256 FFT OFDM/OFDMA PHY Performance

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Purpose:

Support the proposed PHY for 802.16e OFDM mode.

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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

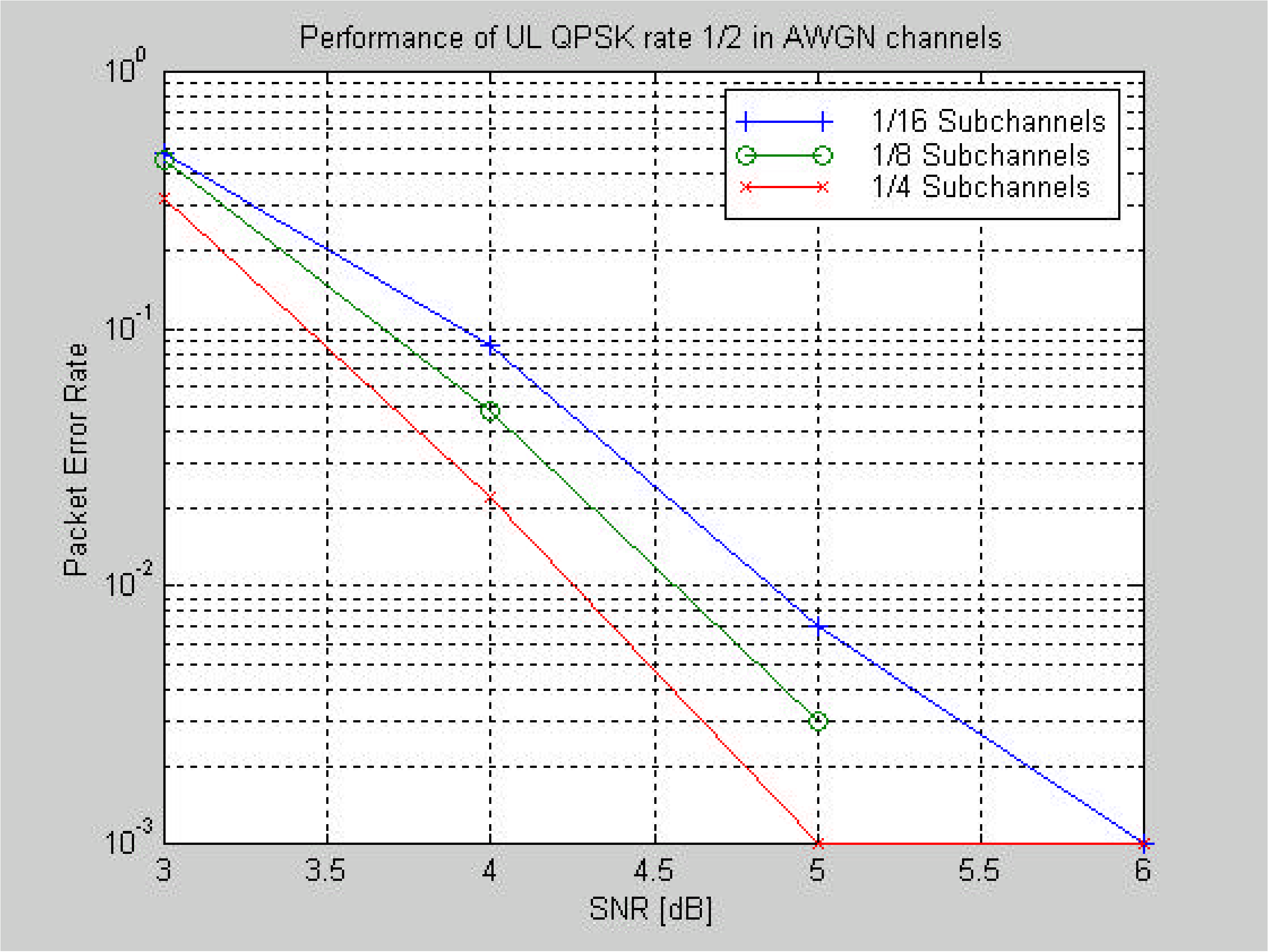
- Static channels
  - Performance in SUI channels
  - Link budget gain with subchannelization
- Mobile channels
  - Effect of channel estimation techniques
  - Performance in mobile channels.

Static channels

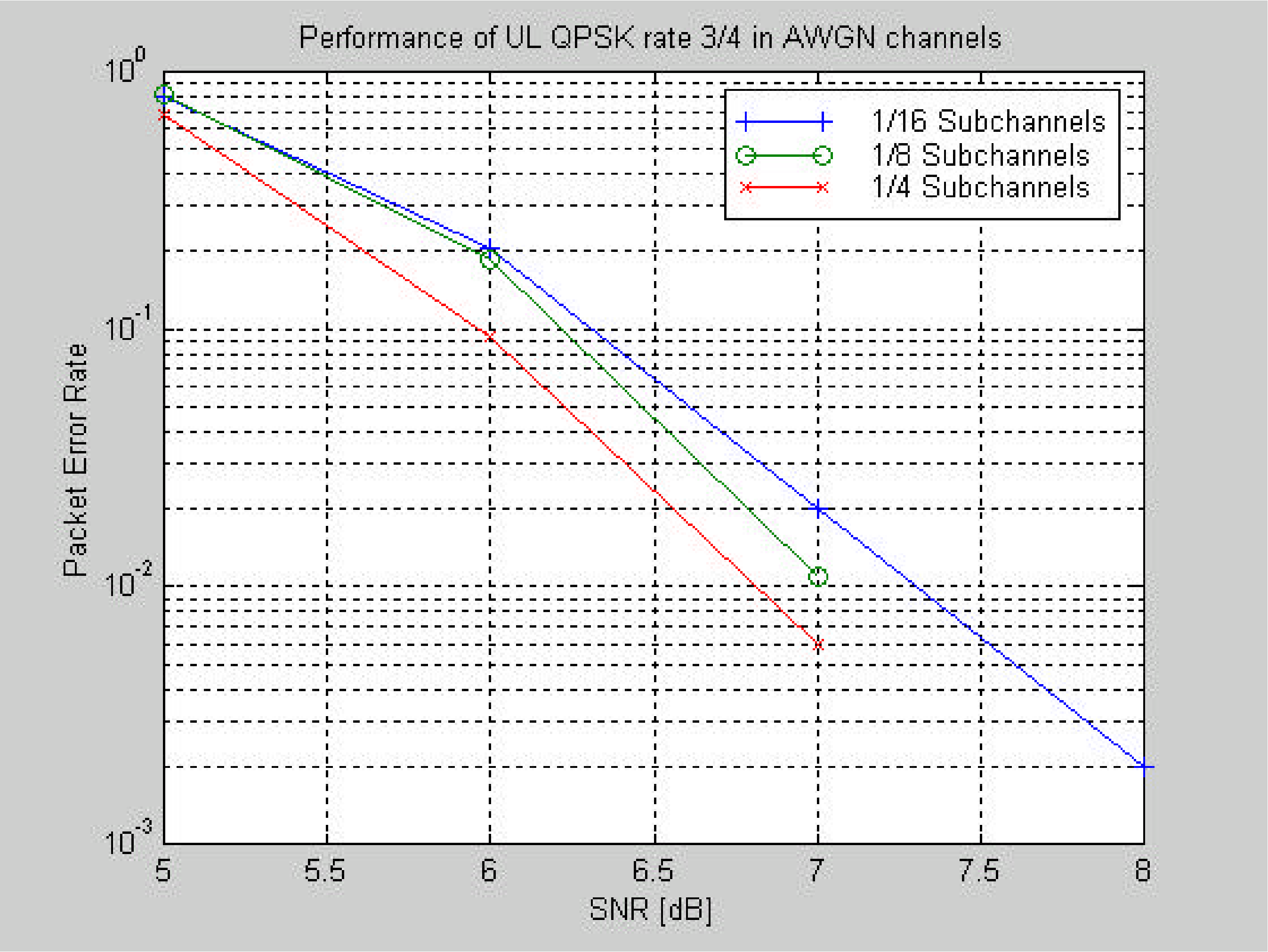
- Conditions
  - AWGN and SUI-1,2,3,4 (omni antenna) static channels
  - QPSK, QAM16 and QAM64. Convolutional code only.
- Comparison between
  - 1, 2 or 4 out of 16 subchannels.
    - Equivalent to one out of total of 16, 8 or 4 subchannels

- SNR – Ratio of received power *density* to noise *density*
  - Equivalently, SNR in active subcarriers.
  - Does not include subchannelization gain
  - For *total* power add $10\log_{10}$(#subchannels)

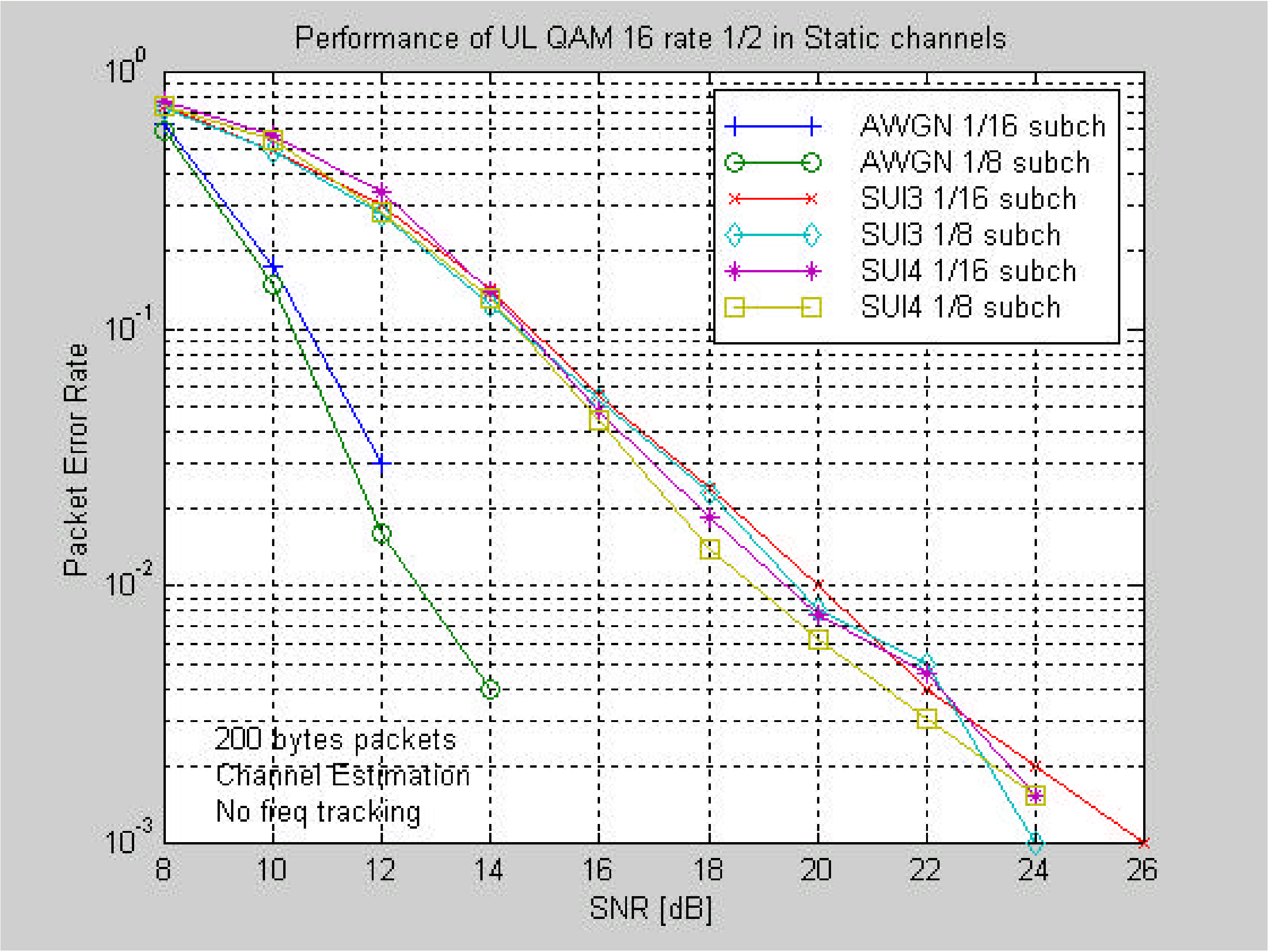
QPSK R=1/2, AWGN



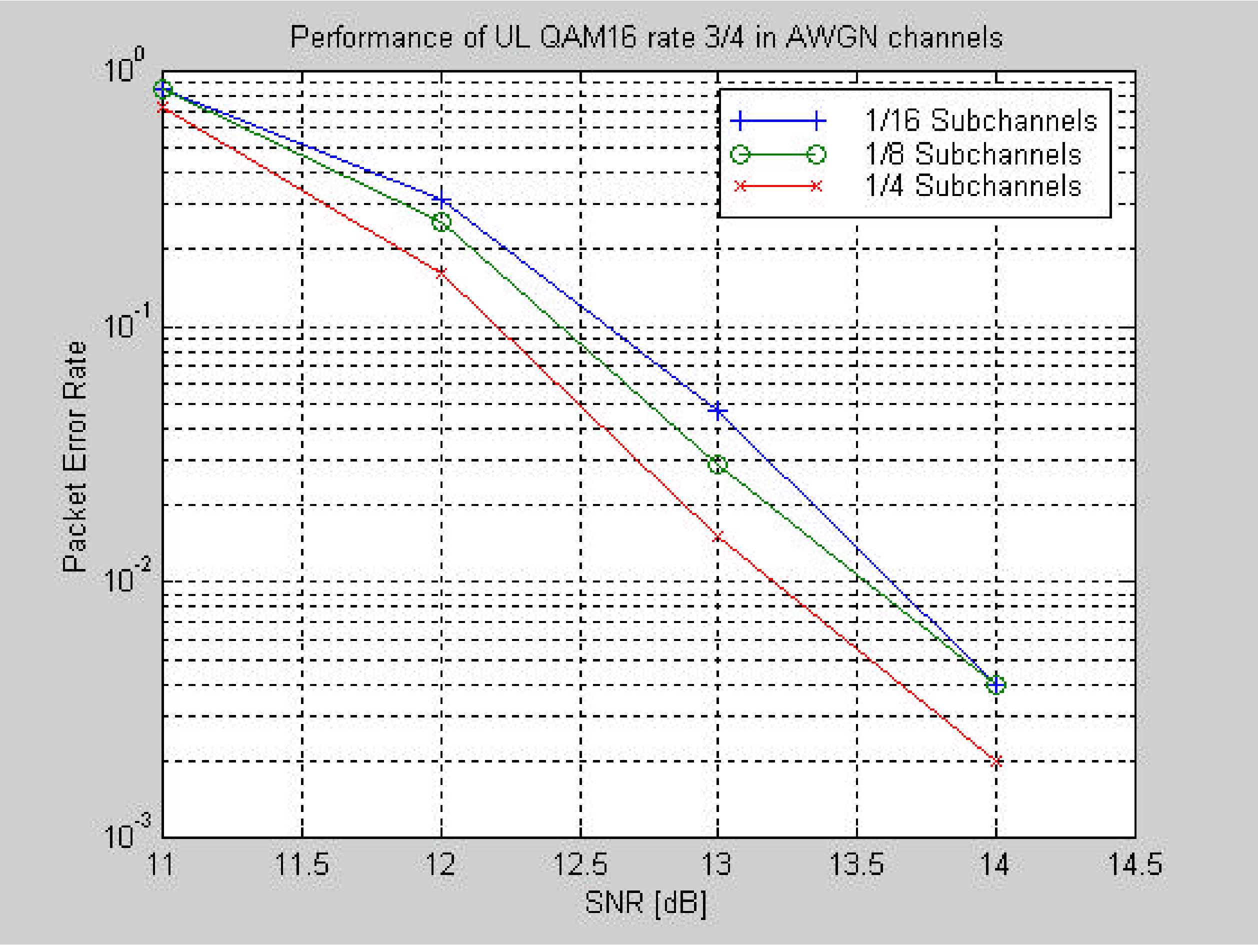
QPSK R=3/4, AWGN



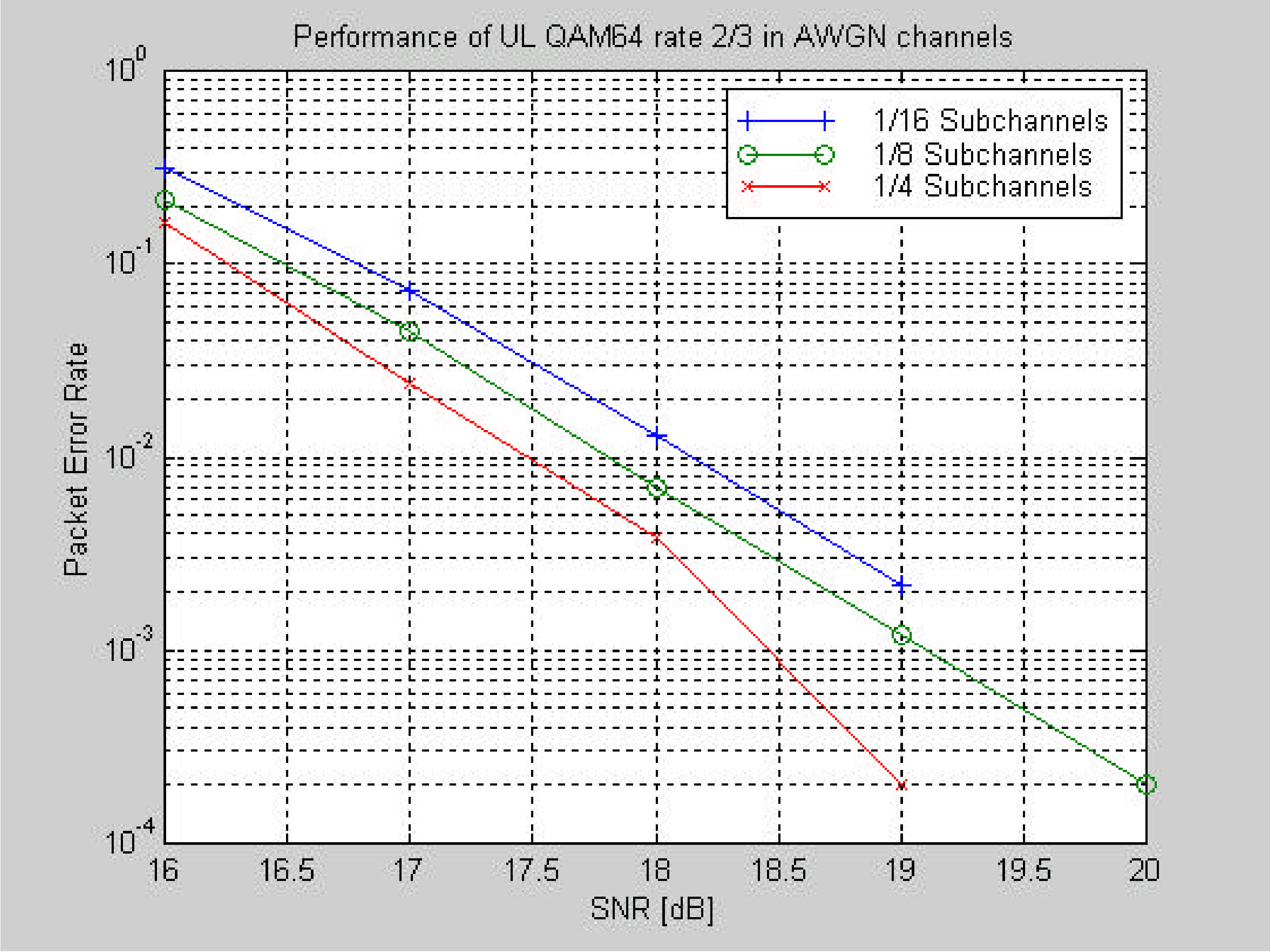
QAM16, R=1/2, AWGN and SUI



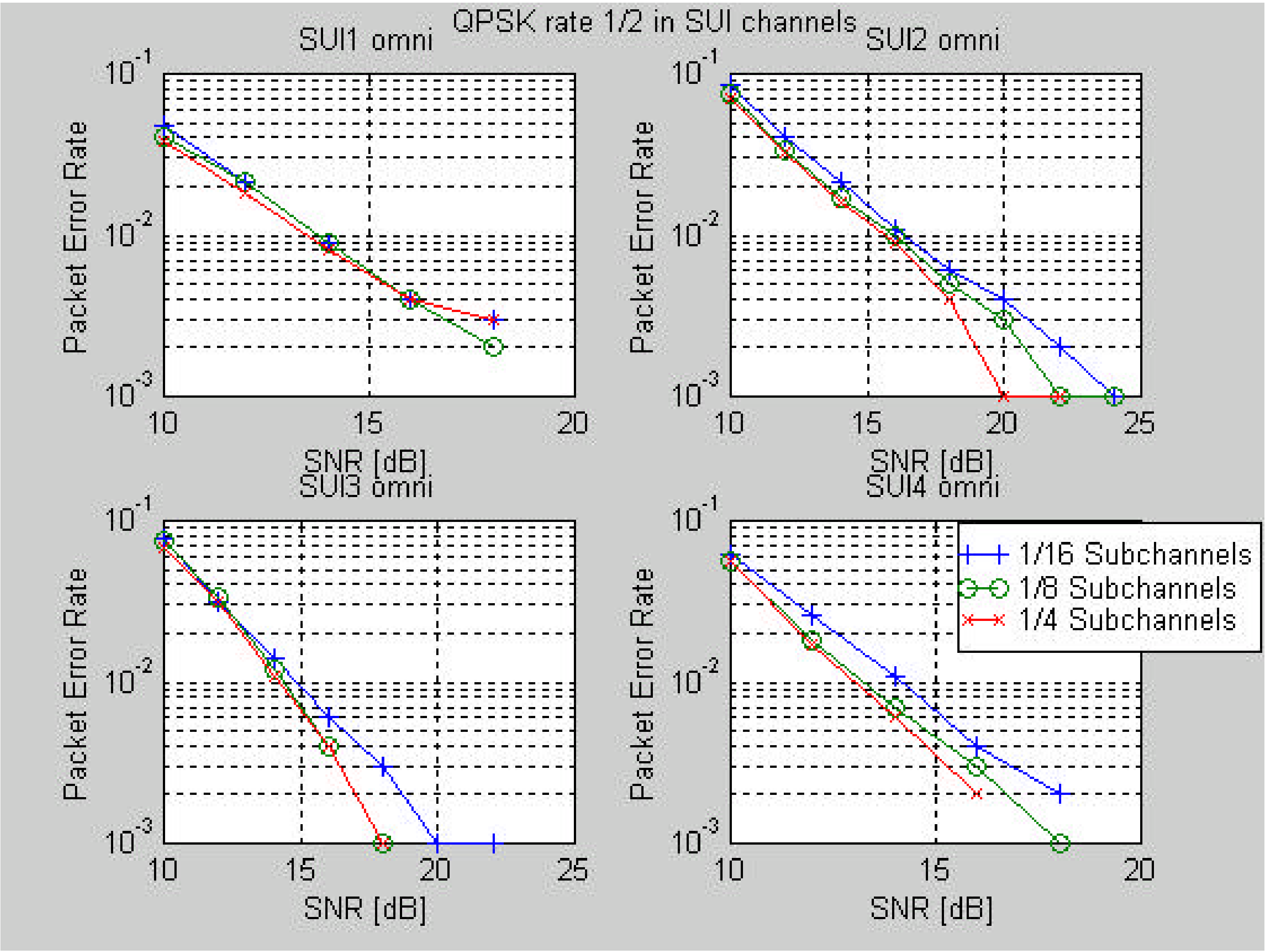
QAM16 R=3/4 ,AWGN



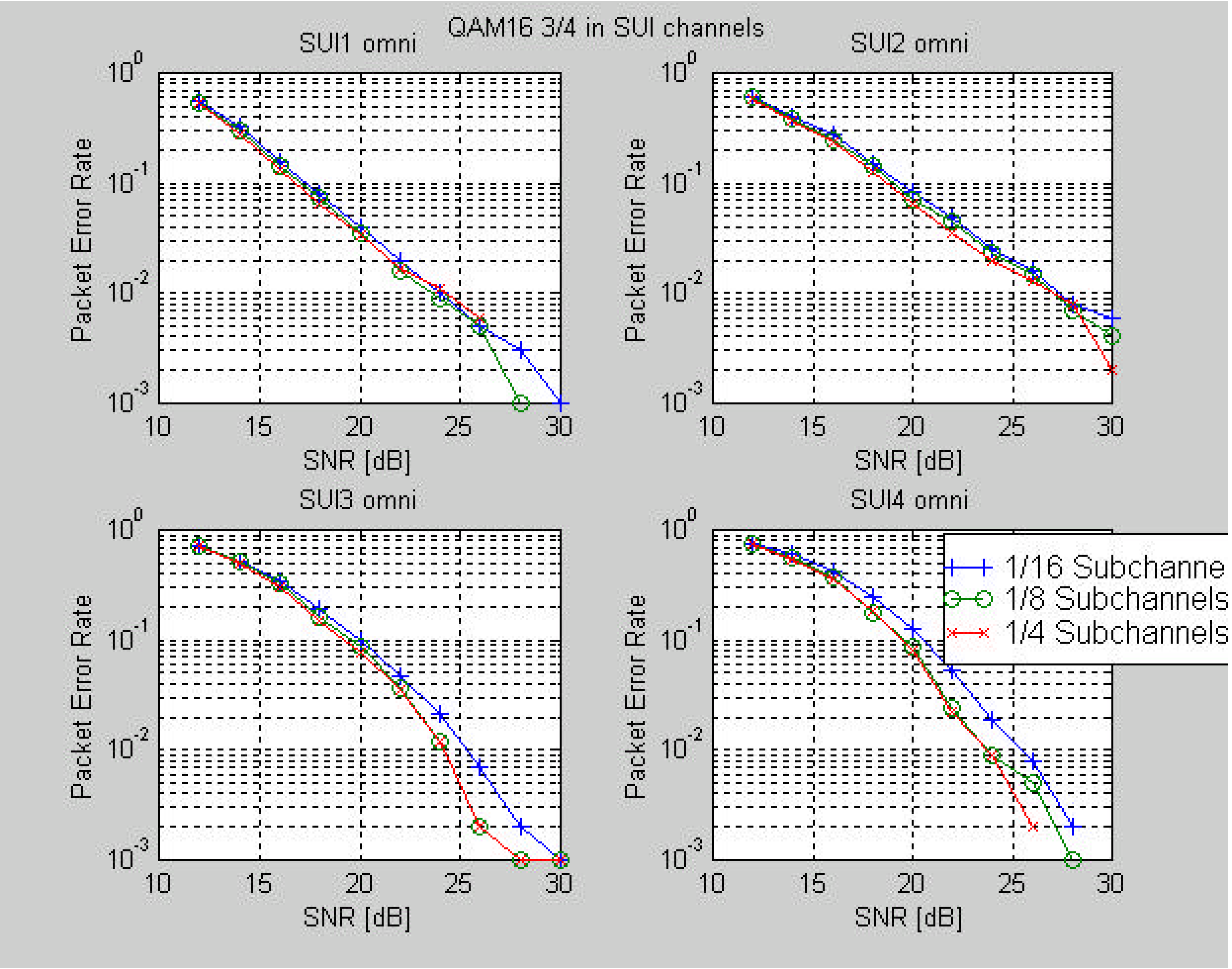
QAM 64, R=2/3, AWGN



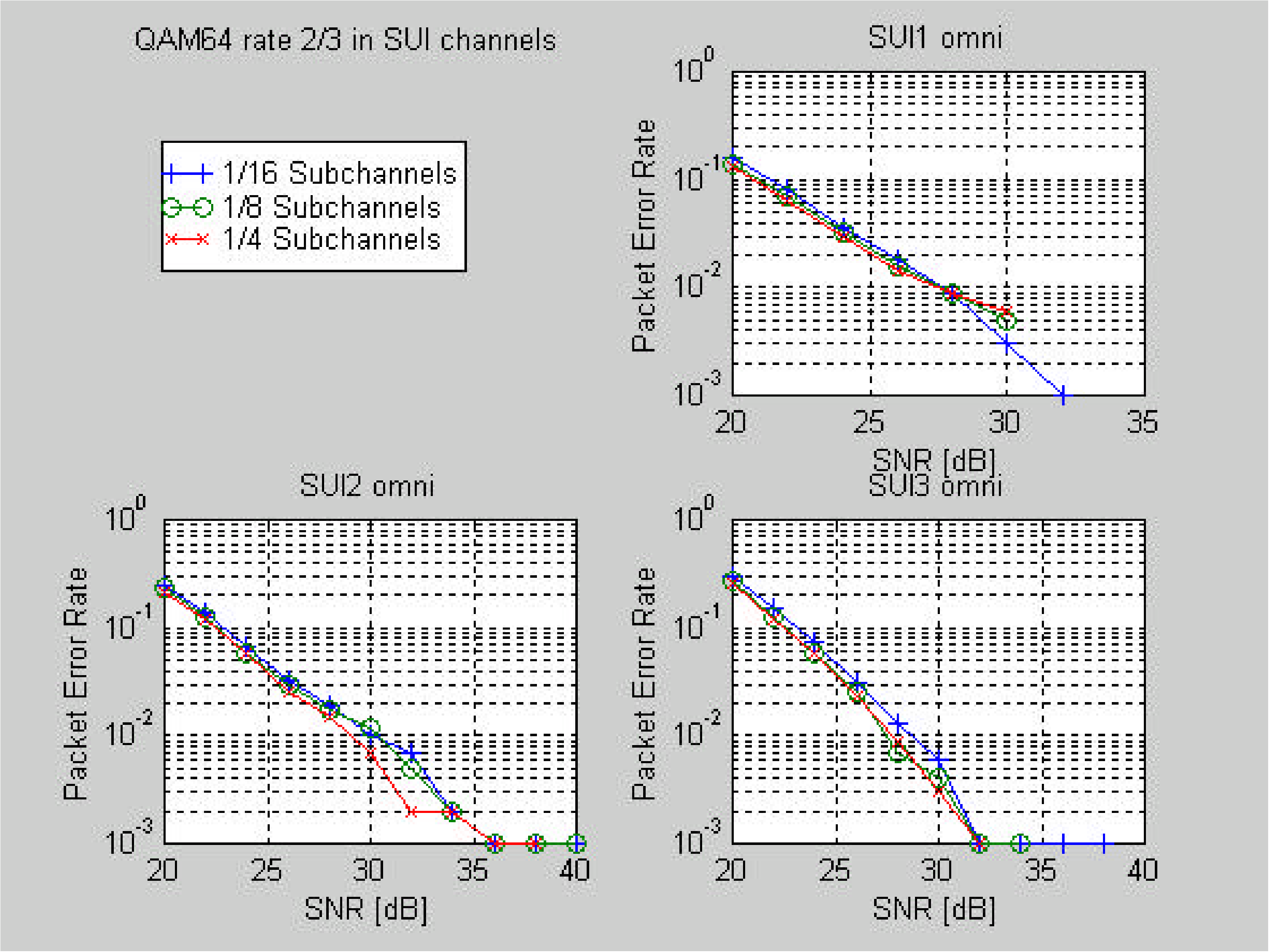
QPSK, R=1/2, SUI channels



QAM16 R=3/4, SUI channels



QAM64, R=2/3, SUI channels



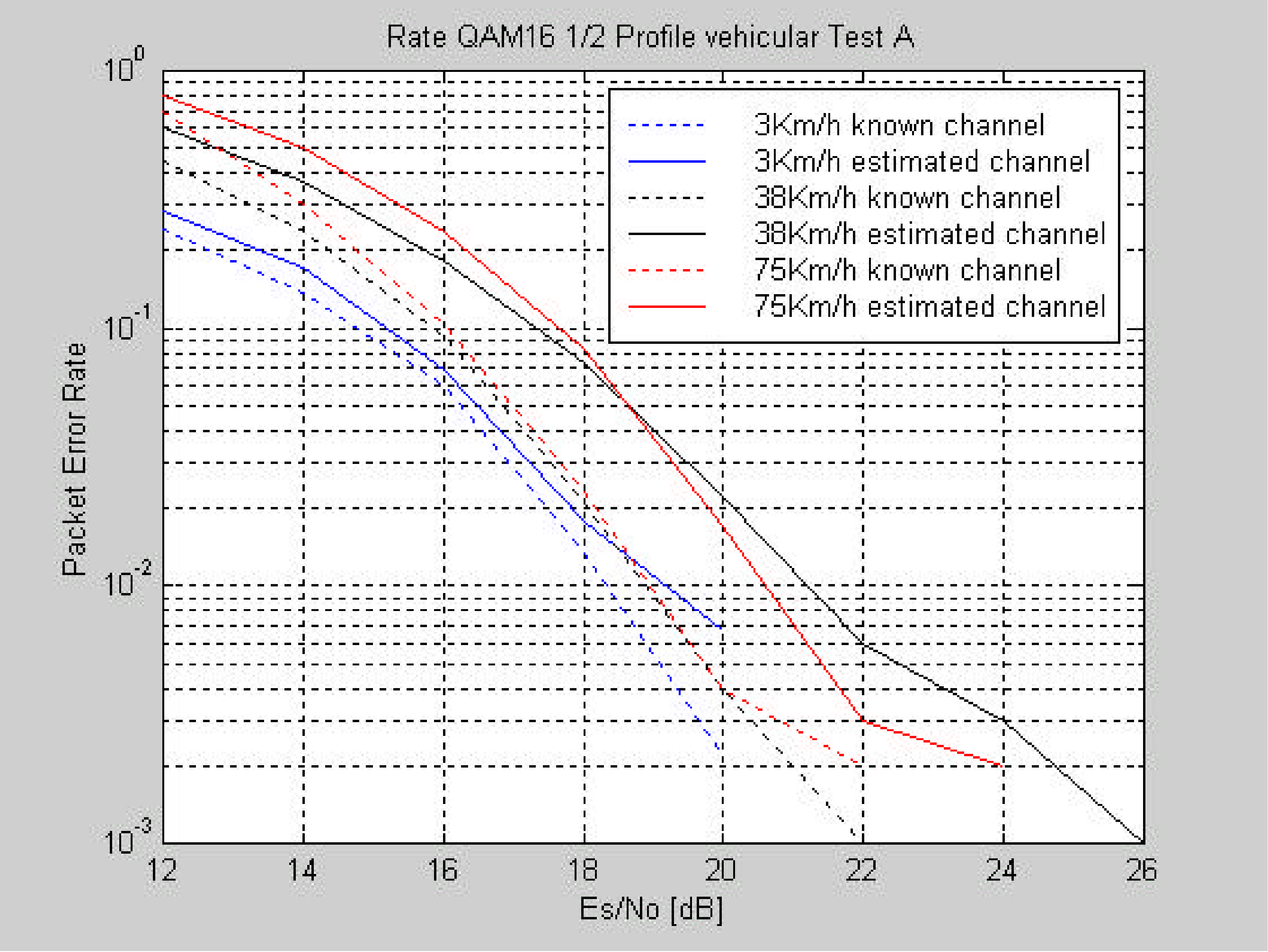
Static channels- conclusions

- 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

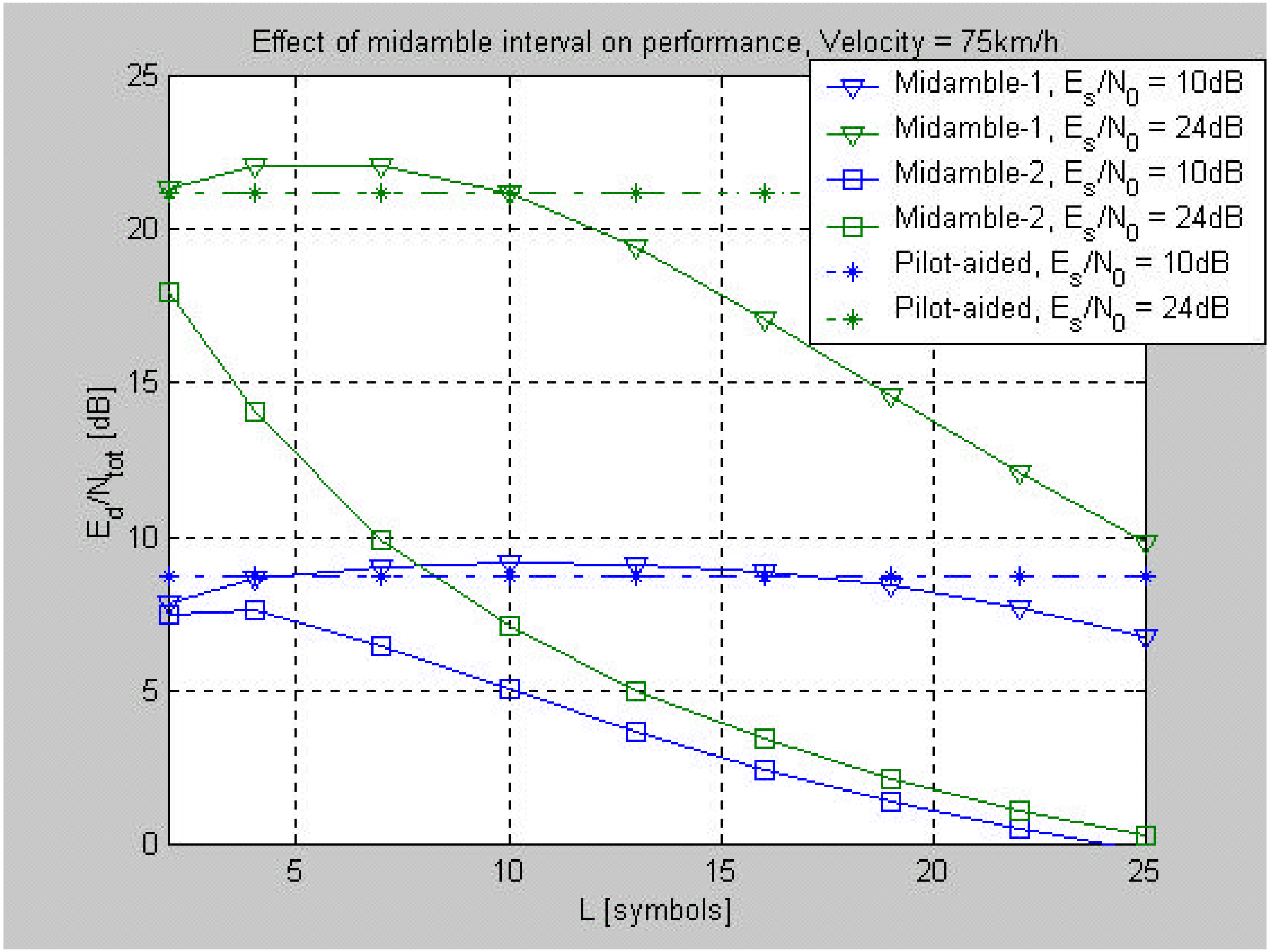
Dynamic channels-results



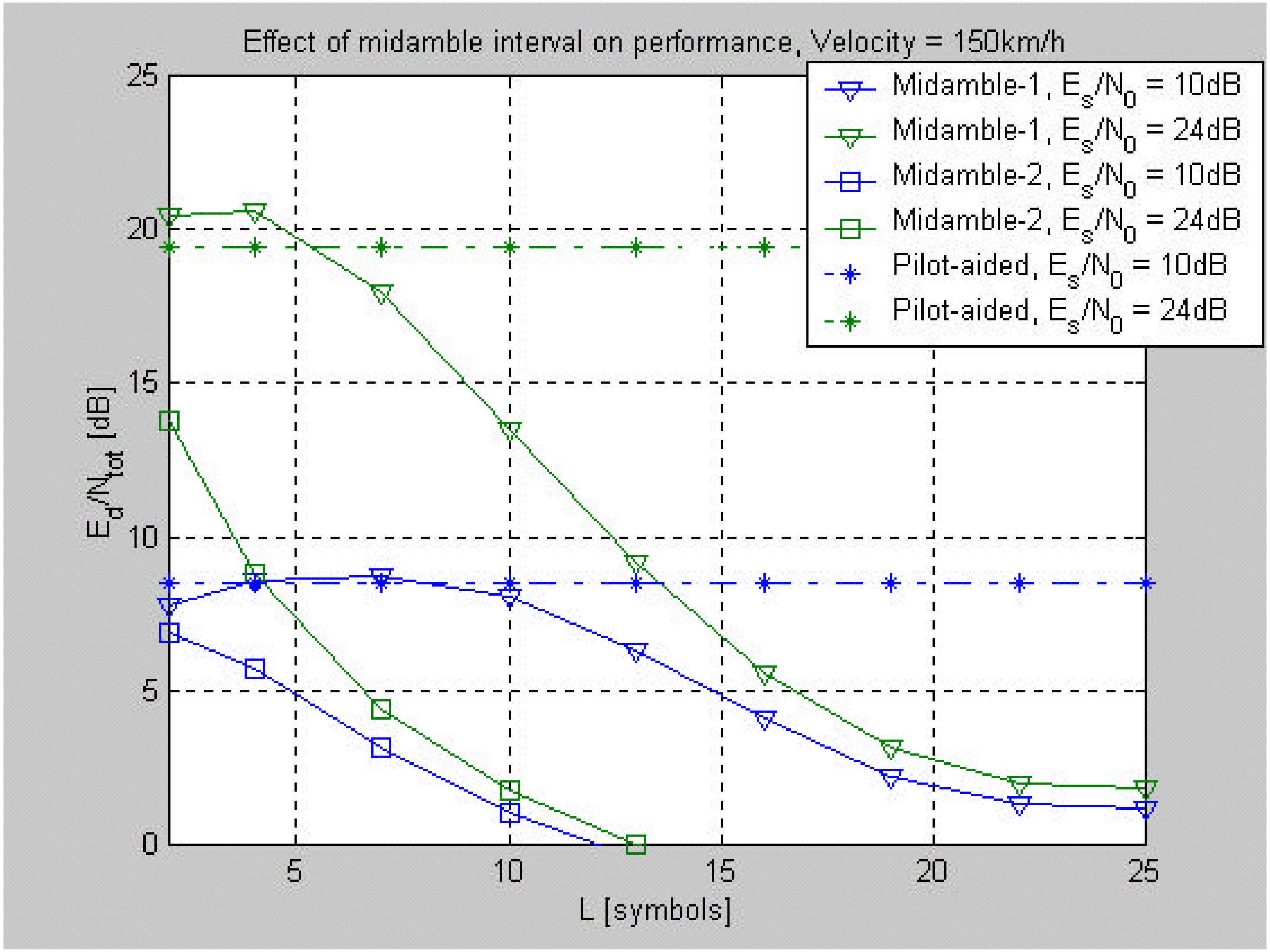
Effects of Midamble spacing

- 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_{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.