

# 256 FFT OFDM/OFDMA PHY Performance

## IEEE 802.16 Presentation Submission Template (Rev. 8.3)

Document Number:

C802.16e-03/35

Date Submitted:

2003-07-18

Source:

Tal Kaitz

Naftali Chayat

Ran Yaniv

Alvarion

21a Habarzel St

Tel Aviv Israel

Voice:

+972-3-6456273

Fax:

+972-3-6456222

E- mail:

talkaitz@alvarion.com

Venue:

IEEE 802.16 #26 SFO

Base Document:

Purpose:

Support the proposed PHY for 802.16e OFDM mode.

Notice:

This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.

Release:

The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.

IEEE 802.16 Patent Policy:

The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <<http://ieee802.org/16/ipr/patents/policy.html>>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <<mailto:chair@wirelessman.org>> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <<http://ieee802.org/16/ipr/patents/notices>>.

# 256 FFT OFDM/OFDMA PHY Performance

Nafatli Chayat, Tal Kaitz, Ran Yaniv  
Alvarion

# Introduction

- To support mobility operation the 256 OFDM PHY layer was enhanced.
- Most notable improvements:
  - Introduction of 16 subchannels OFDMA in the UL, to allow SS with low transmit power.
  - Introduction of periodic midambles for support of time varying channels.
- In this contribution highlights some of the PHY layer performance aspects.

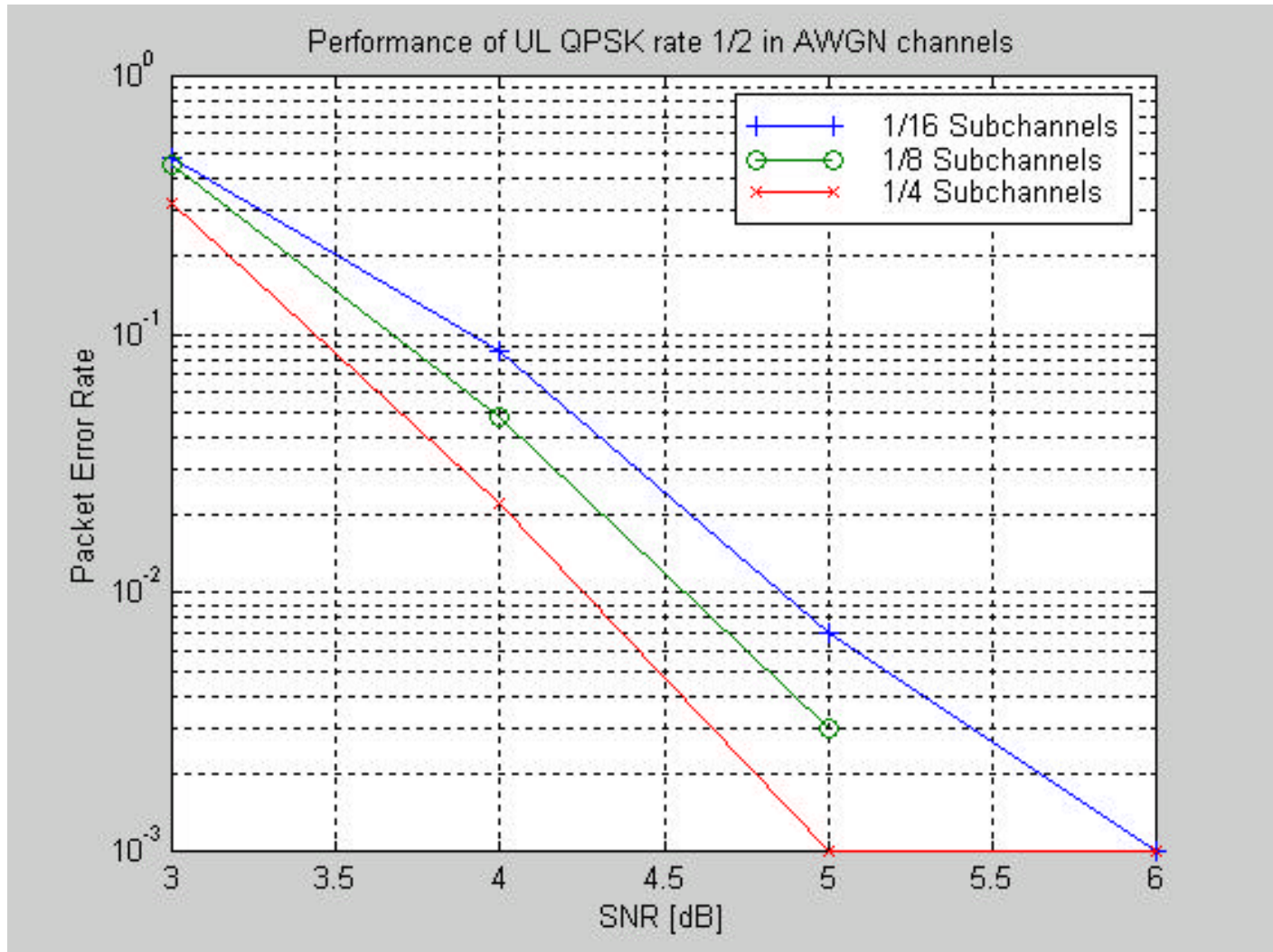
# Overview

- Static channels
  - Performance in SUI channels
  - Link budget gain with subchannelization
- Mobile channels
  - Effect of channel estimation techniques
  - Performance in mobile channels.

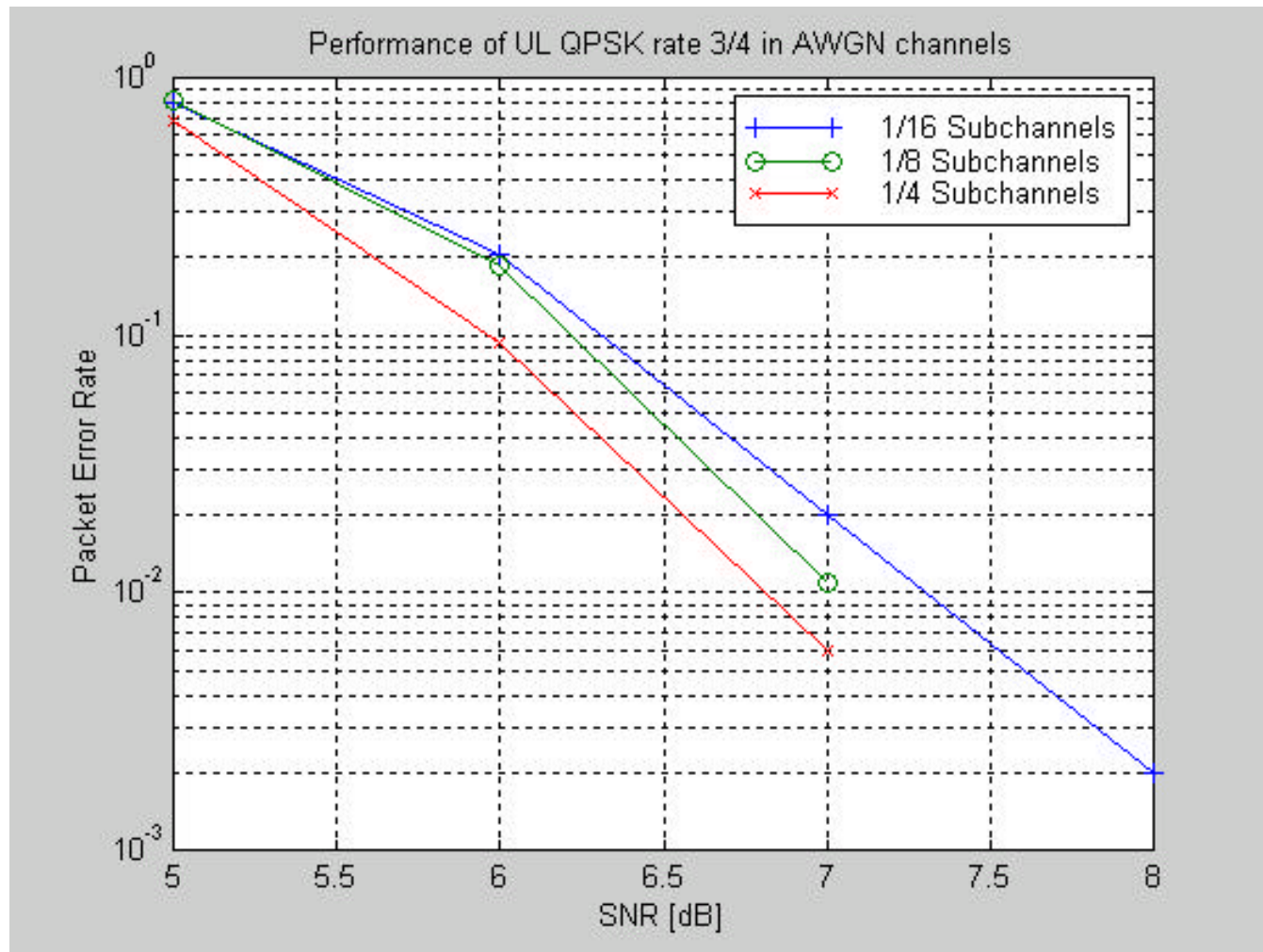
# Static channels

- Conditions
  - AWGN and SUI-1,2,3,4 (omni antenna) static channels
  - QPSK, QAM16 and QAM64. Convolutional code only.
- Comparison between
  - 1, 2 or 4 out of 16 subchannels.
    - Equivalent to one out of total of 16, 8 or 4 subchannels
- SNR – Ratio of received power *density* to noise *density*
  - Equivalently, SNR in active subcarriers.
  - Does not include subchannelization gain
  - For *total* power add  $10\log_{10}(\text{\#subchannels})$

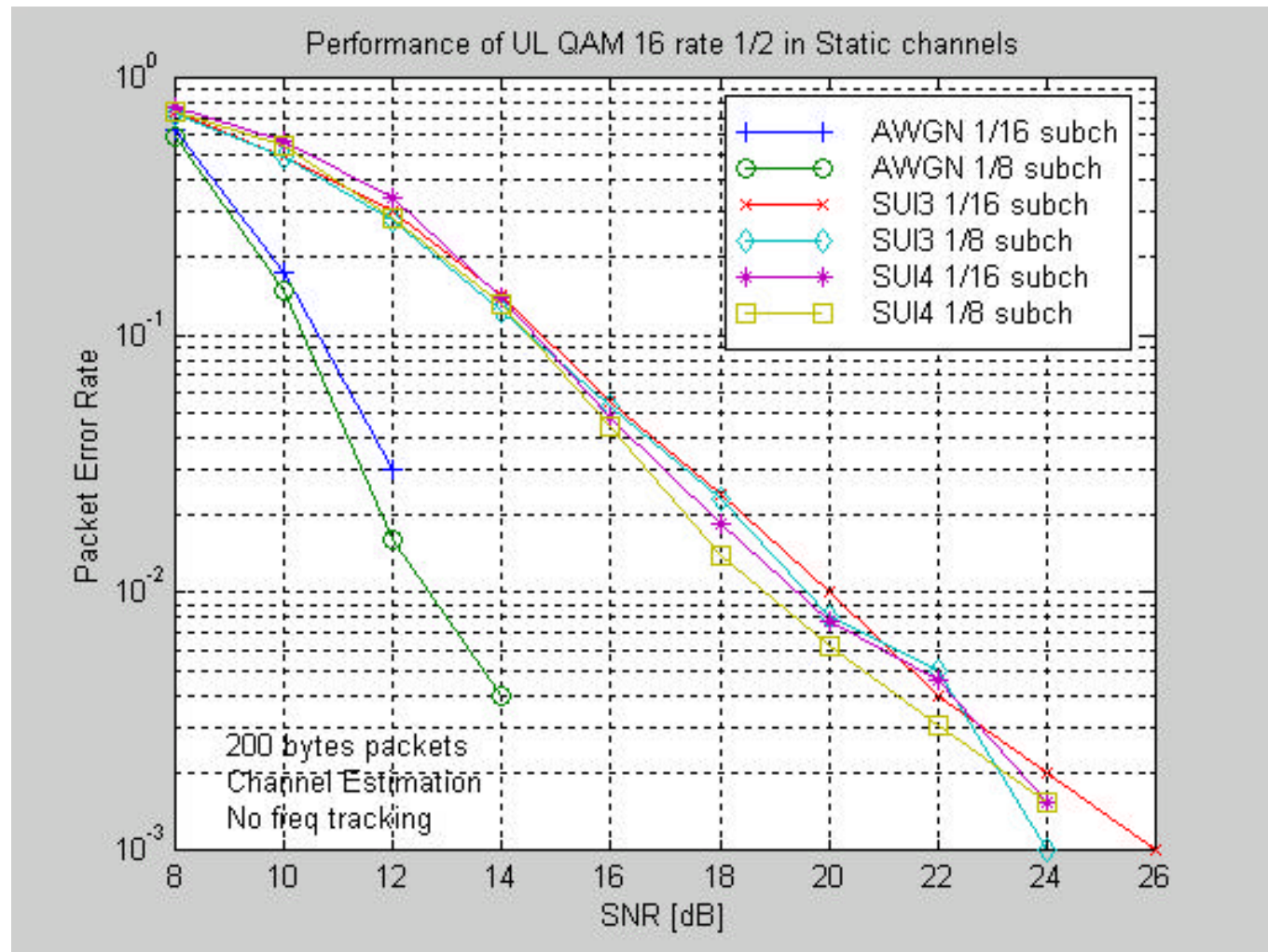
# QPSK $R=1/2$ , AWGN



# QPSK $R=3/4$ , AWGN

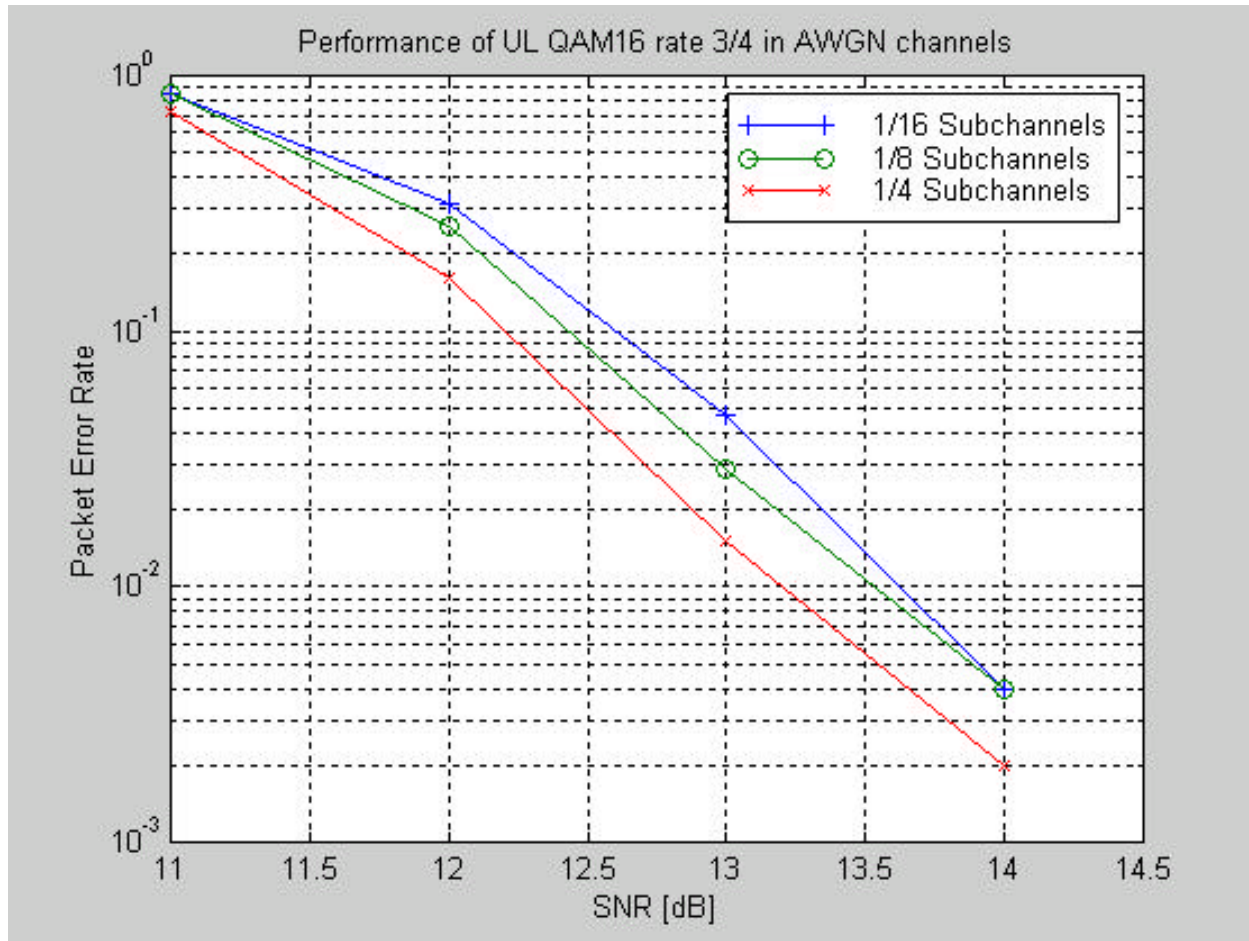


# QAM16, $R=1/2$ , AWGN and SUI

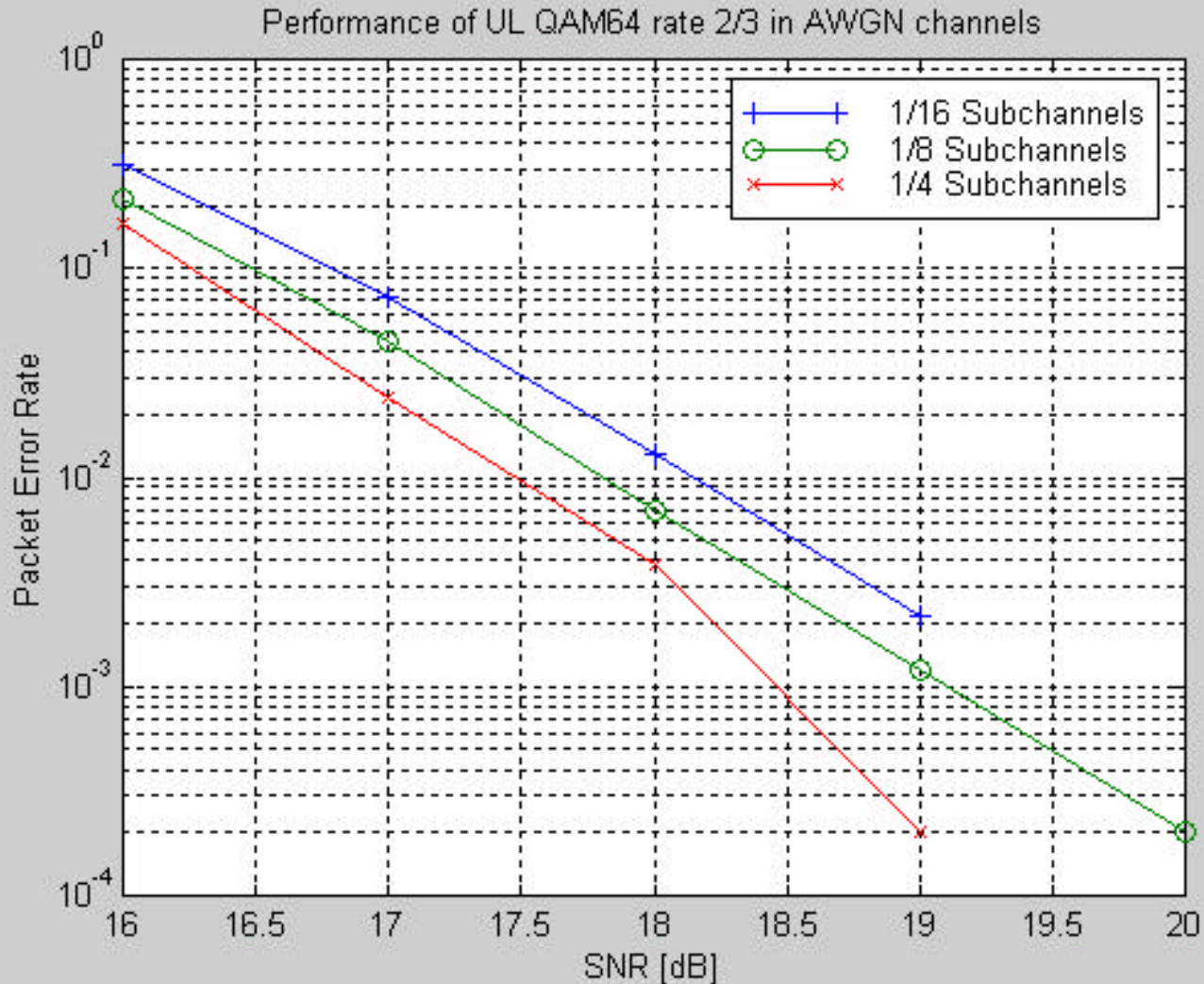




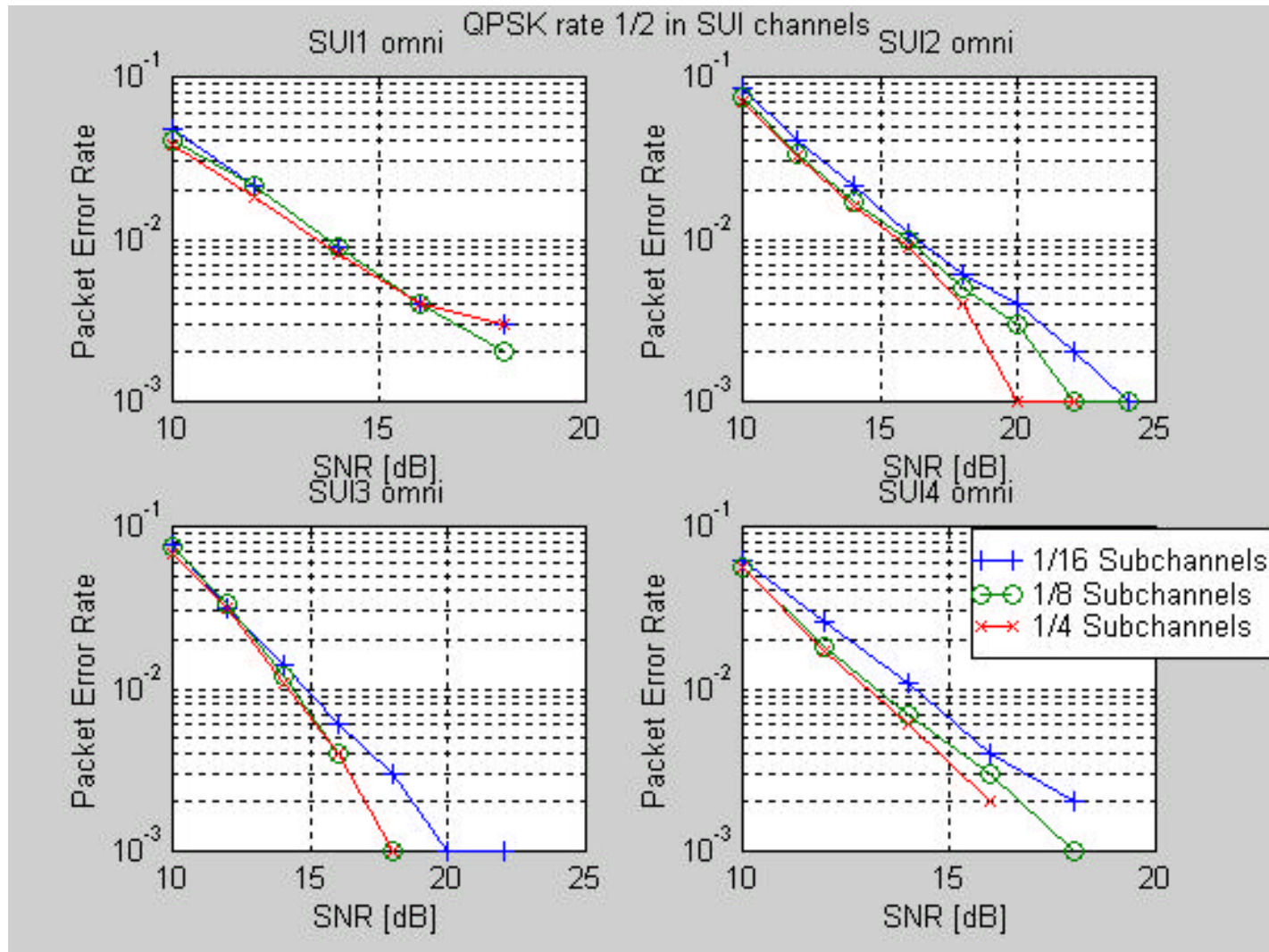
# QAM16 R=3/4 ,AWGN



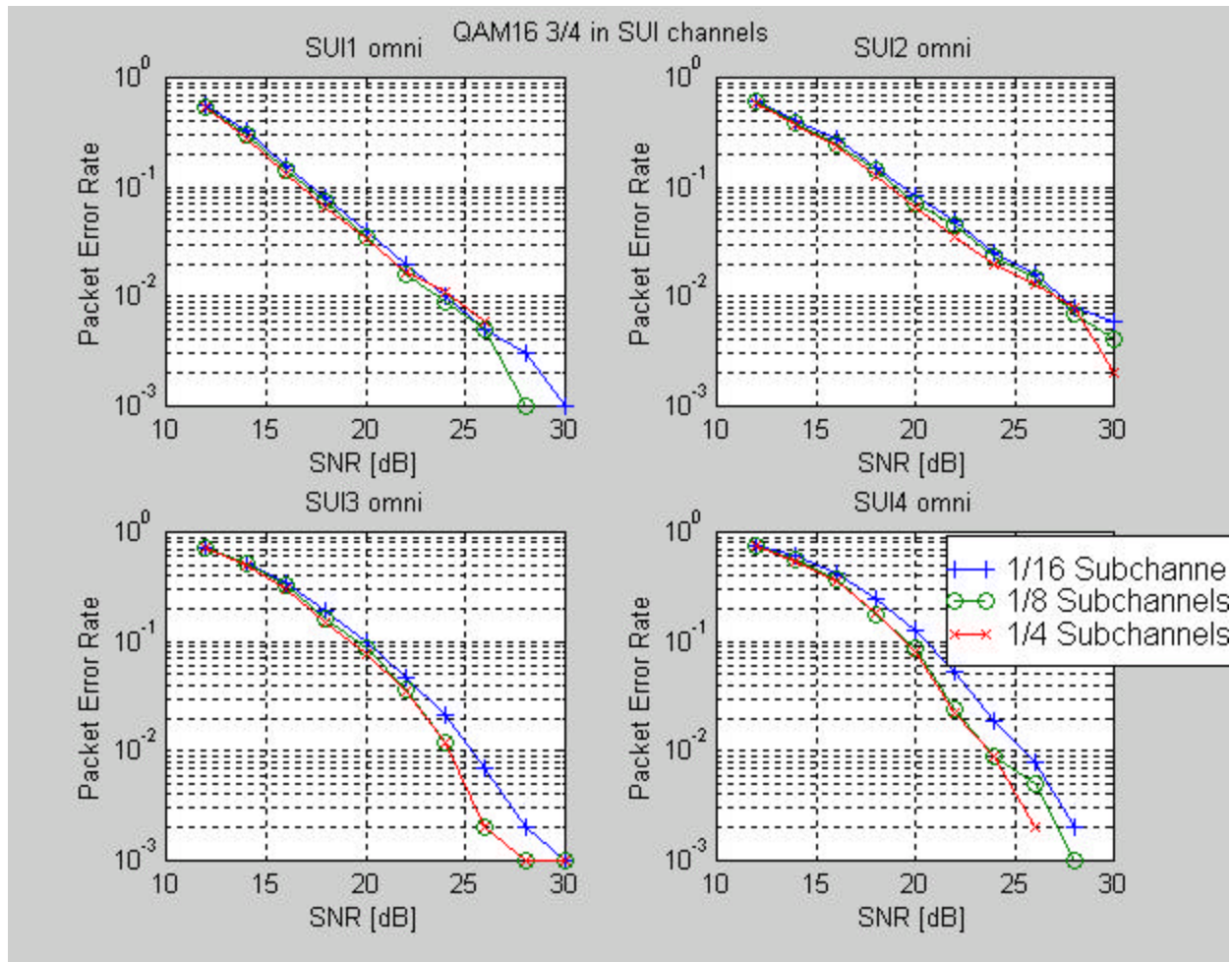
# QAM 64, $R=2/3$ , AWGN



# QPSK, $R=1/2$ , SUI channels

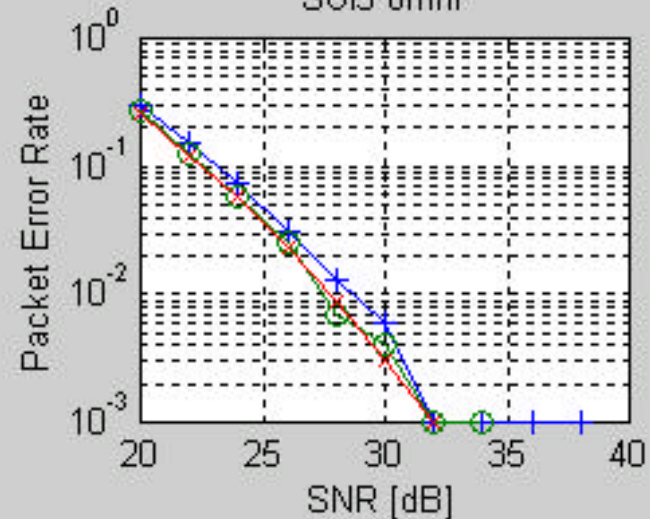
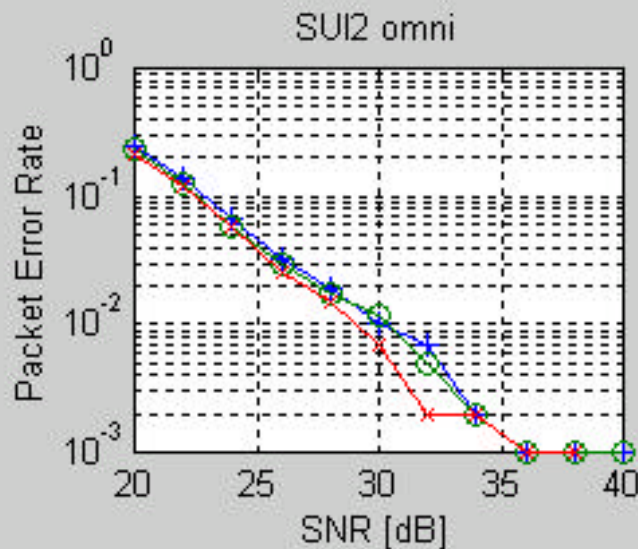
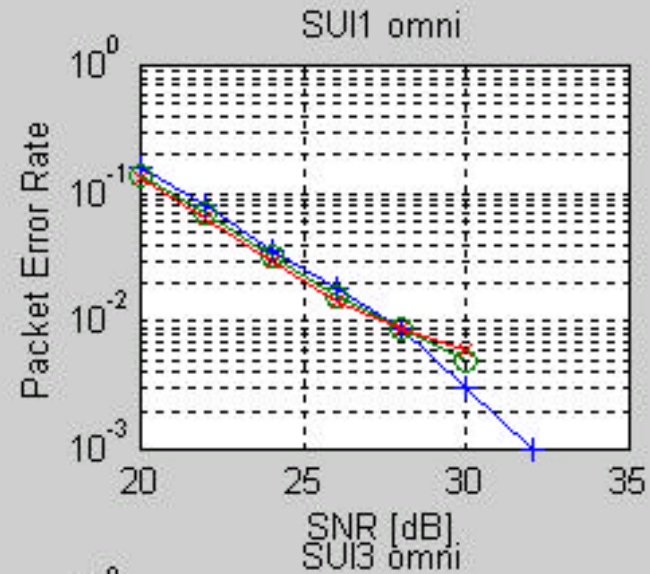
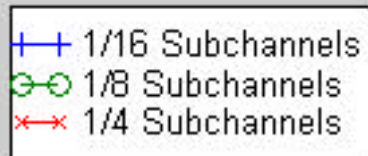


# QAM16 R=3/4, SUI channels



# QAM64, $R=2/3$ , SUI channels

QAM64 rate 2/3 in SUI channels





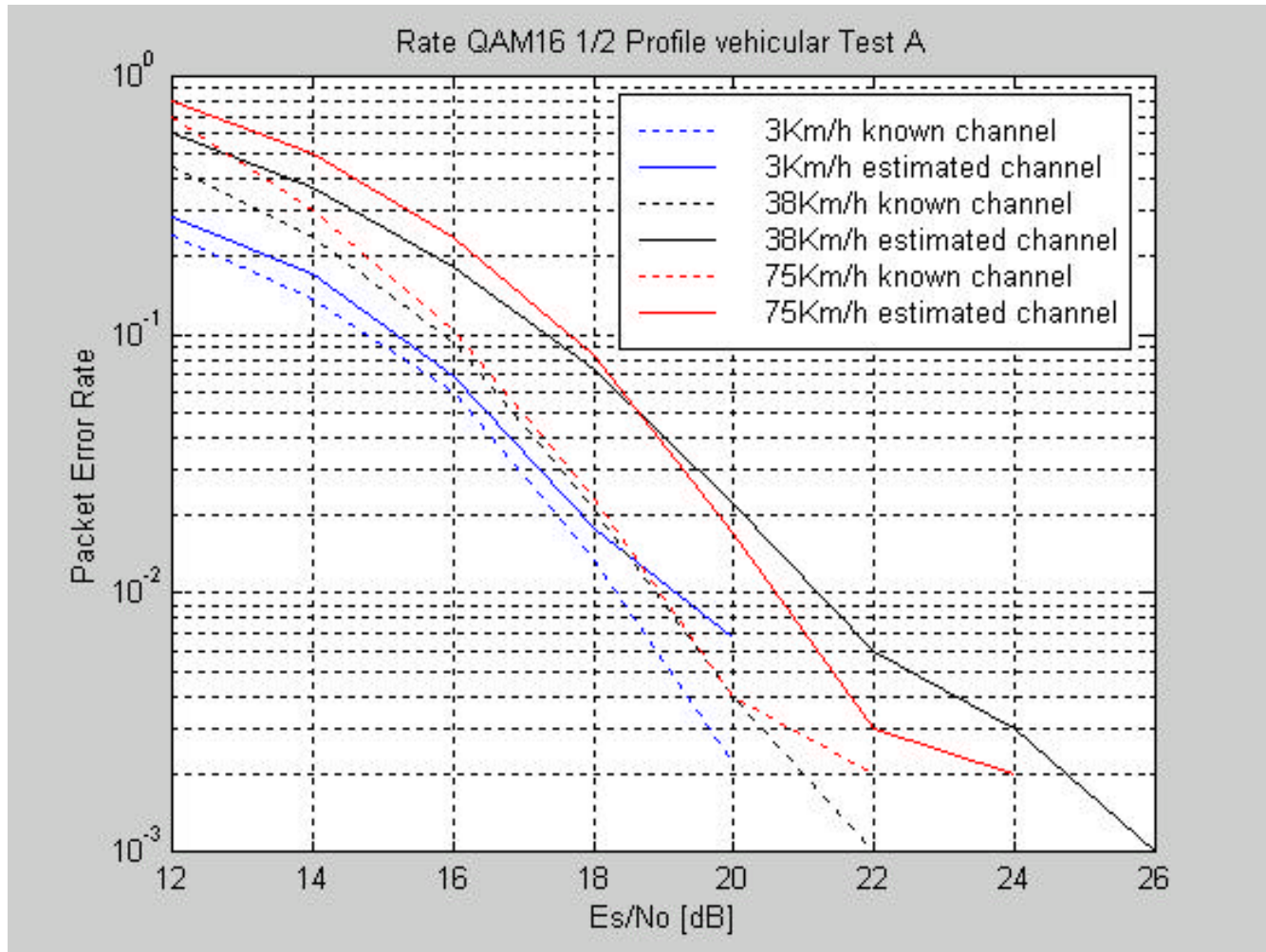
# Static channels- conclusions

- SNR degradation of 0.5dB for AWGN, 1 dB for severe channels when going from 8 subchannels to 16 subchannels
- Means that out of the theoretic 3 dB additional gain, 2-2.5 dB are realized.
- Most of the degradation comes from channel estimation and not from the ECC

# Dynamic Channels

- Midamble based tracking.
  - The results are based on IEEE802.16e-03/18 which is indicative of 16-subchannel performance in the sense that the training is spaced some 7 symbols apart
- Channels:
  - ITU-R Vehicular test A
  - 6 taps up to 2.5uS.
- Ref parameters: 3.5GHz, 3.5MHz
- Velocities 3-75Km/H

# Dynamic channels-results

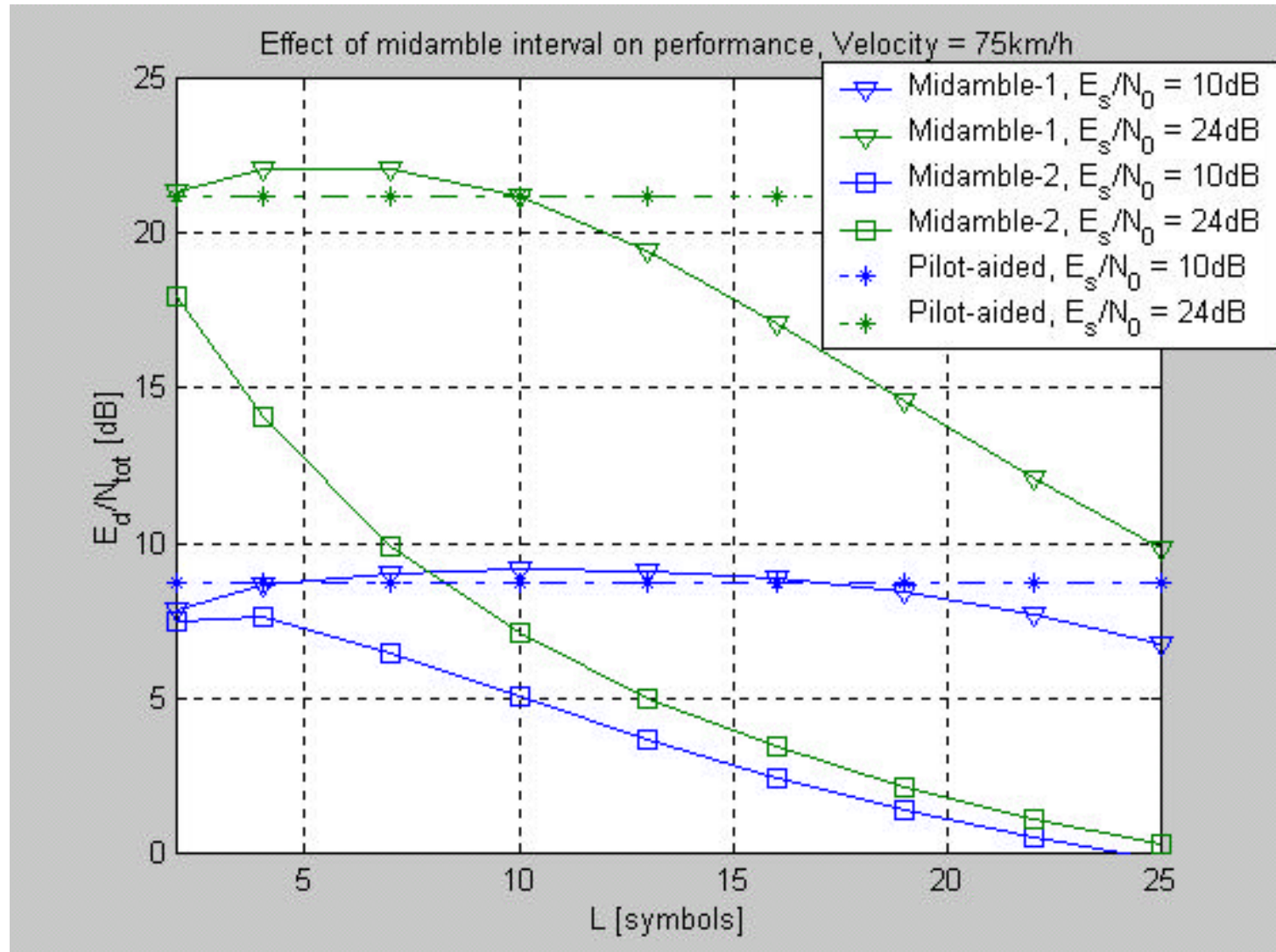




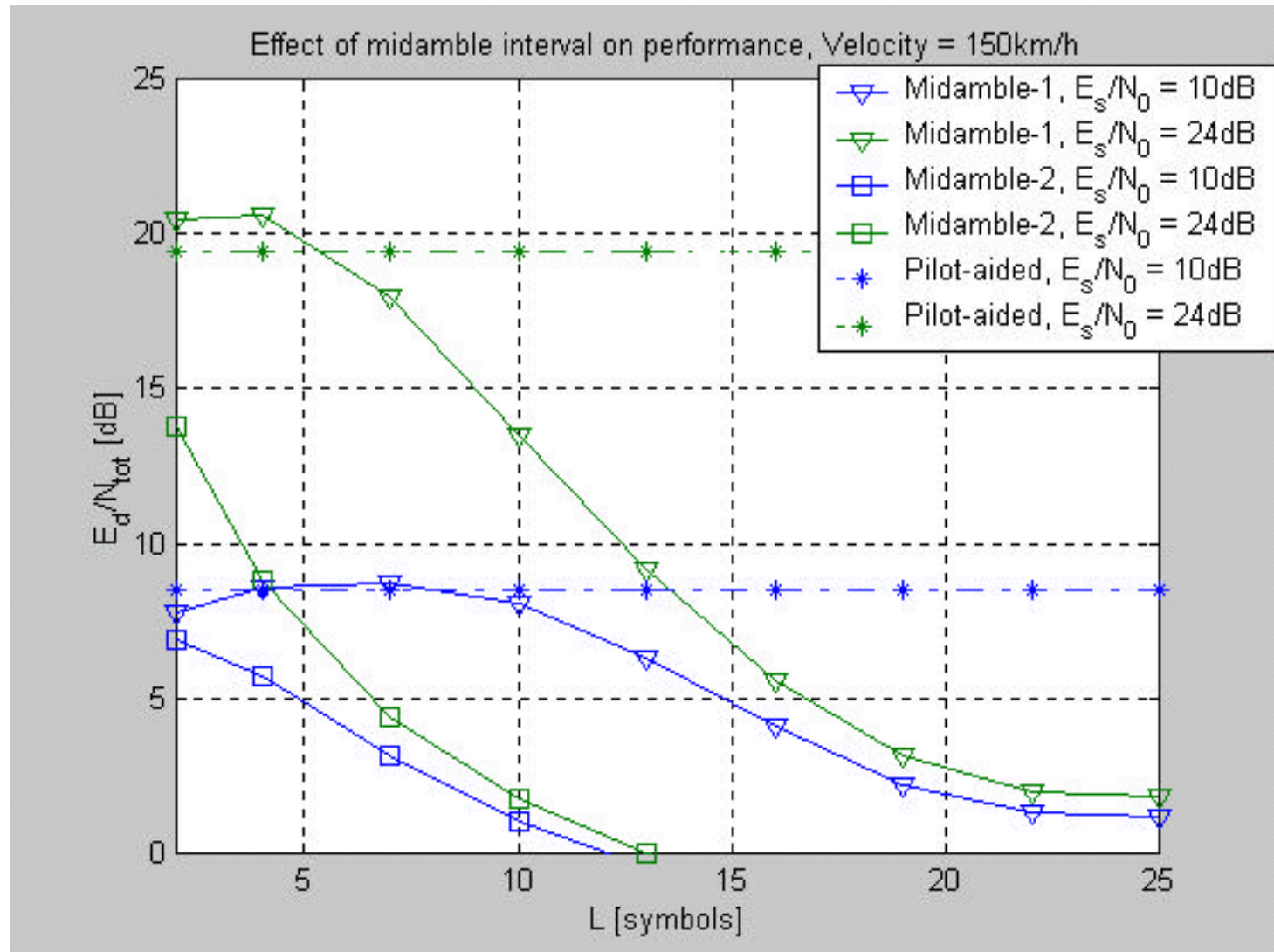
# Effects of Midamble spacing

- Based on results from (from IEEE802.16e-03/18), which considered downlink but are applicable to UL as well
  - Disregard the “pilot-aided” curves
- Considers effects of two estimation schemes
  - Complex “1”: interpolate between two midambles
  - Simple “2”: estimate and hold until new midamble
- Target SNR 10dB (QAM16) and 24dB (QAM64).
- Estimation distortion  $E_d/N_{\text{tot}}$  vs. midamble spacing,  $L$ .

# Performance vs. Midamble Spacing (1)



# Performance vs. Midamble Spacing (2)



# Midamble spacing- conclusions

- For complex interpolation scheme
  - 75Km/H :  $L < 20$  symbols – huge buffering
  - 150Km/H:  $L < 10$  symbols
- For simple ‘estimate and hold’ scheme:
  - 75Km/H :  $L < 8$  symbols
  - 150Km/H:  $L < 4$  symbols – significant degradation

# Summary – 16-subchannel UL OFDMA

- The UL OFDMA was shown to provide most of the theoretical link budget gain, even under multipath conditions.
- The midamble scheme can support, with simple signal processing scheme, and with small overheads, velocities of up to 75Km/h.
- With more complex processing schemes, the system can support velocities higher than 150Km/h.