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Agenda Item:	**AH24: High Speed Downlink Packet Transmission**
Source:	**Sony Corporation**
Title:	**Simulation results for Enhanced DSCH**
Document for:	**Discussion/Information**

1. Introduction

This document presents initial simulation results for the Enhanced DSCH [1,2] and addresses the issue of AMCS mode adaptation rate. The intention of this contribution is to show some benefits of changing the rate of link adaptation by varying the averaging length of reported SIR for AMCS mode selection. This document also addresses the issue of SIR estimation variance to show that its effect is small enough.

2. Simulation Objective

Simulation is conducted to investigate the following technical issues.

?? Interaction with AMCS adaptation and Hybrid-ARQ

It is easy to assume that faster adaptation rate leads to better link adaptation performance if only one adaptation mechanism is present. However, E-DSCH combines the use of adaptive modulation/coding scheme with Hybrid-ARQ for link adaptation. Hybrid ARQ itself is link adaptation method, and due to the inherent nature of Hybrid-ARQ (chase combining method), the AMCS mode needs to be kept constant among the 1st transmission packet and re-transmission packets. This implies that the applied AMCS mode at re-transmission stage may be far away from optimal mode causing non-efficient re-transmission if the AMCS mode is adapted to instantaneous SIR. The AMCS adaptation using long-term SIR (slow adaptation) may reduce this effect. The trade-off between gain obtained by faster link adaptation and gain obtained by re-transmission need to be investigated.

?? Influence of SIR estimation variance

To give control of resource management to UTRAN, it is likely that the measured link quality (SIR) need to be reported to UTRAN. In practice, measured SIR by UE has some variance and may not be sufficient for link adaptation purposes as suggested in [5]. This is especially true if the fast link adaptation is carried out by using instantaneous SIR. The trade-off between adaptation rate and report accuracy need to be investigated.

3. Simulation Conditions

3.1. Link Level Simulation

The basic principle of link simulation condition is in line with simulation assumptions presented in [3]. The main differences reside in definition of AMCS mode. The results presented in this document does not include newly added mode that utilizes R=1/4 Turbo code, and includes Turbo code trellis termination for each code block. The AMCS modes used in this document are shown in Table 1. Other simulation parameters are shown in Table 2.

Table 1 AMCS Mode

AMCS Mode	Modulation	TC Coding Rate	Data Rate (kbps/DSCH code)
1	*Not Implemented*		
2	QPSK	R=1/2	118.2
3	QPSK	R=3/4	177.3
4	8PSK	R=3/4	267.3
5	16QAM	R=1/2	238.3
6	16QAM	R=3/4	357.3
7	64QAM	R=3/4	537.3

Table 2 Simulation Parameters

Spreading	Chip rate	3.84Mcps
	Over-sampling	None, 1-sample/chip
	PDSCH SF	32
	Pilot_Ec/Ior	-10dB
	DSCH_Ec/Ior	-1dB
	Multi-code	No (1-DSCH code only)
Modulation	PDSCH Modulation	QPSK, 8PSK, 16QAM, 64QAM
	Channel Estimate	CPICH
FEC	DSCH FEC	PCC TC: k=4, R=1/2, 3/4:
	Frame Length	3.33msec (5-slot)
	Interleave Length	3.33msec (5-slot)
Adaptation	DSCH SIR Estimation	Ideal/from CPICH and power offset Info.
	SIR report delay	1-PDSCH Frame (3.33msec)
Radio Channel	Antenna Diversity	Not Applied
	Channel	1-path: AWGN, 6Hz, 30Hz, 240Hz flat fade
	Feedback Info. Error Rate	0%
Other	ARQ Scheme	Chase combine (Type III)
	Max re-transmission number	1,2,10 (1=No retransmission)
	Power Control	OFF
	Associated DPCH modeling	As OCNS

3.2. System Simulation (simplified version)

A simplified version of system simulation is carried out in order to obtain some idea of average throughput gain /loss using the instantaneous SIR for AMCS mode adaptation. The simulation assumes that data for user at the base station is stored in the buffer with infinite size and are always available for transmission. This implies that base station is always utilizing full DSCH resources (code, time slot, and power). The simulation also assumes that all the mobile speed in a service area is constant at 3km/h and experiences 6Hz flat fading. The other simulation parameters are in line with [4] and some key parameters are listed in Table below.

Table 3 System Simulation Parameters

BTS Parameter	Cell	19 Hexagonal cell/ 3-sector. See Fig. 1
	Cell Step Size	2800m
	Carrier Frequency	2.0GHz
	Tx antenna diversity	None
	BS antenna pattern	As in [4]
	BS antenna ga in	14dBi
	Max. BS TX Power	44dBm (25W)
	CPICH Ec/Ior	-10dB
	DSCH_Ec/Ior	-14dB per code
	DSCH code resource	20
	Packet Scheduling	Round Robin
Channel Parameter	Propagation Model	1-path; average Ec/Nt is assumed to stay constant within a packet frame (3.33msec).
	Flat fading model	Jakes
UE parameter	Rx antenna gain	0dBi
	Rx antenna diversity	None
	Receiver NF	8dB
	SIR Estimation	Ideal
	ARQ	E-DSCH: Type III (chase combine)
	Cell Selection	Ideal

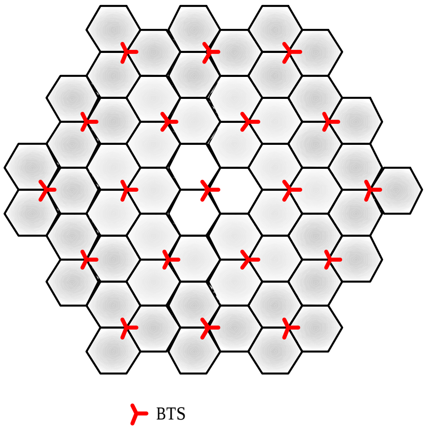

Fig. 1 Cell Layout Model

4. Simulation Results

4.1. The "Hull"

The "hull" characteristics for AMCS without hybrid ARQ under fading conditions of 6, 30 240Hz is shown in Fig. 2. The "hull" represents the throughput characteristics of E-DSCH when AMCS mode is adapted using long-term averaged Ec/Nt (equivalent to SIR). Throughput shown here is normalized with respect to maximum throughput achievable with AMCS mode 7 (64QAM, R=1/2). The "hull" for AMCS with hybrid ARQ under the fading condition of 6Hz is shown in Fig. 3. Maximum transmission count for hybrid ARQ case is set to 2 or 10. Hybrid ARQ gain is observed as the maximum transmission count increase.

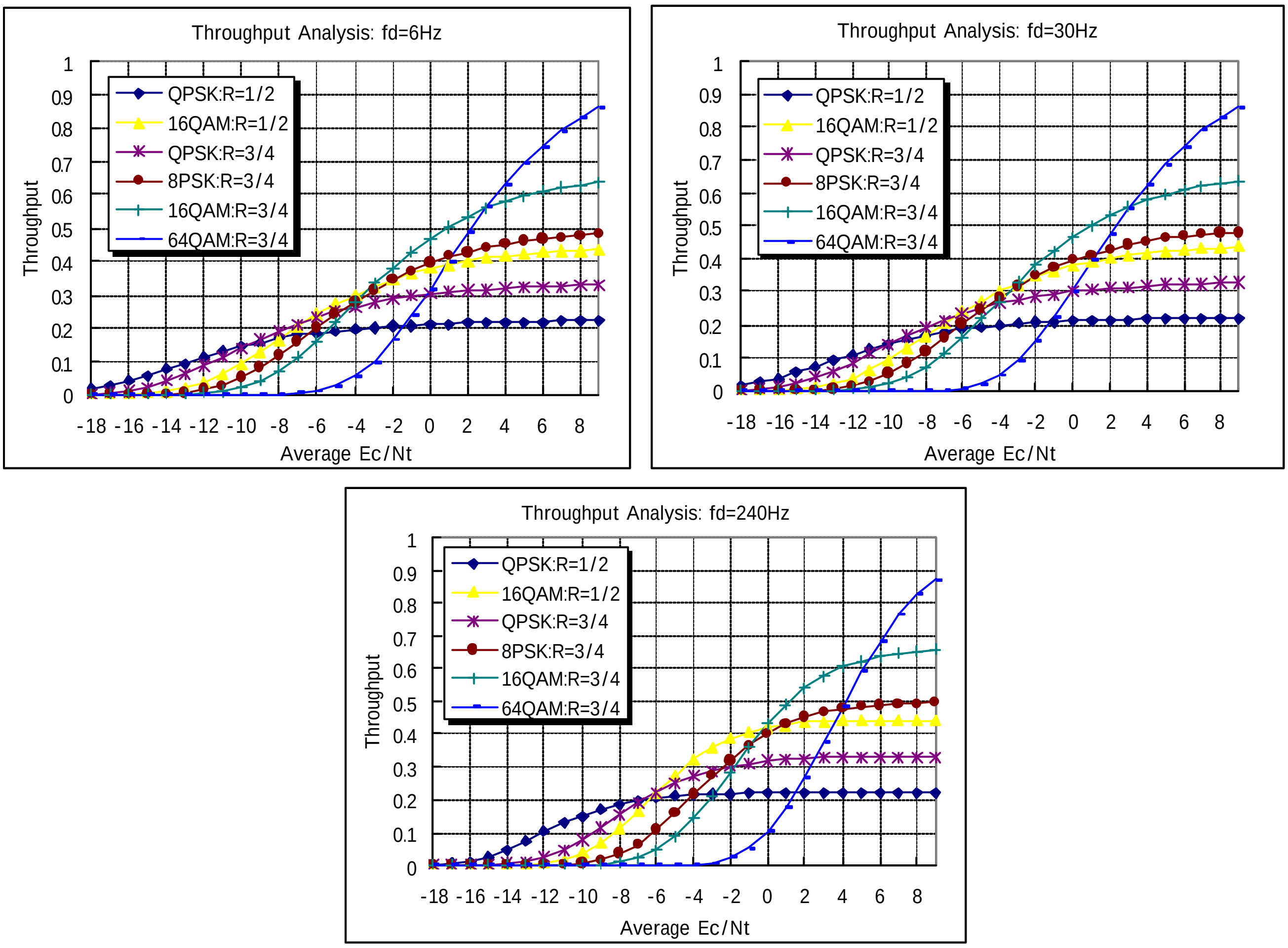

Fig. 2 Throughput without H-ARQ

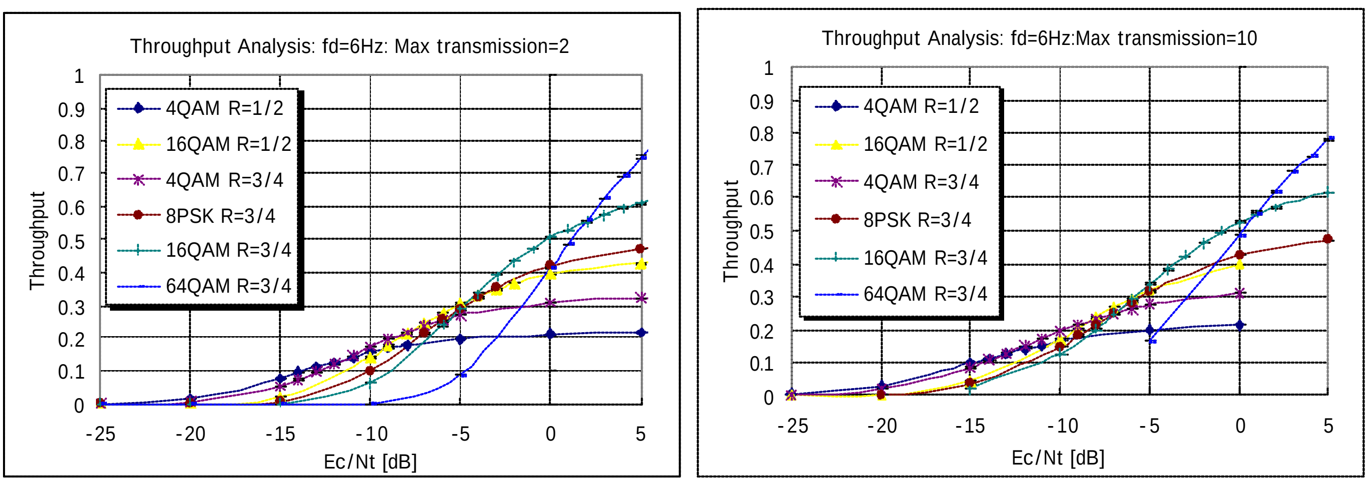

Fig. 3 Throughput with H-ARQ (Max transmission count = 2, 10)

4.2. AMCS mode adaptation rate vs. Throughput

Instead of using long-term average, more instantaneous SIR is used for AMCS mode adaptation. The reported SIR from UE averaged for AMCS mode selection and the number of averaging is changed to see its effect. As expected, the throughput characteristic converges to the "hull" as the number of averaging increases. For slow fading conditions, faster link adaptation (less averaging) gives more gain whereas, for fast fading condition, increasing the adaptation rate does not give any gain. Under fast fading conditions, link adaptation performance is limited to the feedback delay of SIR measurement (2 E-DSCH frames). In such conditions, reported SIR needs to be averaged long enough, and the "hull" characteristics are found to be optimal.

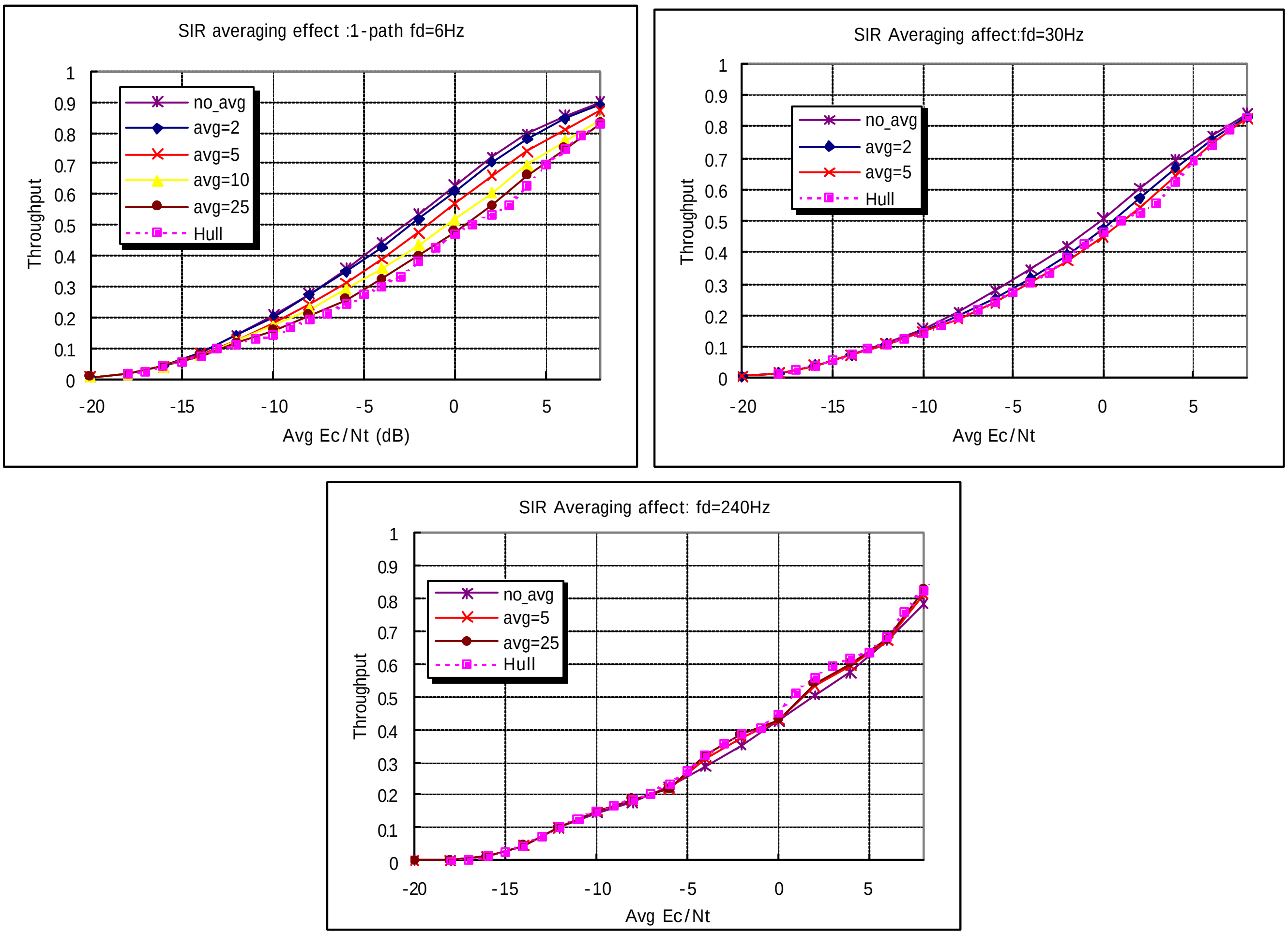

Fig. 4 Influences on SIR Averaging (No re-transmission case)

The throughput characteristics of E-DSCH with hybrid ARQ is shown in Fig. 5. The characteristics of instantaneous SIR adaptation (no averaging—reported SIR is directly used for mode adaptation) are compared against the "hull" under the fading condition of 6Hz. Even with the interaction with hybrid ARQ, it is sown that throughput gain can be achieved by using instantaneous SIR for mode adaptation.

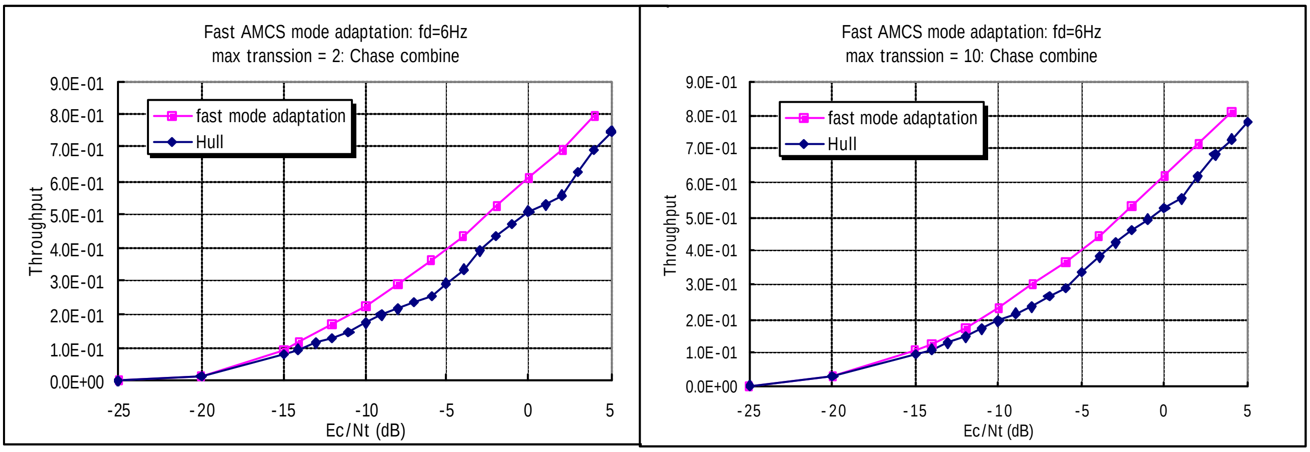

Fig. 5 fast AMCS mode adaptation with H-ARQ (max transmission count =2, 10)

4.3. Average throughput gain over the "Hull" characteristics

According to link level simulation results, average throughput is calculated by obtaining Ec/Nt distribution over the service area using system simulator. The percentage of throughput gain obtained by using instantaneous SIR for AMCS mode adaptation over adaptation using average SIR is shown in Table 4. The gain reduces as the gain of hybrid ARQ increases by re-transmission. Nevertheless, the results suggest that it is preferable to use instantaneous SIR for AMCS mode adaptation given that the link characteristics change slowly.

Table 4 Average throughput gain using instantaneous SIR for AMC mode adaptation (fd=6Hz, ideal SIR)

	No re-transmission	Max-Transmission=2	Max Transmission=10
Avg throughput gain	26%	23%	15%

4.4. Influence of SIR measurement variance

The previous results suggest that more gain can be obtained by adapting AMC mode with instantaneous SIR estimate reported by UE. However, in real situation where UE estimates SIR using CPICH received symbols and DSCH/CPICH power offset information from higher layer signaling, reducing the number of average will lead to more variance in reported SIR value as shown in Fig. 6.

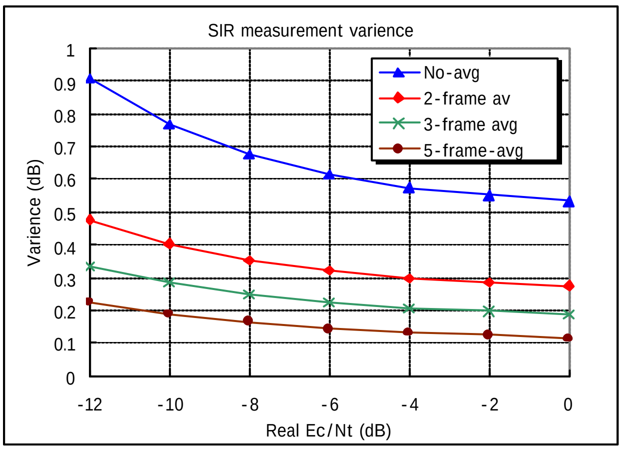

Fig. 6 SIR measurement Error and Variance

Degradation of throughput performance can be expected as large variance in reported SIR causes inappropriate AMCS mode adaptation. However, as seen in Fig. 7, this effect is small enough (less than 0.5dB degradation) to put more weight on adaptation speed rather than SIR accuracy.

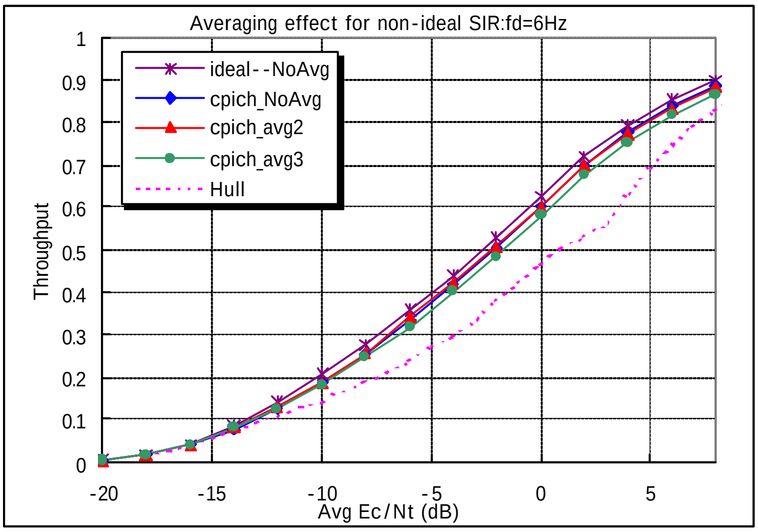

Fig. 7 Throughput gain with non-ideal SIR estimation (No re-transmission case)

5. Conclusion

Throughput characteristics of Enhanced DSCH using instantaneous SIR for AMCS mode adaptation were shown in this document to investigate the effect of AMCS interaction with hybrid ARQ. In slow varying channel conditions, it is shown that larger throughput can be obtained by adapting AMCS mode to instantaneous SIR reported from UE rather than adapting with long-term averaged SIR. On the other hand, under fast varying channel conditions, reported SIR need to be averaged long enough. Since UTRAN is able to obtain some information on varying rate of DL channel condition through the use of previously reported SIRs, power control information, etc., UTRAN may choose to change AMCS adaptation rate (number of averaging on reported SIR) to maximize cell throughput.

Further results with more analysis and more aligned simulation assumptions defined in [3] and [4] will be produced in the near future.

6. References

[1] Motorola: "Feasibility study of advanced techniques for High Speed Downlink Packet Access", TSGR1#12(00)0556, April, 2000

[2] Motorola: "High Speed Packet Access", TSGR1#13(00)0727, May, 2000

[3] Ericsson, Motorola, Nokia: "Link Evaluation Methods for HSDPA" TSGR1#15(00)1093, Aug, 2000

[4] Ericsson, Motorola, Nokia: "Common HSDPA System Simulation Assumptions" TSGR1#15(00)1094, Aug, 2000

[5] Nokia: "Considerations on HSDPA" TSGR1#14(00)0868, July, 2000