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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 in Mobility Support of HSDPA
Document for: Discussion

1 Introduction

In previous HSDPA feasibility study [1], most system level study related to HARQ focused on the low-speed scenarios. In the last TSG-RAN WG1/WG2 joint meeting, it is agreed that as a requirement HSDPA should provide full mobility support, including low-speed, medium-speed and high-speed scenarios. Thus it is of interesting to study the system level performance of HARQ for medium to high vehicle speed scenarios. The technique of long-range prediction (LRP) [4,5,9,10] has been proposed to compensate the MCS selection delay and hence improve the performance in low to medium-speed cases. In this contribution, we present the simulation results of using long-range prediction to improve the system performance of AMCS and HARQ in medium to high-speed (15, 30, 120Kmph) mobility support of HSDPA.

2 Simulation parameters

Simulation parameters are similar to the simulation case 1 in Section 11.3.7.1 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	10/15	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 15, 30, 120 Kmph	Jakes model

3 Simulation Results

In lower speed scenario (such as speed<=15Kmph), the fading signal over the HSDPA frame is approximately constant and can be treated as block fading. Hence the frame error rate for HARQ with Chase combining can be determined by the accumulated SNR from the link level performance over AWGN channel. For medium to high-speed scenario, the frame error rate depends on both the accumulated SNR and the diversity gain from combining multiple fading signals [11]. Using the link level simulation results of HARQ with Chase combining for medium and high vehicle speed [11], we perform the system level simulation study for mobility support of HSDPA.

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 throughput versus Ec/Ioc of a single code for HSDPA with and without the channel prediction at 30Kmph. Notice that for this medium speed the performance improvement by channel prediction is 0.5 to 1.0 dB with Ec/Ioc between –5 to 5dB.

Figure 3 shows the throughput versus Ec/Ioc of a single code for HSDPA without the channel prediction at 120Kmph. For this high-speed case, the channel prediction is not feasible for corresponding Rayleigh fading. The MCS selection is likely determined by the mean SNR over Rayleigh fading. However, if both Rayleigh and shadow (lognormal) fading are considered, it might be possible to predict the fluctuation of shadow fading and hence precede proper MCS selection to improve the throughput.

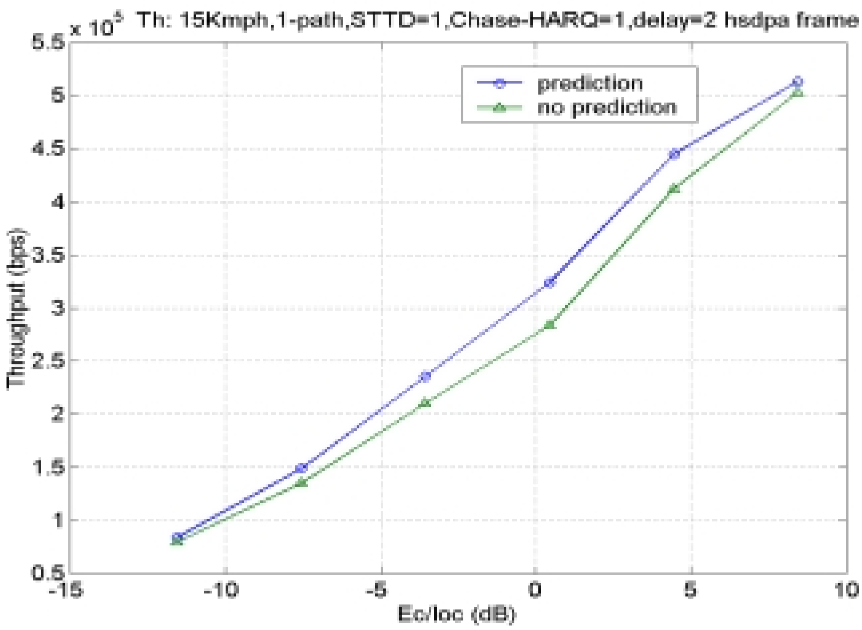

Figure 1. Throughput versus Ec/Ioc with and without channel prediction. Total delay=2 HSDPA frame, 1-path Rayleigh channel, speed = 15kmph, STTD on, HARQ with Chase Combining, ideal feedback. Max re-transmission=15.

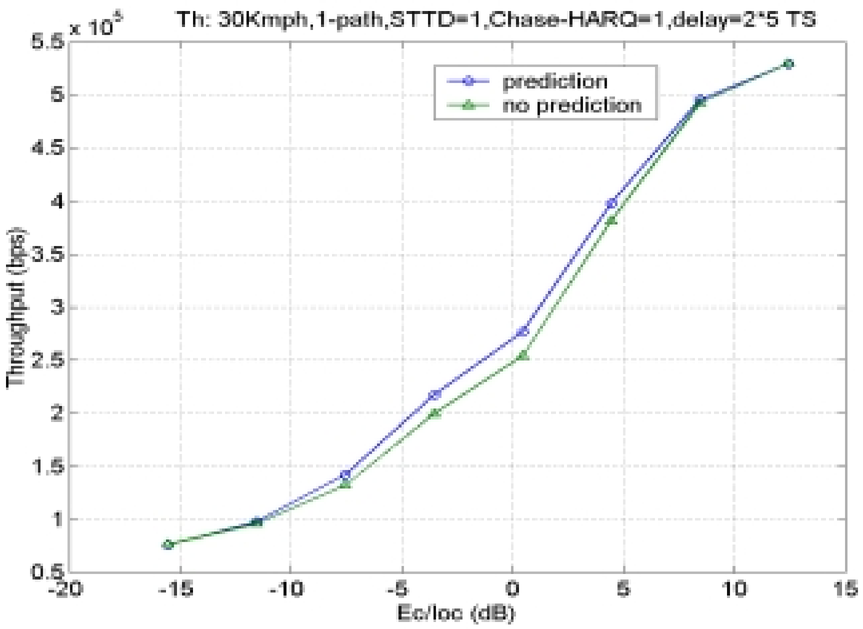

Figure 2. Throughput versus Ec/Ioc with and without channel prediction. Total delay=2 HSDPA frame, 1-path Rayleigh channel, speed = 30kmph, STTD on, HARQ with Chase Combining, ideal feedback. Max re-transmission=10.

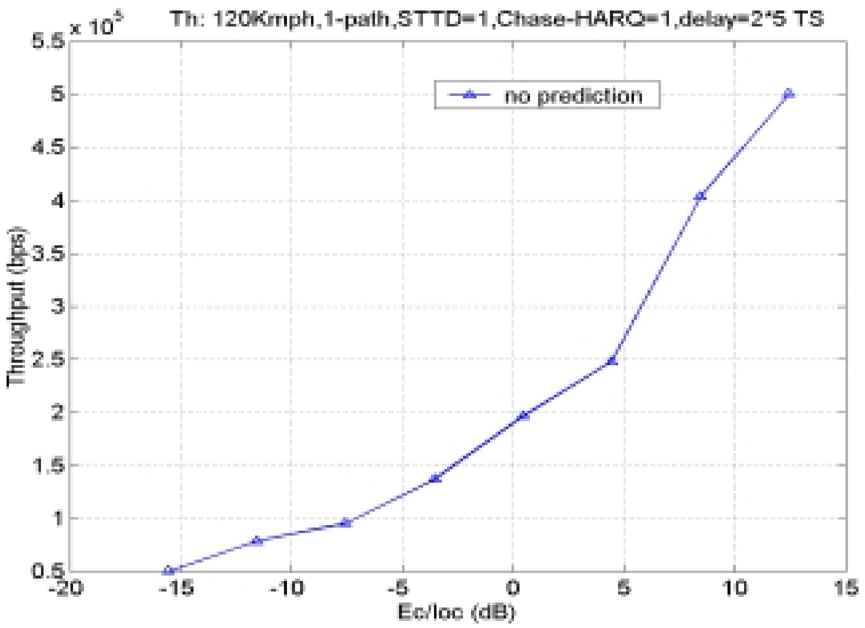

Figure 3. Throughput versus Ec/Ioc without prediction. Total delay=2 HSDPA frame, 1-path Rayleigh channel, speed = 120kmph, STTD on, HARQ with Chase Combining, ideal feedback. Max re-transmission=10.

4 Conclusion

We evaluate the throughput performance in medium to high vehicle speed scenarios for mobility support of HSDPA. For medium-speed case (such as 10 to 30Kmph), the technique of long-range prediction (LRP) can be used to improve the system performance. For high-speed case, it might be possible to predict the signal fluctuation due to shadow fading and thus improve the throughput. Further study is needed. Based on the potential performance improvement, the long-range prediction (LRP) technique [4,5,9,10] should be incorporated with AMCS and HARQ, especially in the mobility support of HSDPA.

5 References

[1] 3GPP TR V0.6.0 (2000-05), Physical Layer Aspects of UTRA High Speed Downlink Packet Access, (Release 2000), TSG-RAN Working Group1 meeting#19, TSGR1#19, R1-01-0430, Las Vegas, USA, 27th Feb.-2nd March, 2001

[2] TSG RAN R1-00-1326, Wiscom Technologies, "Link level simulation results for HSDPA", TSGR1#17, Stockholm, Sweden, November 21-24, 2000.

[3] TSG RAN R1-00-1327, Wiscom Technologies, "Influence of channel estimation on the link level performance of HSDPA", TSGR #17, Stockholm, Sweden, November 21-24, 2000.

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

[7] 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.

[8] TSG RAN R1-01-0136, Wiscom Technologies, "Simulation results for Section 13.3.7.1 of TR 25.848", TSGR1#18, Boston, MA, USA, Jan. 15-18, 2001.

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[11] TSG RAN R1-01-0538, Wiscom Technologies, "Link Level Performance of HARQ with Chase Combining for Medium and High Vehicle Speed", TSGR1#20, Busan, Korea, May21-25, 2001.