TSG-RAN Working Group 1 meeting #20 TSGR1#20(01)-0471
May 21 – 25, Busan, Korea

Agenda item : AH24: HSDPA

Source: Texas Instruments

Title: Alternative to 8 PSK modulation/coding scheme for HSDPA.

Document for: Discussion and Approval

1. Simulations

The current HSDPA proposal includes the following modulation and coding rates [1]:

Table 1: The modulation and coding schemes (MCS) and the bandwidth efficiency of each mode in the current HSDPA proposal are shown.

Modulation	Coding rate	bps/Hz	Info. Rate (Mbps) for 20 codes, spreading factor = 32
QPSK	1/4	0.5	1.2
QPSK	1/2	1	2.4
QPSK	3/4	1.5	3.6
16-QAM	1/2	2	4.8
8-PSK	3/4	2.25	5.4
16-QAM	3/4	3	7.2
64-QAM	3/4	4.5	10.8

The bandwidth efficiency of 8 PSK, rate ¾ is 2.25 bps/Hz. We note that the same bandwidth efficiency can be achieved by 16 QAM, rate 9/16 code. Similarly, the bandwidth efficiency of 16 QAM rate 5/8 is 2.5 bits/s/Hz. In this submission we compare the performance of 8PSK, rate ¾, 16 QAM rate 9/16 and 16 QAM rate 5/8. Table 2 below summarizes the simulation parameters.

Table 2. Simulation parameters

Carrier frequency	2 GHz
Chip rate	3.84 Mcps
Spreading factor	32
Number of multi-codes	20
Frame length	3.33 ms (5-TS)
CPICH power	10 % total
E_c / I_{or}	80 %
Channel coding / decoding	8 PSK, rate ¾, 16 QAM rate 9/16, 16 QAM rate 5/8 Max-Log-Map decoding (8 iterations)
Channel model	AWGN
Channel estimation	Perfect Channel Estimation (PCE)

Figures 1, 2 below show the performance comparison of 8 PSK, rate ¾, 16 QAM rate 9/16 and 16 QAM rate 5/8. The puncturing pattern for rate 9/16 is given below. The first row is the systematic bit, the second row is the first parity bit and the third row is the second parity bit output from the first component convolutional encoder for the Turbo code. The fourth row is the interleaved systematic bit, the fifth row is the first parity bit and the sixth row is the second parity bit output from the second component convolutional encoder for the Turbo code.

$$P = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

The puncturing pattern for rate 5/8 is given below:

$$Q = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

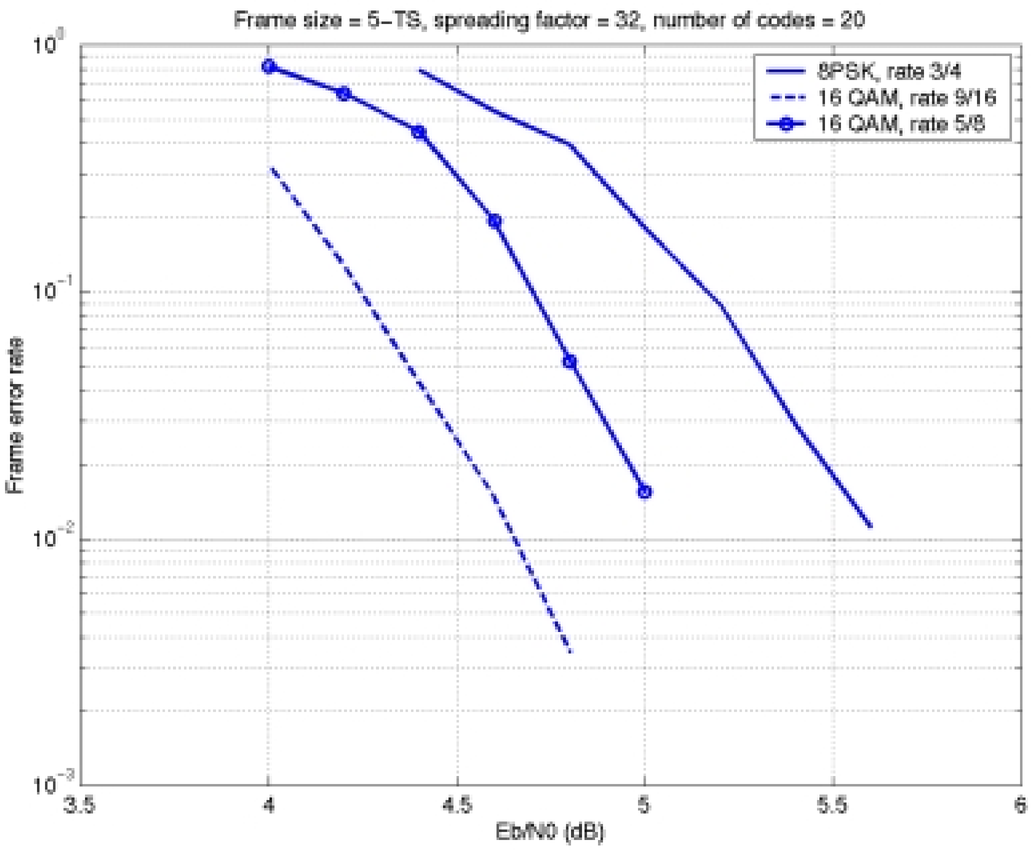

Figure 1: Performance comparison of 8 PSK, rate ¾, 16 QAM rate 9/16 and 16 QAM rate 5/8 is shown.

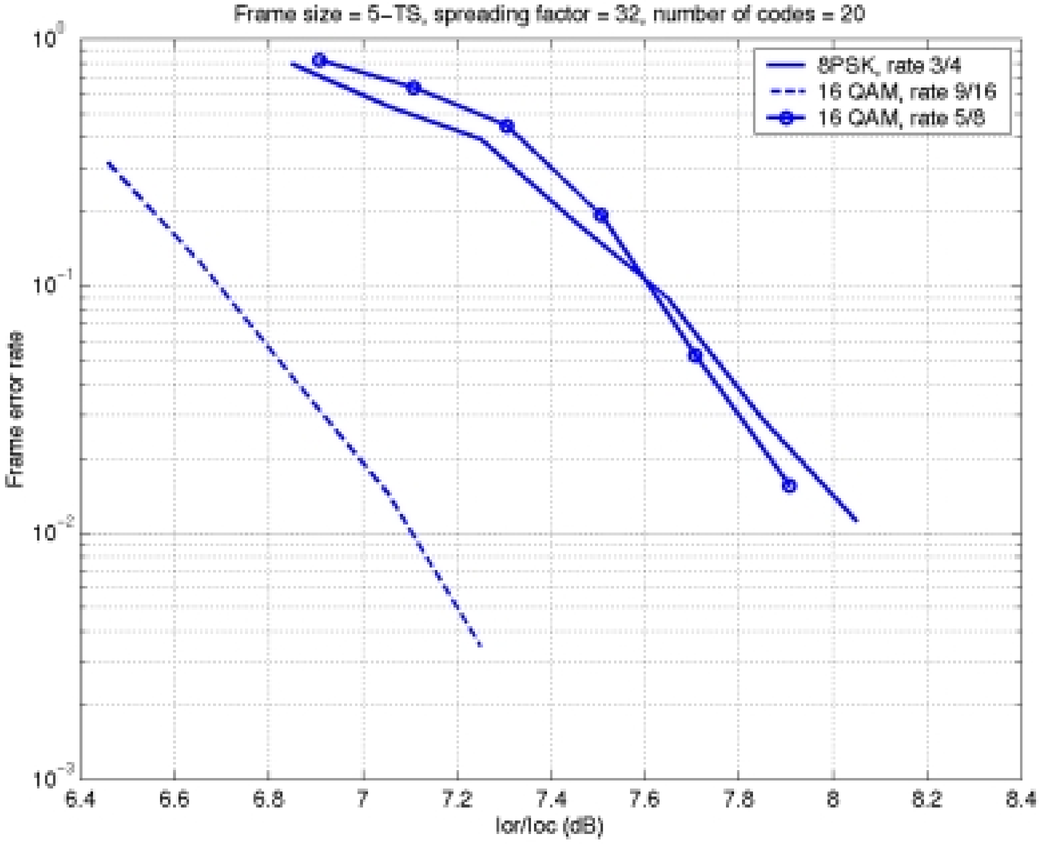

Figure 2: Performance comparison of 8 PSK, rate ¾, 16 QAM rate 9/16 and 16 QAM rate 5/8 is shown.

2. Proposal for MCS for HSDPA

From figures 1, 2 we can draw the following conclusions:

- For the same bandwidth efficiency, 16 QAM rate 9/16 has approximately 0.9 dB better performance compared to 8 PSK, rate ¾. Hence, the 8 PSK, rate ¾ mode of HSDPA can be replaced by 16 QAM, rate 9/16 for the same bandwidth efficiency with a better performance.
- The required Eb/N0 for 16 QAM, rate 5/8 is lower than 8 PSK, rate ¾ while achieving a better bandwidth efficiency of 2.5 bps/Hz.

From table 1 we can see that the bandwidth efficiency of 16 QAM, rate ½ quite close to 8 PSK, rate ¾. Hence, instead of employing 16 QAM, rate 9/16 we propose to employ 16 QAM, rate 5/8 to achieve a better spread of spectral efficiency.

Hence we propose to replace the 8-PSK, rate 3/4 by 16-QAM rate 5/8 coding.

The new proposed modulation and coding schemes (MCS) for HSDPA can be summarized as follows:

Table 3: The proposed MCS and the bandwidth efficiency of each mode is shown.

Modulation	Coding rate	bps/Hz	Info. Rate (Mbps) for 20 codes, spreading factor = 32
QPSK	1/4	0.5	1.2
QPSK	1/2	1	2.4
QPSK	3/4	1.5	3.6
16-QAM	1/2	2	4.8
16-QAM	***5/8***	***2.5***	***6.0***
16-QAM	3/4	3	7.2
64-QAM	3/4	4.5	10.8

References

[1] 3Gpp Technical Specification for Physical Layer Aspects of UTRA High Speed Downlink Packet Access, 3G TR 25.848 V0.6.0.