TSG-RAN Working Group 1 Meeting #20 **TSGR1#20(01)0512**
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Agenda Item: **AH24: High Speed Downlink Packet Transmission**
Source: **Sony Corporation**
Title: **Follow up on variable C/I feedback rate proposal**
Document for: **Discussion/Decision**

1. Introduction

In the last HSDPA ad-hoc meeting, the variable C/I feedback rate proposal was presented[1]. It was agreed that if the explicit C/I feedback is to be used, then the rate of feedback is made configurable by a higher layer [2][3]. It was left for RAN1 to further investigate the need for explicit C/I feedback.
This contribution presents further simulation results for proposed scheme and addresses some issues of DL C/I estimation for the case no explicit C/I feedback is used.

2. The Proposal

The proposal is to enable Node-B to estimate DL channel quality (DSCH C/I) using TPC commands in conjunction with explicit C/I feedback from UE. DSCH SIR measure, converted from CPICH SIR, is used for explicit C/I and TPC commands for DPCH are used to compensate for feedback delay associated with explicit C/I feedback. The DSCH SIR measurements only need to be fed back every once in a while to take full advantage of TPC compensation. In addition, it is proposed to include the mechanism in UTRAN to control feedback rate of explicit C/I to allow flexible network implementation and to avoid the over estimation of C/I using TPC due to the soft handover gain achieved on DPCH.
More detailed proposal can be found in [1][4][5].

3. Performance Analysis

Following schemes are evaluated and compared as in [2] to show validity of the proposed scheme.

Case 1. No TPC compensation of explicit C/I measures with C/I feedback every TTI (=5*Tslot).
Used as a reference case. Considered as a baseline HSDPA scheme.
Case 2. No TPC compensation of explicit C/I measures with C/I feedback every 320msec (Fixed).
Used as reference for Case 3 with some uplink resource usage.
Case 3. TPC compensation of explicit C/I measures with C/I feedback every 320msec (Fixed).
C/I feedback rate is determined at call set-up and fixed throughout simulation. DPCH may go into soft handover state depending on average CPICH RSCP criteria evaluated every 1.5 sec.
Case 4. TPC compensation with variable C/I feedback
C/I feedback rate is controlled by RNC. C/I feedback is made every TTI (5*Tslot) for UEs with more than 2 strong active set. All other UEs are assigned to make C/I feedback every 320msec as in case 4. Handover criteria and feedback rate is evaluated every 1.5 sec.

Simulation is performed with similar manner as in [2] with new parameters as listed below.

- Maximum DSCH power allocation is reduced to 70% of Total Node-B power (previously 80%).
- Interference from surrounding cells is made dynamic according to DSCH traffic. (Previously set to max)
- Performance under Round Robin scheduler is added.
- Only 3km mobility cases are evaluated (Previously a combined results from 1,3,30km).
- Chase combine is done at symbol level (Before PSK/QAM demodulation)
- FCS is disabled.

3.1. Benefit of TPC compensation

Figure 2 illustrates performance gain when using TPC commands in conjunction with explicit C/I feedback. It can be seen that even if the feedback rate for explicit C/I is reduced to once in every 320msec (Case 3), it performs better than the case where explicit C/I is fed back every 3.33msec with no TPC compensation (Case 1).

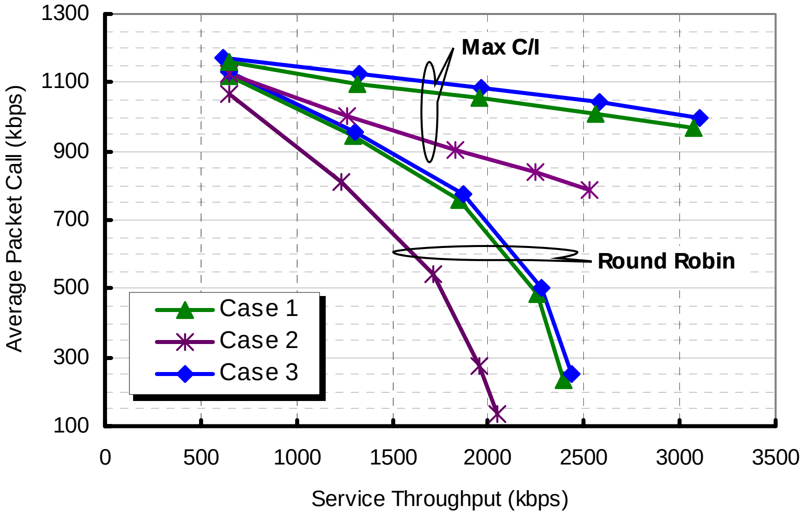

Figure 1 TPC Compensation Gain

3.2. Benefit of Variable Feedback Rate

Figure 2 illustrates performance gain when using variable C/I feedback rate (Case 4). Some noticeable gain can be seen can be seen over fixed C/I scenario (Case 3). Table 1 and Table 2 is a summary of throughput statistics for 64-user per sector case. The use of variable feedback rate scheme improves residual BLER. This may become more significant as the number of maximum number of retransmission by H-ARQ is reduced and combined with Layer 2 SR procedure.

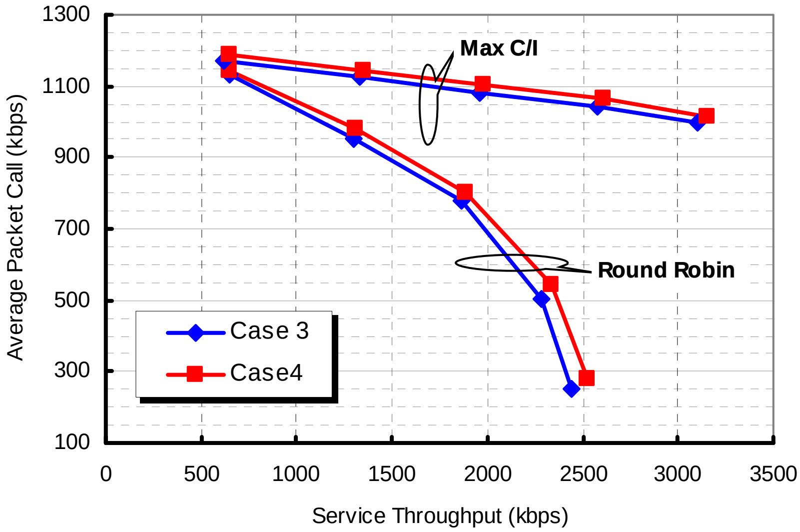

Figure 2 Variable Feedback Gain

Table 1 Performance comparison under Max C/I scheduler

64-users/sector Max C/I	Service (kbps)	Packet (kbps)	Packet Call Cumulative Distribution (%) < 32k	< 64k	< 128k	< 256k	< 384k	< 768k	<1.152M	Util	Residual Error
TPC:variabl feedback (case4)	2608.5	1062.0	1.0	2.4	5.7	12.1	18.2	35.7	56.0	0.86	3.8E-04
TPC:feedback per 320ms(case3)	2576.7	1043.9	1.4	3.5	7.5	14.0	19.7	35.9	55.8	0.89	6.6E-04
Baseline:feedback per TTI(case1)	2557.8	1009.1	1.5	3.5	7.5	14.7	21.2	39.4	59.9	0.89	7.8E-04
Baseline:feedback per 320ms(case2)	2247.0	837.4	7.1	12.2	19.3	27.8	33.9	50.2	67.8	0.95	2.3E-03

Table 2 Performance comparison under Round Robin scheduler

64-users/sector Round Robin	Service (kbps)	Packet (kbps)	Packet Call Cumulative Distribution (%) < 32k	< 64k	< 128k	< 256k	< 384k	< 768k	<1.152M	Util	Residual Error
TPC:variabl feedback (case4)	2341.2	541.0	0.4	2.4	13.1	34.4	49.9	74.7	88.1	0.93	4.4E-04
TPC:feedback per 320ms(case3)	2280.3	511.6	0.4	3.4	16.1	38.3	53.2	76.6	89.0	0.94	8.3E-04
Baseline:feedback per TTI(case1)	2261.5	481.6	0.5	4.3	18.7	42.6	57.4	79.5	90.6	0.94	8.8E-04
Baseline:feedback per 320ms(case2	1951.5	272.1	1.7	14.3	40.6	68.7	80.4	91.9	96.5	0.98	3.6E-03

4. Discussion

From the results provided above, it can be conclude that the use of TPC commands to compensate for delay and reduced rate of explicit C/I feedback are beneficial. It can be also said that enabling more frequent C/I feedback for UEs in soft handover state has some performance advantages.

At the same time, the results shown give some motivation to eliminate explicit C/I report completely and rely on TPC gain alone for DL channel quality estimation as some simulation results for such scheme were provided in [6]. However, having feedback capability is thought to be beneficial from the following arguments.

- Absolute mapping of DPCH Power to DSCH quality
  In case no explicit C/I is supplied, Node-B must be able to map DPCH power to DSCH quality directly. At least target BLER information is needed at Node-B, and need to be made available for all Node-Bs from RNC. Furthermore, Node-B must be able to convert DPCH power to DSCH quality for all possible physical channel/transport channel configurations.
  The proposed scheme only uses TPC gain only to compensate for fed back C/I measure that give absolute reference, therefore above complexity is not a factor.
- Power control mechanism in UE
  TPC only gives indication to relative channels quality with respect to target SIR that is derived from target BLER of reference TrCH. No exact algorithm or detailed behavior is defined in specification and left as UE implementation matter. There will always be some implementation margin/error on target BLER to target SIR mapping, and it is difficult to quantify this margin to evaluate its influence. Again, the proposed scheme does not have this problem if the assumption that target SIR does not vary suddenly over explicit C/I feedback period hold.

Further more, the proposed scheme does not prevent from disabling explicit C/I feedback completely (feedback rate = 0) to use DPCH power based DSCH quality estimation if Node-B is capable of doing so or in case the DSCH is beam-formed so that feedback information based on common channel quality is no longer reliable.

5. Conclusion

The requirement for C/I feedback functionality is included for HSDPA, and following change be made for TR25.855 Section 9.1.

9.1 Downlink

1.UE identification

This identifies which UE (or UEs), data is transmitted in the next corresponding HS-DSCH TTI.

2. MCS used

This defines what MCS is used in the corresponding HS-DSCH TTI.

3.HS-DSCH power level

This defines the relationship of HS-DSCH and CPICH code power level. UE needs to know this in order to do N-QAM demodulation.

4. Code channels in case of code multiplexing

This identifies the UE (or UEs) the codes it (they) should receive and decode.

5. FHARQ

a. FHARQ process number (= subchannel number for N-channel SAW structure)

This info is needed by the UE, in order to know which received packets should be combined and decoded together.

b. FHARQ redundancy version for IR

This info is also needed by the UE in order to know which received packets should be combined and decoded together.

c. FHARQ packet number, including the idea of aborting failed attempts

The packet number is needed by the UE to know, what packets should be combined together by the Hybrid ARQ entity. It is assumed that only one packet number is needed per TTI. E.g. the number could be somehow tied or mapped to the RLC PDU number of the first TrCH block in the TTI.

There may be also a need for some mechanism for aborting the current ARQ attempt , e.g. in order to limit the maximum number of attempts per frame and instruct the UE to flush the previous attempts from its receiver's buffers .

Here it is assumed that these two methods can be combined to one signaling parameter.

6.Power offset for uplink control channel

This informs the UE what kind of power offset it should use in the uplink, when sending e.g. ACK during soft handover. Node B could estimate the SIR from the uplink, and calculate the needed power offset in the uplink, in order to make sure that an ACK can be decoded reliably.

7.Feedback rate for Measurement Report

This informs the feedback rate for downlink quality measurement for MCS selection.

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6. Reference

[1] SONY: “Variable DL channel condition feedback rate for HSDPA” HSDPA ad-hoc 12A(01)0028, April, 2001

[2] 3GPP support team: “Report of the joint TSG-RAN WG1/WG2 meeting on HSDPA” 12A(01)0045, April, 2001

[3] TR25.855:”High Speed Downlink Packet Access” TSGR2#20(01)0987, April, 2001

[4] SONY: “Reduction of DL channel quality feedback rate for HSDPA” TSGR1#19(01)0338, Feb. 2001

[5] SONY: “Use of TPC for DL channel Quality Estimation”, TSGR1#18(01)0074, Jan. 2001

[6] Panasonic: “DL Channel Estimation Using DPCH Tx-power”, TSGR1#19(01)0207, Feb. 2001

Annex: Simulation Assumptions

Table 3 Modulations and Coding Parameters

Parameter				
Transport CH	Number of TrCH		1	
	TTI (TUI)		5-slot	
	Transport Block Size		24-byte	
	CRC Attachment		Per TTI--16-bit	
AMCS	Mode	Modulation	Coding Rate	Num TrBlk
	MCS1	QPSK	R=1/4	1
	MCS2	QPSK	R=1/2	2
	MCS3	QPSK	R=3/4	3
	MCS5	16QAM	R=1/2	4
	MCS6	16QAM	R=3/4	6
	MCS7	64QAM	R=3/4	9

Table 4 System Simulation Parameters

Parameter	**Explanation/Assumption**	**Comments**
Cellular layout	19-cell, 3-sector/cell with (3-tier)	Statistics from center cell ONLY
Site to Site distance	2800 m	
Propagation model	$L = 128.1 + 37.6\ Log_{10}R$	R in kilometers
Tx-diversity	2-Tx antenna, STTD	
CPICH power	-10 dB	
Other channels	- 7 dB	
Power allocated to HS-DSCH	Max. 70 % of total cell power	
Number of Code allocated to HS-DSCH	Max. 20	SF=32--Fixed
Slow fading	As modelled in UMTS 30.03, B 1.4.1.4	
Std. deviation of slow fading	8 dB	
Correlation between sectors	1.0	
Correlation between sites	0.5	
Correlation distance of slow fading	50 m	
Carrier frequency	2000 MHz	
BS antenna gain	14 dB	
UE antenna gain	0 dBi	
UE noise figure	9 dB	
MCS Selection	DSCH SIR + TPC gain	Unless otherwise specified
DSCH SIR Feedback Delay	4 TTI = (4*5*Tslot)	Plus amount of decimation
TPC delay for use in scheduler	2-slot	4% error rate included
Max. # of retransmissions	10	
Fast HARQ scheme	Chase combining	N=4
BS total Tx power	Up to 44 dBm	
Active set size	3	Maximum size
Fast Cell Selection	Disabled	
UE Mobility	3km/h	