique to predict the channel condition might help to reduce such performance loss. The channel prediction technique [3-4] can be incorporated with the MCS selection rule to improve the AMCS and HARQ performance in HSDPA.

References:

[1] Wiscom Technologies, R1-01-0050, "Performance of AMCS and HARQ for HSDPA in the non-ideal measurement and feedback situations", TSGR1#18, Boston, MA, USA, January 15-18, 2001.

[2] Wiscom Technologies, R1-00-0051, "Effect of feedback delay on the performance of AMCS and HARQ for HSDPA", TSGR1#18, Boston, MA, USA, January 15-18, 2001.

[3] Wiscom Technologies, R1-00-1393, "Use of Long-Range Prediction for channel estimation and its application in HSDPA," TSGR1#17, Stocholm, Sweden, November 21-24, 2000.

[4] Wiscom Technologies, R1-01-0025, "On the Need of Long-Range Prediction of Channel Estimation in HSDPA and Text Proposal," TSGR1#18, Boston, MA, USA, January 15-18, 2001

[5] Ericsson, R1-01-0036, "HSDPA System Performance," TSGR1#18, Boston, MA, USA, January 15-18, 2001.

13.3.7.2 Case 2