TSG-RAN Working Group 1 Meeting #17 **TSGR1#17(00)1377**

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Agenda Item:	**AH24: High Speed Downlink Packet Transmission**
Source:	**SONY Corporation**
Title:	**HS-DSCH simulation results**
Document for:	**Discussion/Information**

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1. Introduction

The current simulation assumption for proposed HS-DSCH scheme makes use of 7 AMCS modes to adapt to channel quality [1][2]. In an effort to reduce number of AMCS modes to simplify the scheme, link level and system level simulation are conducted to analyze HS-DSCH performance when some of the AMCS modes were not used. The document shows that removal of QPSK R=1/4, 8PSK R=3/4, and 64QAM R=3/4 is possible with negligible system throughput loss.

2. Simulation Parameters

Following cases are considered in this document:

1. Full 7-AMCS
2. 5-AMCS without QPSK R=1/4, 8PSK R=3/4
3. 5-AMCS without 8PSK R=3/4, 64QAM R=3/4
4. 4-AMCS without QPSK R=1/4, 8PSK R=3/4, 64QAM R=3/4
5. 7-AMCS based on the “Hull” characteristics

Particular interests reside in case 2, 3, 4 where R=1/4 turbo coding, 8PSK modulation, and/or 64QAM modulation are removed to reduce implementation complexity for both Node-B and UE. Reducing the number of AMCS mode itself regardless of modulation and coding combination may have some other benefits such as robustness against reporting /measurement error and reduction of control information.

Link Level Simulation is performed in accordance with [2]. A varience of 1dB is added to reported DL channel quality measurement to include throughput loss caused by selecting a non-optimal AMCS mode. Other simulation parameters are provided in Annex A. Analytical System Level simulation is also performed to estimate system gain/loss for each case. A round robin scheduler with highest priority assignment for re-transmission data is assumed for the analysis. System Level Simulation parameters are provided in Annex B.

3. Simulation Results

3.1. Max transmission Count=1 (No ARQ)

Simulation results in case no ARQ is utilized are summarized in Table 1. Throughput reduction can be observed as the number of AMCS modes is reduced. Reduction of throughput is small (approximately 8%) even when all of QPSK R=1/4, 8PSK R=3/4, and 64QAM R=3/4 mode (Case 4) are removed from currently defined 7 AMCS set (Case 1). It can also be said that contribution of 8PSK R=3/4 and 64QAM R=3/4 is quite small as case 3 exhibits less than 2% loss in throughput. Case 2, without QPSK R=1/4 and 8PSK, exhibits relatively larger loss indicating that use of QPSK R=1/4 mode may be beneficial for services with small delay requirement.

Table 1: HS-DSCH Throughput Performance (No ARQ/STTD)

	Throughput (Mbps/sector/carrier)				
	System Total	0km (Rice)	1km	3km	30km
Case 1: 7-AMCS	**2.516**	2.95	2.67	2.52	2.11
Case 2: 5-AMCS	**2.365**	2.72	2.49	2.38	2.04
Case 3: 5-AMCS	**2.471**	2.90	2.60	2.47	2.11
Case 4: 4-AMCS	**2.316**	2.67	2.41	2.31	2.04
Case 5: Hull 7AMCS	**2.301**	2.96	2.20	2.20	2.19
QPSK R=1/2	***1.426***	*1.55*	*1.41*	*1.40*	*1.39*

3.2. Max Transmission Count=10 (Type III Soft-combine H-ARQ)

Simulation results in case H-ARQ with maximum transmission count of 10 are summarized in Table 2. Throughput loss due to reducing the nmber of AMCS modes becomes even smaller as the ARQ gain is dependent on FER operation point. Reduction of QPSK R=1/4 mode (Case 2) does not cause significant loss in throughput since larger H-ARQ gain achieved by QPSK R=1/2 mode at high FER region is able to compensate for it. Throughput difference between full 7-AMCS (case 1) and 4-AMCS without QPSK R=1/4, 8PSK R=1/2, 64QAM R=3/4 (case 4) is approximately 2%.

More detailed simulation results including link level throughput and re-transmission characteristics are shown in Annex C.

Table 2: HS-DSCH Throughput Performance (Type III H-ARQ/STTD)

	Throughput (Mbps/sector/carrier)				
	System Total	0km (Rice, k=12dB)	1km	3km	30km
Case 1: 7-AMCS	**2.776**	3.16	2.88	2.82	2.45
Case 2: 5-AMCS	**2.772**	3.15	2.88	2.83	2.45
Case 3: 5-AMCS	**2.732**	3.08	2.81	2.75	2.44
Case 4: 4-AMCS	**2.716**	3.08	2.81	2.75	2.40
Case 5: Hull-7AMCS	**2.708**	3.19	2.67	2.65	2.56
QPSK R=1/2	***1.739***	*1.87*	*1.74*	*1.72*	*1.69*

4. Conclusion

Following conclusion can be drawn from the simulation results presented:

?? The use of 64QAM R=3/4 mode, 8PSK R=3/4 mode, and QPSK R=1/4 mode does not contribute to significant increase in system throughput for services that allows re-transmission delay. These modes may be removed from AMCS set to reduce implementation complexity. If needed, 64QAM may be defined as a part of UE capability for terminals targeted for heavy use in indoor environments.

?? The QPSK R=1/4 mode may be useful for users at cell edge for services with more strict delay requirements.

5. References

[1] Motorola: “High Speed Packet Access”, TSGR1#13(00)0727, May. 2000
[2] Ericsson, Motorola, Nokia: “Link Evaluation Methods for HSDPA ” TSGR1#15(00)1093, Aug. 2000
[3] Ericsson, Motorola, Nokia: “Common HSDPA System Simulation Assumptions” TSGR1#15(00)1094, Aug. 2000
[4] Philips: “Throughput of HSDPA ”, TSGR1#16(00)1202, Oct. 2000
[5] SONY: “Simulation results for E-DSCH”, TSGR1#16(00)1238, Oct. 2000
[6] TR25.HSPA, “Physical Layer Aspects of UTRA High Speed Downlink Packet Access”, TSGR1#16(00)1316, Oct. 2000

Annex A: Link Level Simulation Assumptions

The basic principle of link simulation condition is in line with simulation assumptions presented in [2]. The main differences reside in definition of AMCS mode. The AMCS modes used in this document are shown in Table 3. Other simulation parameters are shown in Table 4.

Table 3 AMCS Mode

AMCS Mode	Modulation	TC Coding Rate	Data Rate (kbps/DSCH code)	7-AMCS (case 1)	5-AMCS (case 2)	5-AMCS (case 3)	4-AMCS (case 4)
1	**QPSK**	**R=1/4**	59.1	**Y**	**N**	**Y**	**N**
2	QPSK	R=1/2	118.2	**Y**	**Y**	**Y**	**Y**
3	QPSK	R=3/4	177.3	**Y**	**Y**	**Y**	**Y**
4	**8PSK**	**R=3/4**	267.3	**Y**	**N**	**N**	**N**
5	16QAM	R=1/2	238.3	**Y**	**Y**	**Y**	**Y**
6	16QAM	R=3/4	357.3	**Y**	**Y**	**Y**	**Y**
7	**64QAM**	**R=3/4**	537.3	**Y**	**Y**	**N**	**N**

Table 4 Simulation Parameters

Spreading	Chip rate	3.84Mcps
	Over-sampling	None, 1-sample/chip
	PDSCH SF	32
	Pilot_Ec/Ior	-10dB
	DSCH_Ec/Ior	-14dB per code
Modulation	PDSCH Modulation	QPSK, 8PSK, 16QAM, 64QAM
	Channel Estimate	CPICH
FEC	DSCH FEC	PCC TC: k=4, R=1/4, R=1/2, 3/4:
	Frame Length	3.33msec (5-slot)
	Interleave Length	3.33msec (5-slot)
Adaptation	DSCH SIR Estimation	1dB variance added to ideal measurement
	SIR report delay	3-PDSCH Frame (3*3.33msec)
Radio Channel	Antenna Diversity	STTD
	Channel	Rice: k=12dB fd=2Hz Rayleigh: fd=2Hz, 6Hz, 60Hz
	Feedback Info. Error Rate	0%
Other	ARQ Scheme	Chase combine (Type III)
	Max re-transmission number	1,10 (1=No retransmission)
	Power Control for DSCH	No
	Associated DPCH modeling	Modeled as OVSF

Annex B: System Level Simulation Assumptions

Analytical version of system simulation is carried out in order to obtain some idea of average throughput within a service area. 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 the base station is always utilizing full DSCH resources (code, time slot, and power). The simulation also assumes modified version of mobile speed distribution as shown in Table 6. The other simulation parameters are in line with [3] and some key parameters are listed in Table below.

Table 5 System Simulation Parameters

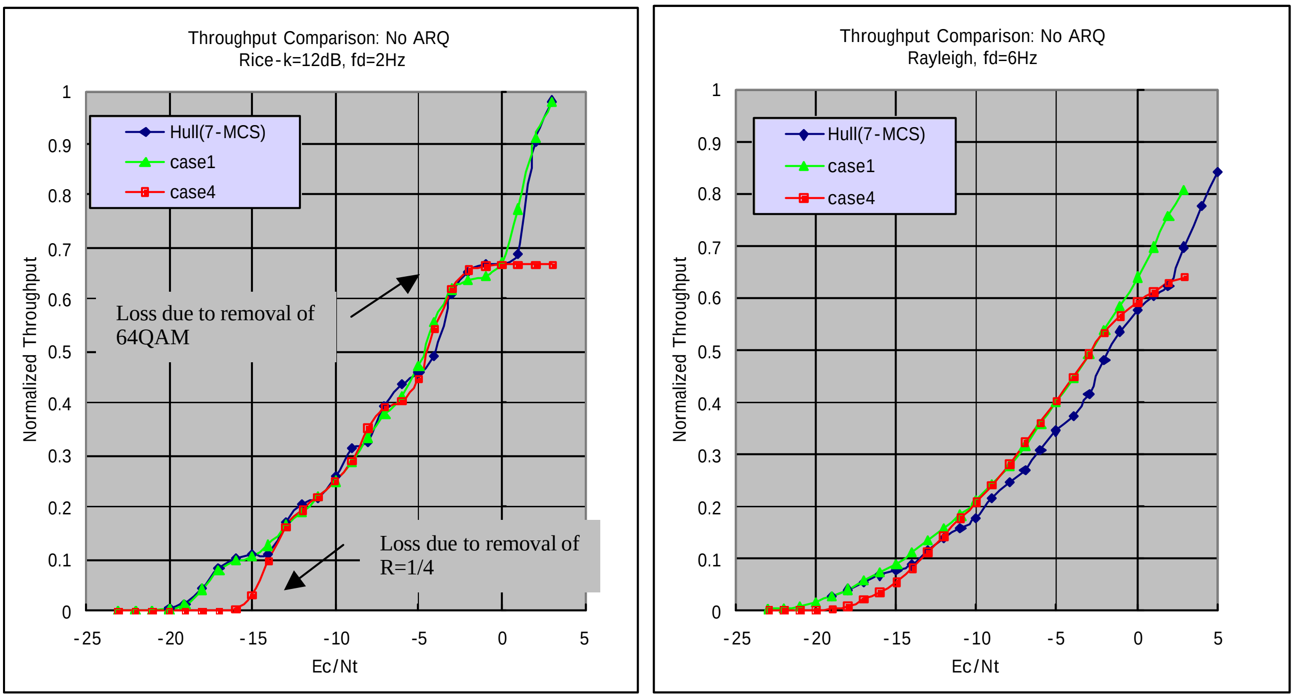
BTS Parameter	Cell	19 Hexagonal cell. 3-sector per cell.
	Cell Step Size	2800m
	Carrier Frequency	2.0GHz
	TX antenna diversity	None
	BS antenna pattern	As in [3]
	BS antenna gain	14dBi
	Max. BS TX Power	44dBm (25W)
	CPICH Ec/Ior	-10dB
	DSCH_Ec/Ior	-14dB per code
	DSCH code resource	20
	Packet Scheduling	Round Robin with highest priority on retransmission
Channel Parameter	Propagation Model	1-path. Average Ec/Nt is assumed to stay constant within a packet frame.
	Flat fading model	Jakes
	Shadowing Model	Stdv=8dB, cell correlation=0.5, sector correlation=1.0
UE parameter	Rx antenna gain	0dBi
	Rx antenna diversity	None
	Receiver NF	8dB
	SIR Estimation	Ideal
	ARQ	E-DSCH: Type III (chase combine)
	Active Set Selection	Ideal Based on Average Ec/Nt
	STTD	Ideal Based on Frame Ec/Nt

Table 6 Modified Mobility Distribution

Speed (kph)	0	1	3	8	10	15	20	30	40	50	60	70	80	90	100
Percentage	14	37	19	0	0	0	0	30	0	0	0	0	0	0	0

Annex C: Detailed Simulation Results

C-1. Link Level Throughput Comparison (No ARQ)


Throughput Comparison: No ARQ
Rice-k=12dB, fd=2Hz

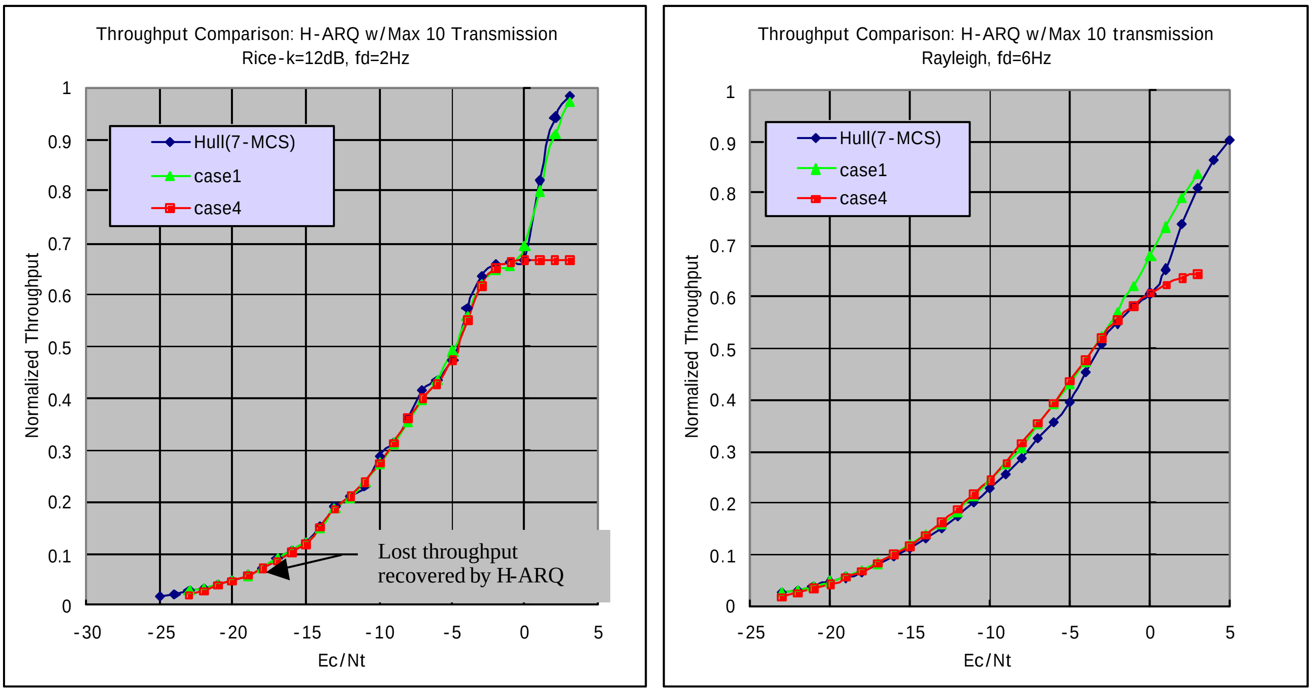
Loss due to removal of 64QAM

Loss due to removal of R=1/4

Throughput Comparison: No ARQ
Rayleigh, fd=6Hz

Fig. 1 Link Level Throughput analysis (No ARQ)

C-2. Link Level Throughput Comparison (Type-III ARQ: Max Transmission=10)

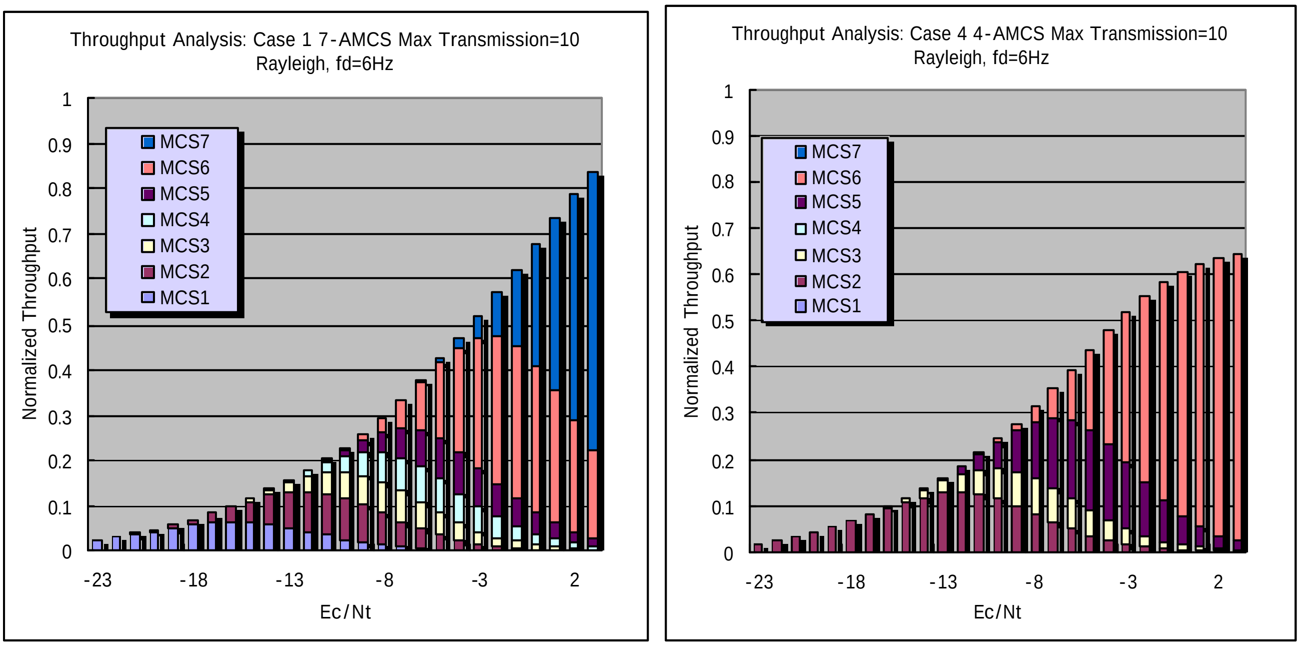

Throughput Comparison: H-ARQ w/Max 10 Transmission
Rice-k=12dB, fd=2Hz

Lost throughput recovered by H-ARQ

Throughput Comparison: H-ARQ w/Max 10 transmission
Rayleigh, fd=6Hz

Fig. 2 Link Level Throughput analysis (H-ARQ Type III)

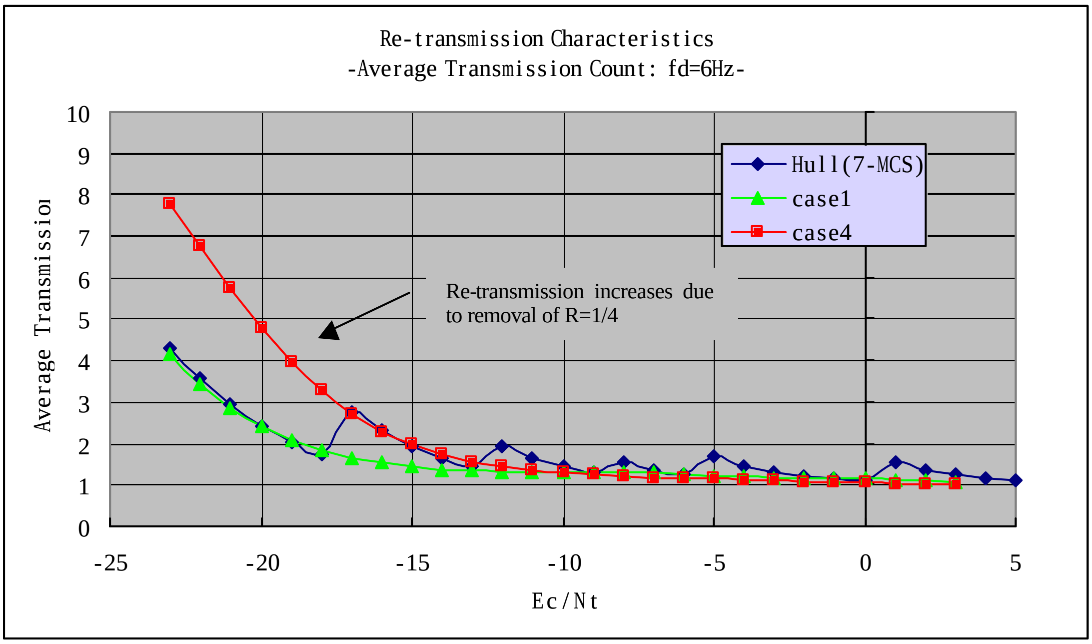
C-3. Throughput Contribution of each AMCS:


Throughput Analysis: Case 1 7-AMCS Max Transmission=10
Rayleigh, fd=6Hz

Throughput Analysis: Case 4 4-AMCS Max Transmission=10
Rayleigh, fd=6Hz

Fig. 3 Throughput Contribution of each AMCS mode (Rayleigh, fd=6Hz)

C-4. Average Retransmission Comparison


Re-transmission Characteristics
-Average Transmission Count: fd=6Hz-

Re-transmission increases due to removal of R=1/4

Fig. 4 Delay Characteristics (Rayleigh, fd=6Hz)

C-5. Ec/Nt distribution within service area

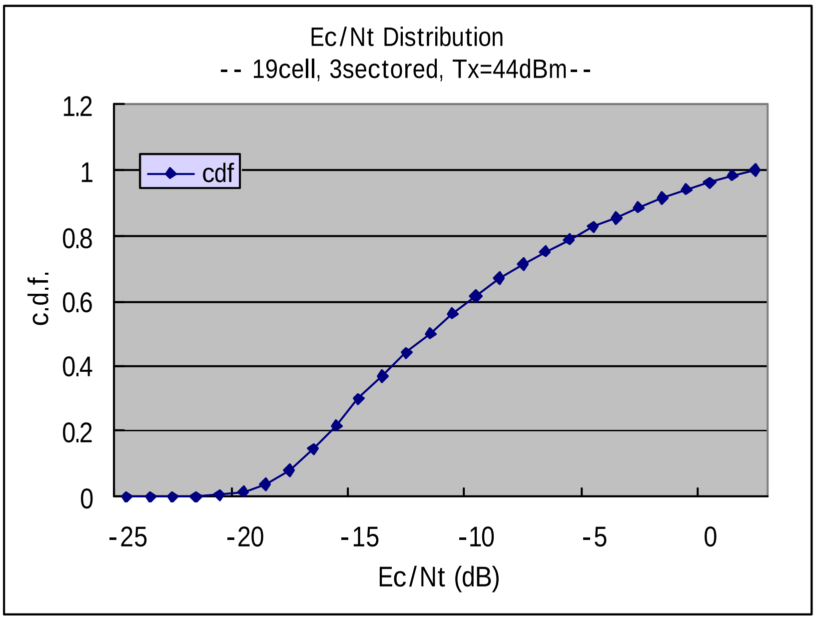


Fig. 5 Ec/Nt Distribution within a Service Area