Preamble Performance for Various HF Standards

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Presentation Overview

- Motivation
- Preambles of Various HF Standards
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Motivation

- US MIL-STD188-110B is being updated to include a new family of wideband HF (WBHF) waveforms
- New family of waveforms will not contain a re-inserted preamble
  - Allows for “ACQ on Data” if all TX waveform parameters are known at the receiver
- Will a lack of a re-inserted preamble affect the performance of Automatic Repeat Request (ARQ) systems ?
  - For secure ARQ systems .. Does a reinserted preamble help ?
    - If there is important crypto info contained in initial part of transmission, a reinserted preamble would not benefit the system
    - If crypto also “ACQs on Data” .. Significant overhead may be inserted into bit stream

Preambles of Various HF Standards

- HF Standards
  - STANAG 4285
  - STANAG 4539 / US MIL-STD-188-110B
- Preambles
  - STANAG 4285
    - 80 symbol preamble inserted every 106.7 msec (i.e. every 256 symbols)
    - Does not “autobaud”
      - All TX parameters known at receiver
    - Many opportunities to acquire
      - Very useful for broadcast applications
      - May not be as desirable for ARQ systems
      - Lots of overhead for reinserted preamble (i.e. lower effective data rates or weaker FEC)

Preambles of Various HF Standards

- STANAG 4539 / US MIL-STD-188-110B
  - Lower data rate waveforms (i.e. main body 110A/B)
    - Preamble contains data rate and interleaver length information
      - 3 bits for data rate, 1 bit for interleaver size
    - Two different preamble lengths based on interleaver size
      - 0.6 seconds (short and zero interleaver)
      - 4.8 seconds (long interleaver)
  - Higher Data Rates (i.e. 110B Appendix C)
    - Initial preamble => 287 symbols
    - Reinserted preamble => 103 symbols
    - Contains info on 6 data rates and 6 interleaver sizes
      - 6 bits of information

Preambles of Various HF Standards

- Draft of US MIL-STD-188-110C WBHF Waveform
  - Preamble length is programmable
    - Can vary from 0.120 seconds to greater than 9.6 seconds
  - Preamble contains following info:
    - Data rate (4 bits)
    - Interleaver size (2 bits)
    - FEC Constraint Length (1 bit)
    - 2 parity bits
    - 1 free bit
  - No reinserted preamble

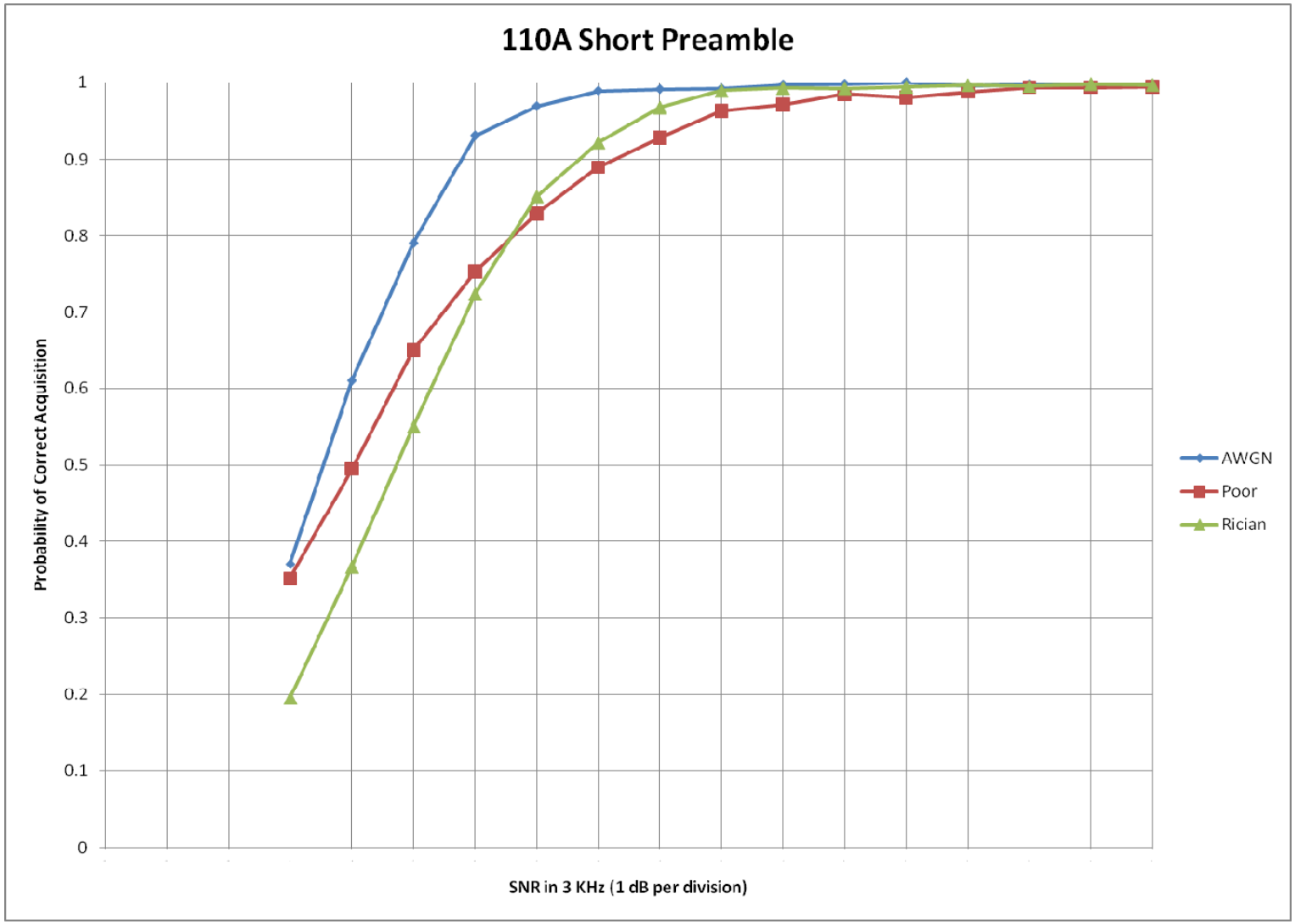
Performance of Preambles

- The following performance plots are the results of computer simulations which tested whether the modem acquired the right data rate and interleaver setting
  - For each acquisition test, a random frequency offset between +/- 75 Hz was selected
  - Random channel simulator gain and time delay were also introduced (all random values drawn from uniform distributions)
  - Noise and Fading process seeded with different random numbers for each test
- Plots show relative performance
  - Relative to 110A short preamble

Performance of Preambles

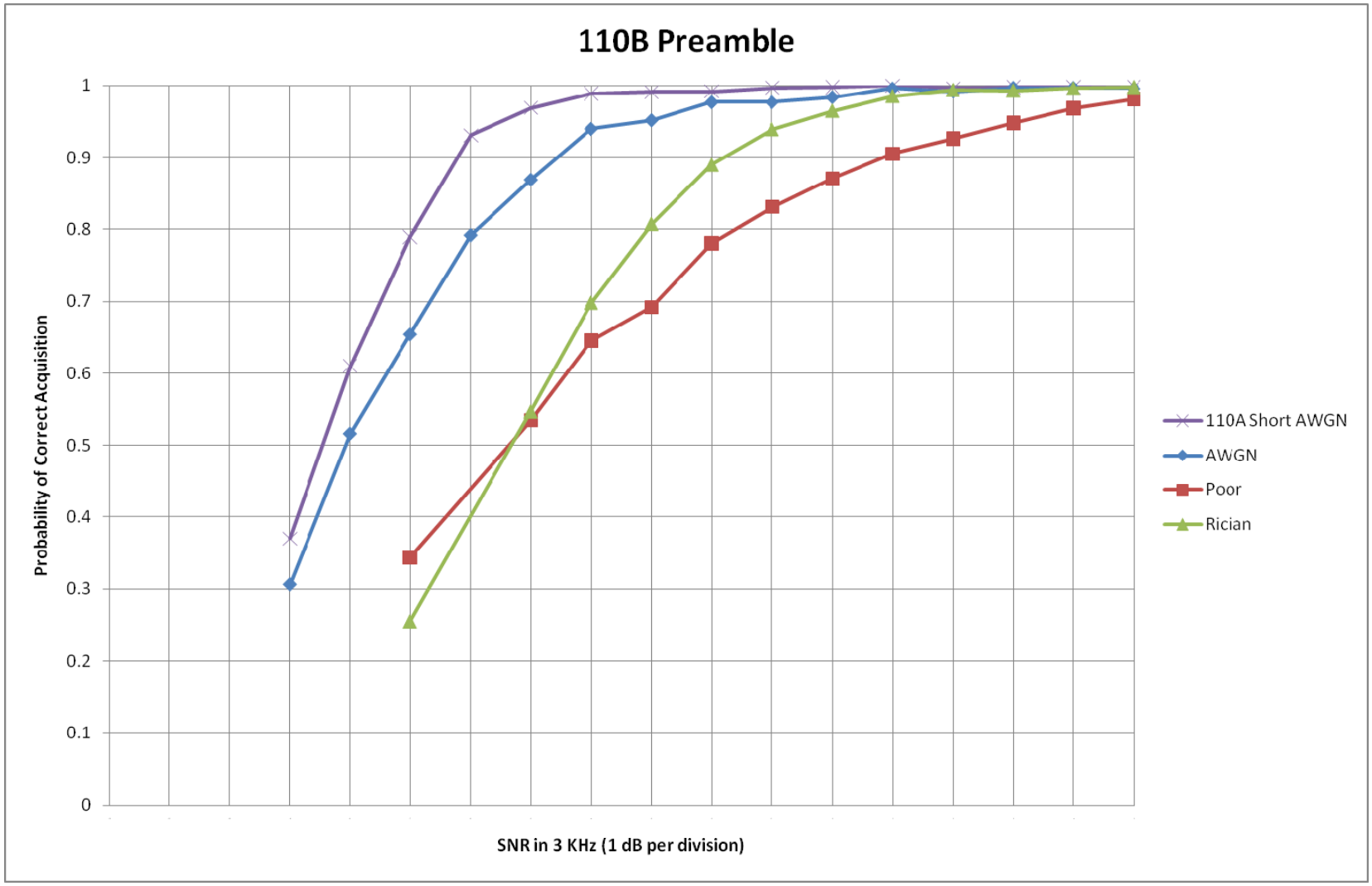
- Three channels tested
  - Additive White Gaussian Noise (AWGN)
  - Mid-Latitude Disturbed Channel
    - 2 Equal Power Paths, 2 msec apart, 1 Hz fade rate on both paths
    - Labeled Poor in plots
  - Rician Channel
    - 2 Equal Power Paths, 2 msec apart, 1st path static, 2nd path 2 Hz fade rate
- Labels
  - 110A: 75 bps to 4800 bps (main body 110A/B)
  - 110B: 3200 bps to 12800 bps (110B Appendix C)

Performance of 110A Preamble



Performance of 110A Preamble

Performance of 110B Preamble



Performance of 110B Preamble

- Acquisition performance of both 110A and 110B is several dB lower than SNRs required for waveforms to provide reliable data
  - Except for 75 bps waveform
- A reinserted preamble requires higher SNRs for proper acquisition
  - Unless reinserted preamble has the same length as the initial preamble
- Performance of ARQ systems more dependent on a good initial preamble than on a reinserted preamble

Summary

- Acquisition performance of 110A and 110B waveforms is very good
- Assuming no crypto issues, a reinserted preamble would likely not improve performance of ARQ systems (i.e. throughput) in a significant way