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Agenda Item: AH24: High Speed Downlink Packet Access
Source: **Wiscom Technologies**
Title: Use Long-Range Prediction to Improve the Performance of AMCS and HARQ with MCS Delay
Document for: Discussion

1 Introduction

In previous contribution [8,10], we have presented the HSDPA system performance losses due to the MCS feedback and selection delay. The losses can be as much as 1 to 1.5 dB for typical 2 HSDPA frame delays at intermediate vehicle speed. The technique of long-range prediction (LRP) [4,6,9] has been proposed to compensate the MCS selection delay and hence reduce such performance losses. In this contribution, we present the simulation results of using long-range prediction to improve the system performance of AMCS and HARQ with MCS feedback and selection delay.

2 Simulation parameters

Simulation parameters are similar to the simulation case 1 in Section 12.3.7.1 of [1] and listed below.

Parameter	**Explanation/Assumption**	**Comments**
CPICH power	-10 dB	10% of total cell power
Other channels	- 7 dB	20% of total cell power
Ec/Ior for HSDPA transmission	-1.55 dB	70% of total cell power
MCS selection rule	CPICH measurement	
MCS update rate	once per 3.33ms (5TS HSDPA frame)	
CPICH measurement transmission delay	1 HSDPA frame	
MCS selection delay	1 HSDPA frame after receiving measurement report	
Std. dev. of CPICH measurement error	varying, based on the CPICH symbol average	
CPICH measurement rate	once per 3.33ms	
CPICH measurement report error rate	0%	
Fast HARQ feedback error rate	0%	
Max. # of retransmissions	15	Retransmissions by fast HARQ
MCS levels	QPSK 1/2 & 3/4, 16QAM1/2 & 3/4, 64QAM 3/4.	
Fast HARQ scheme	2-channel stop-and-wait with Chase combining	The effective SIR is the sum of SIR's of all combining packets.
STTD	On	
Carrier frequency	2 GHz	
Specify Fast Fading model	1-path Rayleigh with speed 3, 15 kmph	Jakes model

3 Simulation Results

To investigate the potential improvement of using long-range prediction (LRP) in the case of MCS feedback and selection delay, we compare the throughput of AMCS and HARQ scheme with and without channel prediction. Here the MCS delay means the total 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 total delay will include at least CPICH measurement report delay and MCS selection delay after Node B receiving the measurement report. As defined in the simulation assumption (also in Section 12.3.7.1 of [1]), the typical total delay is 2 HSDPA frames, which is 6.67ms in 5-time-slot HSDPA frame case.

In this simulation, since we are only interested in the impact of MCS delay, we assume that the CPICH measurement report and HARQ feedback are both error free. To examine the prediction algorithm working in real situation, instead of assuming the CPICH measurement error being 0dB, we calculate the measurement by averaging CPICH symbols with noise level depending on Ec_CPICH/Ior and Ior/Ioc values. The LRP prediction algorithm is implemented in the system level simulation to test the performance improvement.

Figure 1 shows the comparison of throughput versus Ec/Ioc of a single code for HSDPA between with and without the channel prediction. The vehicle speed is 15 Kmph in this case. Notice that the performance improvement by channel prediction is 1 to 1.5 dB with Ec/Ioc between –5 to 5dB. When the channel becomes better or worse, i.e., Ec/Ioc > 5dB or Ec/Ioc < -5dB, the MCS selection is more likely to be the highest or lowest MCS. Thus the difference between prediction and non-prediction decreases as expected. Figure 2 shows the comparison of throughput vs. Ec/Ioc between prediction and non-prediction at vehicle speed of 3 Kmph. As presented in previous contribution [8], at very low vehicle speed case, limited MCS selection delay does not cause significant performance loss due to slow changing channel. Thus there is no significant difference between prediction and non-prediction.

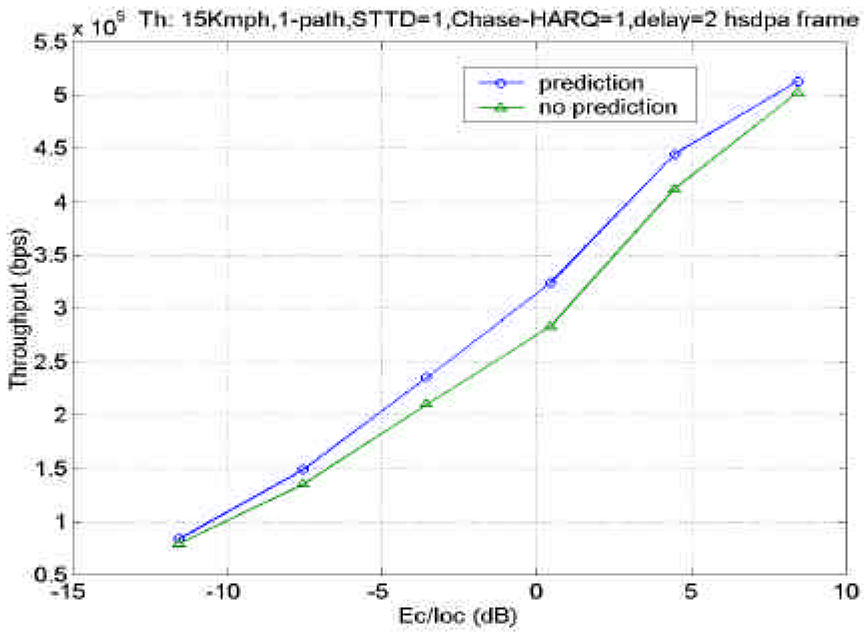

Figure 1. Throughput versus Ec/Ioc with and without channel prediction. Total delay=2 HSDPA frame, 1-path Rayleigh channel, speed = 15kmph, STTD on, HARQ with Chase Combining, ideal feedback.

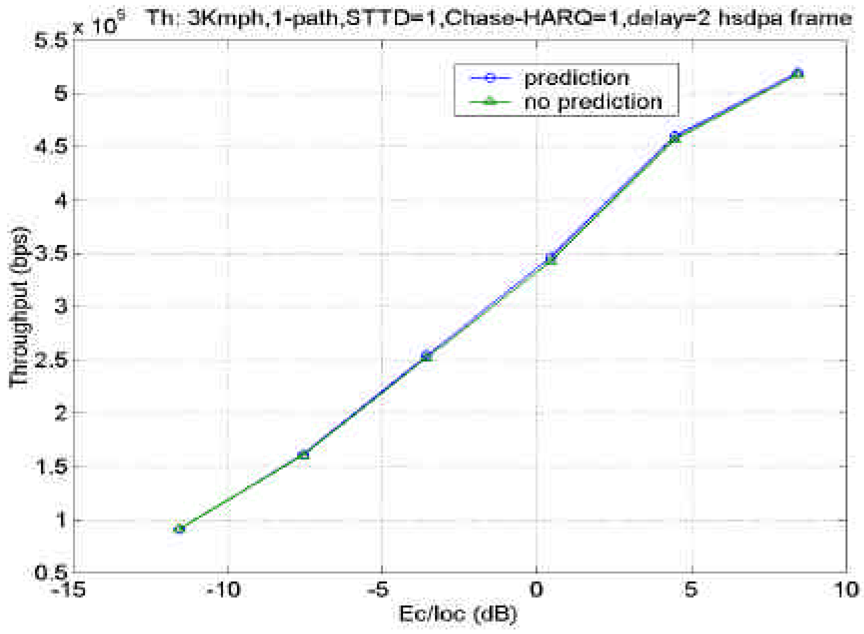

Figure 2. Throughput versus Ec/Ioc with and without channel prediction. Total delay=2 HSDPA frame, 1-path Rayleigh channel, speed = 3kmph, STTD on, HARQ with Chase Combining, ideal feedback.

4 Conclusion

We evaluate the system performance of using long-range prediction (LRP) for AMCS and HARQ scheme with MCS delay. For the typical MCS delay of 2 HSDPA frames, the performance improvement by using prediction is as much as 1.0 to 1.5 dB with Ec/Ioc between –5 to 5dB at intermediate vehicle speed. Based upon the potential performance improvement, the long-range prediction (LRP) technique [4,6,9] should be incorporated with the MCS selection algorithm to improve the AMCS and HARQ performance in HSDPA.

5 References

[1] 3GPP TR V0.5.0 (2000-05), Physical Layer Aspects of UTRA High Speed Downlink Packet Access, 3GPP Release 2000, TSG-RAN Working Group1 meeting#18, TSGR1#18, R1-01-0186, Boston, Massachusetts, USA, 15th-18th Jan. 2001.
[2] TSG RAN R1-00-1326, Wiscom Technologies, “Link level simulation results for HSDPA”, TSGR1#17, Stockholm, Sweden, November 21-24, 2000.
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[4] TSG RAN R1-00-1393, Wiscom Technologies, “Use of Long-Range Prediction for channel estimation and its application in HSDPA,” TSGR1#17, Stockholm, Sweden, November 21-24, 2000.
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[6] TSG RAN R1-01-0025, Wiscom Technologies, “On the Need of Long-Range Prediction of Channel Estimation in HSDPA and Text Proposal,” TSGR1#18, Boston, MA, USA, January 15-18, 2001.
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[8] TSG RAN R1-01-0051, Wiscom Technologies, “Effect of MCS selection delay on the performance of AMCS and HARQ for HSDPA,” TSGR1#18, Boston, Massachusetts, USA, Jan. 15-18, 2001.
[9] TSG RAN R1-01-0249, Wiscom Technologies, “Long-Range Prediction (LRP) of Faded Signals in HSDPA for FDD and TDD,” TSGR1#18, Boston, Massachusetts, USA, Jan. 15-18, 2001.

[10] TSGR1#18(01) 0136, Wiscom Technologies, “Simulation results for Section 13.3.7.1 of TR 25.848,” TSG-RAN Working Group 1 Meeting #18, Boston, Massachusetts, USA, Jan. 15-18, 2001.