TSG-RAN Working Group1 meeting#14

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Agenda Item: HSDPA

Source: Motorola

TITLE:

Link Evaluation Methods for High Speed Downlink Packet Access (HSDPA)

DATE:

July 3rd, 2000

SOURCE:

Motorola

ABSTRACT:

This document provides background information regarding the link evaluation of proposals for systems to provide high-speed packet downlink packet access for 3GPP.

1 Introduction

1.1 Study Objective and Scope

The objective of this document is to propose a set of definitions, assumptions, and a general framework for performing link simulations for High Speed Downlink Packet Access (HSDPA).

1.2 Simulation Description Overview

A symbol level downlink simulator may be used to simulate the performance of higher order modulation schemes, Space-Time Transmit Diversity (STTD) and Hybrid ARQ. The general forward link simulation model is shown in Figure 1. The terminology used throughout the document is as follows: I_{or} is the total transmitted power density by a BTS, $\hat{I}_{or}$ is the post-channel transmitted power density, $I_{oc} + N_o$ is the other cell interference plus noise power density and I_o is the total received power density at the MS antenna. Note, that the ratio $\hat{I}_{or} / (I_{oc} + N_o)$ is fixed in this simulation model. Since the base station has a fixed amount of power (set by the BTS power amplifier size), it is the average transmitted (often called allocated) power by the BTS to the MS that determines the user capacity of the forward link. This fraction of allocated power is called average traffic channel E_c/I_{or} and is inversely proportional to the forward link capacity.

The M-ary QAM demodulator generates soft decisions as inputs to the Turbo decoder. As a baseline method, the soft inputs to the decoder may be generated by an approximation to the log-likelihood ratio function. First define,

$$\Lambda^{(i)}(z) = K_f \left[\underset{j \in S_i}{Min}\{d_j^2\} - \underset{j \in \overline{S_j}}{Min}\{d_j^2\} \right], \; i = 0,1,2,\cdots,\log_2 M - 1 \qquad (1)$$

where M is the modulation alphabet size, i.e. 8, 16, 32 or 64 and

$$z = A_d A_p a \; \hat{a} \; e^{-j(q+\hat{q})} x + n, \qquad (2)$$

x is the transmitted QAM symbol, A_d is the traffic channel gain, A_p is the pilot channel gain, $a \; e^{jq}$ is the complex fading channel gain, and $A_p \hat{a} \; e^{j\hat{q}}$ is the fading channel estimate obtained from the pilot channel,

$$S_i = \{\forall j : i^{th} \text{ component of } y_j \text{ is "0"}\}, \qquad (3)$$

$$\overline{S_i} = \{\forall j : i^{th} \text{ component of } y_j \text{ is "1"}\} \qquad (4)$$

and K_f is a scale factor proportional to the received signal-to-noise ratio. The parameter d_j is the Euclidean distance of the received symbol z from the points on the QAM constellation in S or its complement. The Pilot/Data gain is assumed known at the receiver. In this case the distance metric is computed as follows

$$d_j^2 = \left| A_p z - Q_j b g^2 \right|^2 \quad Q_j \in S_i \ \textbf{or} \ \bar{S}_i \tag{5}$$

where $b = A_d$ and $g = A_p \hat{a}$ is an estimate formed from the pilot channel after processing through the channel estimation filter.

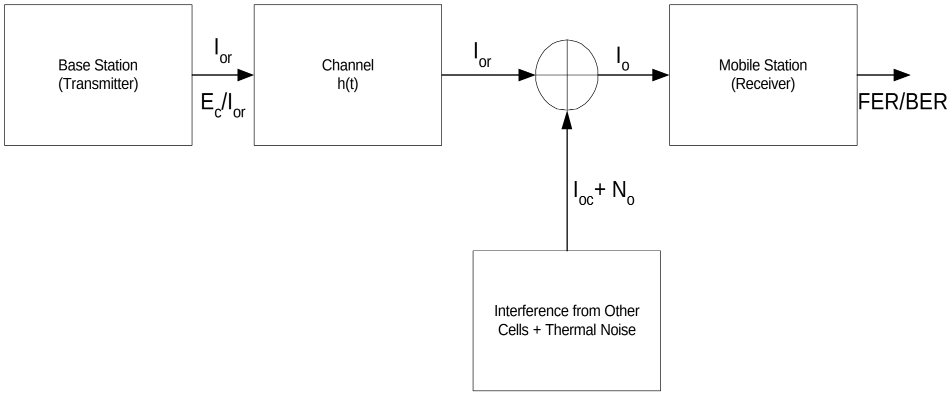

Figure 1. Simulation Block Diagram.

2 Standard Constellations for M-ary Modulation

In case of 8-PSK modulation, every three binary symbols from the channel interleaver output shall be mapped to a 8-PSK modulation symbol according to Figure 2.

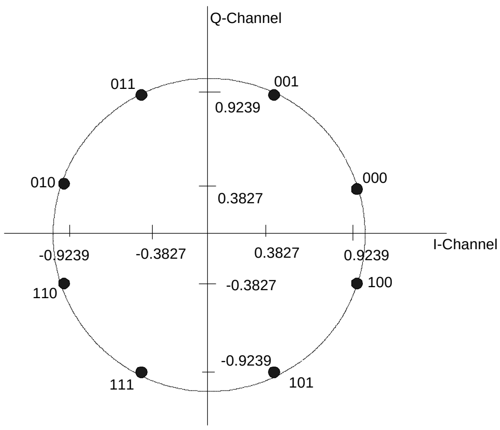

Figure 2. Signal Constellation for 8-PSK Modulation.

In case of 16-QAM modulation, every four binary symbols of the block interleaver output shall be mapped to a 16-QAM modulation symbol according to Figure 3.

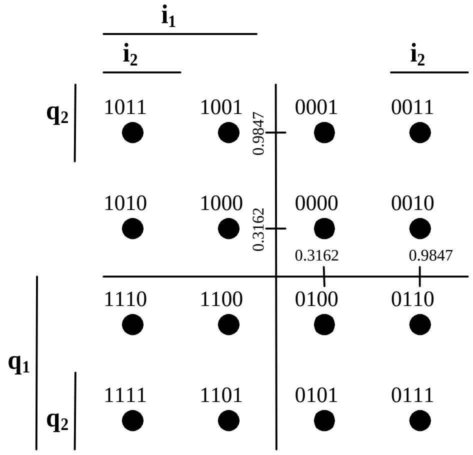

Figure 3. Signal Constellation for 16-QAM Modulation.

In case of 64-QAM modulation, every six binary symbols of the block interleaver output shall be mapped to a 64-QAM modulation symbol according to Figure 4.

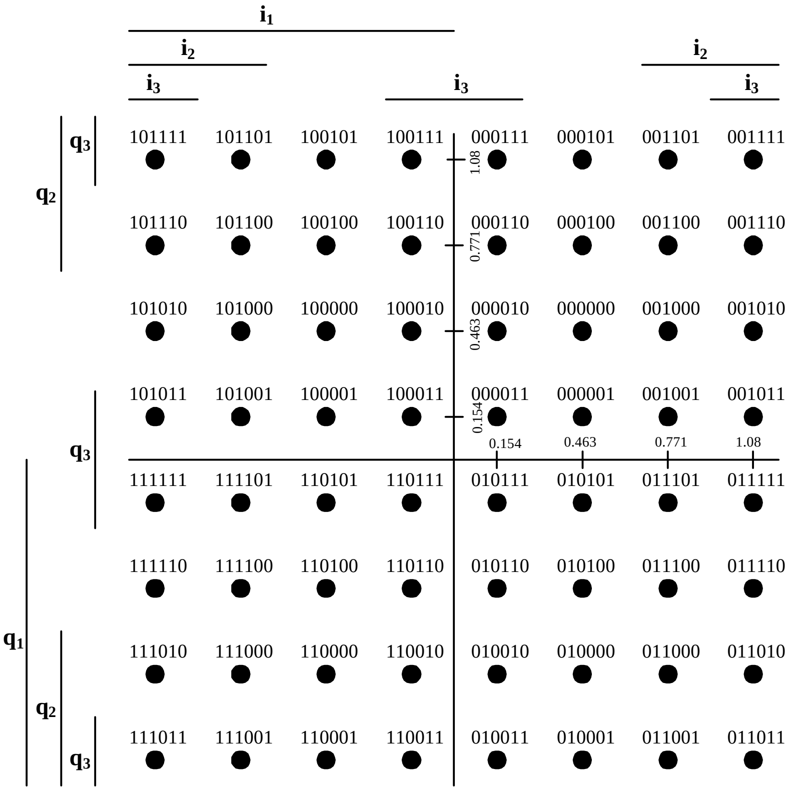

Figure 4. Signal Constellation for 64-QAM Modulation.

3 Performance Metrics and Simulation Parameters:

The following link performance criteria are used:

1. FER vs. E_b/N_t
2. FER vs. E_c/I_{or}

3. FER vs. I_{or}/I_{oc} (for a fixed E_c/I_{or})
4. Throughput vs. E_c/I_{oc}

where throughput measured in term of bits per second : $T = R\left(\frac{1-FER_r}{\overline{N}}\right)$ in bits per second

where T is the throughput, R is the transmitted information bit rate and FER_r is the residual Frame Error Rate beyond the maximum number of transmissions and $\overline{N}$ is the average number of transmission attempts.

4 Simulation Parameters:

Table 1 shows an example of the data rates to be simulated for a frame duration of 3.33 msec. Table 2 provides a list of rest of link simulation parameters.

Table 1. Information bit rate for frame duration of 3.33 msec

Chip Rate = 3.84 Mcps				SF = 32			Frame Size = 3.33 ms	
	20 codes			1 code				
MCS	Info Rate (Mbps)	Packet Size (bits)	Packet Size (octets)	Info Rate (Mbps)	Packet Size (bits)	Packet Size (octets)	Code rate	Modulation
8	10.8000	36000	***4500***	0.54	1800	***225***	**3/4**	64
7	7.2000	24000	3000	0.36	1200	150	1/2	64
6	7.2000	24000	***3000***	0.36	1200	***150***	**3/4**	16
5	4.8000	16000	2000	0.24	800	100	1/2	16
2	3.6000	12000	***1500***	0.18	600	***75***	**3/4**	4
1	2.4000	8000	1000	0.12	400	50	1/2	4

Table 2. Simulation Parameters

Parameter	Value
Carrier Frequency	2GHz
Vehicle Speed	AWGN/3 kmph/30 kmph/120 kmph
Overhead Power Allocation (CPICH+P-CCPCH+S-CCPCH+SCH+PICH..)	20% (-7dB)
Max Traffic Channel Power Allocation	-1dB
Ior/Ioc	Variable
Channel Estimation	Ideal/Non-Ideal
Fader	Jakes

No of iterations for Turbo Codes	8
Metric for Turbo Code	Max[1]
Turbo Code Rates	¼, ½, 1/3, ¾ etc.
Input to Turbo Decoder	Soft
Turbo/Channel Interleaver	As per 3GPP (modified to handle higher data rates)
Hybrid ARQ	Chase Combining/Other Schemes
ACK Feedback Error	0 and 1%
Max number of frame transmissions for H-ARQ	10
Multipath	Up to 3 paths
Information Bit Rates Simulated (Kbps)	As defined
Number of Multicodes Simulated	As defined
STTD	On/Off

[1] Optimum performance can be achieved with max* metric. However, this metric is sensitive to SNR scaling.