# Draft US MIL-STD WB ALE Net Model and Traffic Delivery Measurement

## HF Industry Association Meeting

## 2 / 12 / 2015, San Diego, CA

# Overview

- The draft MIL-STD wideband ALE standard proposes a fast asynchronous scanning mode and features waveforms based on those defined in MIL-STD-188-110C Appendix D
- The draft ALE standard is being designed to support latency sensitive traffic such as IP data
- This work implements a model of a draft MIL-STD wideband ALE network with which traffic delivery characteristics may be measured

# Background

- MIL-STD-188-141C Appendix A
  - 2nd Generation Automatic Link Establishment (2G ALE)
  - Asynchronous fast scanning
  - Broadcasts a leading call for duration of at least one scan rotation followed by linking handshake
  - Long link setup time for data networks
  - No integrated ARQ protocol, must use separate data-link layer such as S5066

- STANAG 4538 Annex C - FLSU
  - 3rd Generation Automatic Link Establishment (3G ALE)
  - Synchronous scanning, slower scan rate than 2G ALE
  - Can be preempted by incoming call while scanning to call channel
  - Typically shorter link setup time compared to 2G, more desirable for data networks
  - Defines integrated data-link ARQ protocols (LDL, HDL)

# Background 2

- MIL-STD-188-110C
  - Appendix C defines serial-tone broadcast waveforms representing the highest speeds achievable within 3kHz, ca. 2000, with a maximum of 12.8kbps (110B)
  - Appendix D defines a suite of serial-tone broadcast waveforms up to 24kHz with a maximum bitrate of 120kbps
  - Developed collaboratively between Rockwell Collins and Harris

- With wider-than-3kHz waveforms now available, HF links intending to use these waveforms must also now negotiate a bandwidth and offset within the channel allocation during link establishment to maximize channel capacity (avoid interference)
- Neither 2G ALE nor 3G ALE currently have native mechanisms with which to negotiate channel bandwidths and offsets

# Harris 1st Generation Adaptive Wideband

- Based on S4538 3G ALE FLSU
- Augments link establishment protocol with bandwidth and offset negotiation phase
- RF-7800H radio provides 110C xD waveforms used by S5066 within RF-6760W-HF Wireless Messaging Terminal for ARQ data link
- Provides adaptive capability, adjusting channel bandwidth and offset in order to avoid interference, minimizing bit errors, maximizing use of overall system capacity
- Channels sensed for local interference during scan and just before negotiation handshake
  - Negotiated bandwidth based on combined local interference environments

# Draft MIL-STD Wideband ALE

HARRIS®

- Currently under development
- Two interoperable linking modes making different trades of linking speed against robustness
- Asynchronous and synchronous scanning
- Asynchronous capture sequence based on 110C xD TLC block
  - 13.3 millisecond capture probe
  - User defined channel dwell time; longer dwell – more capture probe detection opportunities
- Linking PDUs based on 110C xD data waveform
  - 80-bit PDU containing addressing and bandwidth negotiation fields
  - 240 millisecond preamble distinguishes between:
    - 750bps Fast WALE – 106.67ms
    - 75bps Deep WALE – 1.067s
- Designed to negotiate wideband links natively

# Motivation

- The advertisement of higher bandwidths and bitrates invariably brings the expectation that more complex and network intensive applications and services may be used over HF
- In order to sufficiently support latency sensitive and bandwidth intensive traffic over HF networks, over the air protocols as well as individual node behavior must be carefully designed
  - Prohibitive to correctly design without substantial simulation
  - Best studied as an entire network, from traffic generation to on-air interaction
- To that end, in order to study the draft MIL-STD WB ALE, a model network was created
  - Generally supports link establishment so that other candidates can be studied and compared

# Multi-node Traffic Model

- Goal: Measure message service time against traffic load
- Focused on linking protocol's performance in a network
  - Network performance affected by:
    - Dwell time
    - Linking PDU lengths – length of channel occupancy before detection
    - PDU pDet performance
      - WALE pDet performance simulation of individual links has been studied
    - And a whole bunch of non-protocol factors
      - Node persistence
      - Link traffic detection
      - Traffic model, arrival size and lifetime
      - Queued traffic servicing
    - Link traffic performance
  - Becomes a significant multivariate problem (CSMA/x, PDU pDet, pFalse, data-link performance)

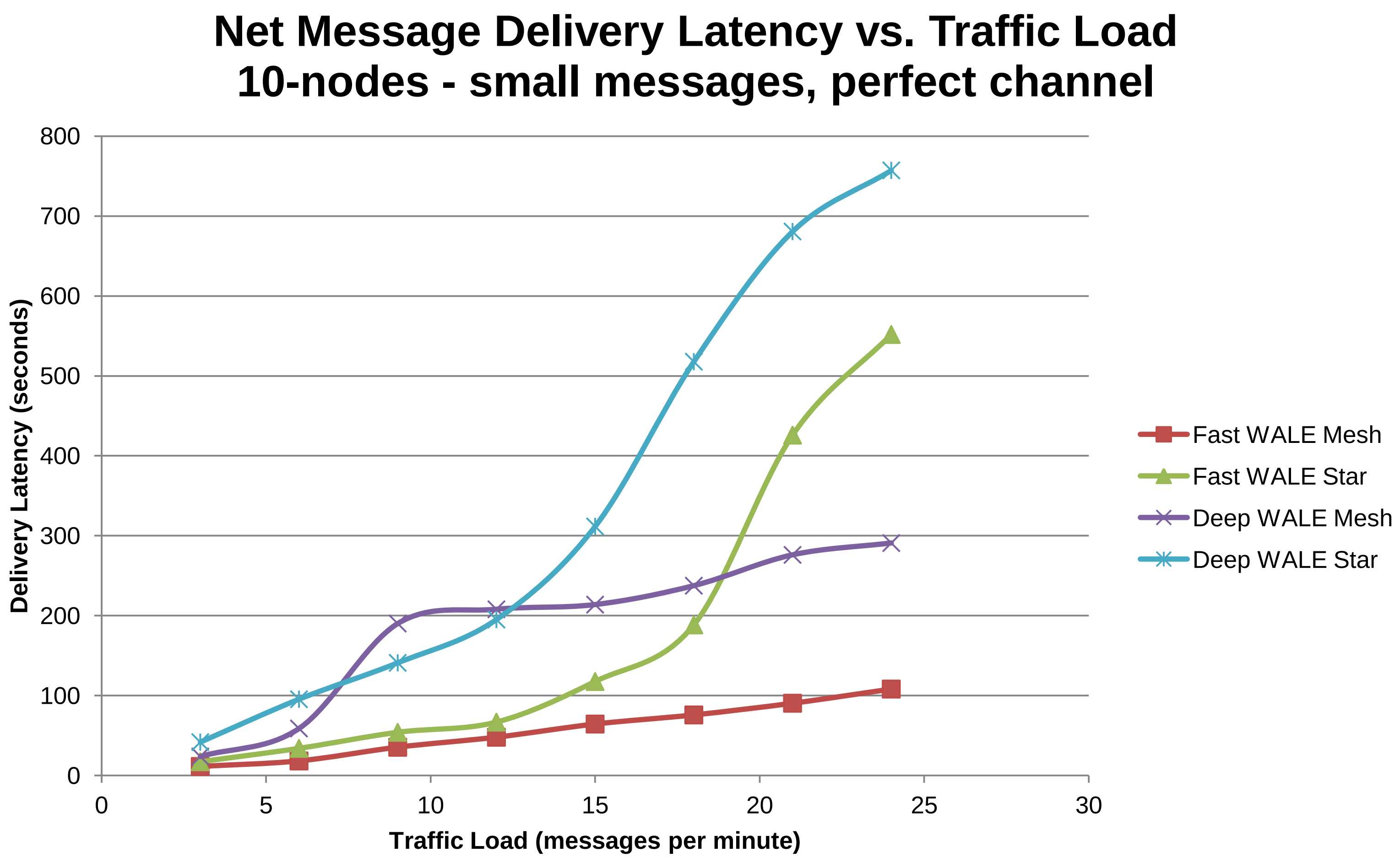
# Current Model Implementation

- Simplified PHY model
  - Use pDet performance for individual PDU decodes
  - If collision, no detection
  - Link traffic progress is paused during collision (assumes ARQ)
- Traffic model
  - Poisson distributed arrival
  - Fixed message size
  - Traffic has infinite life time (Erlang C)
- Star and Mesh network configurations
- CSMA considerations – Actually traffic sensing
  - Sort of P-persistent
    - An amount of holdoff after link termination
  - Collision avoidance
    - Will only transmit on a channel observed to be free with stations not involved in recent previous link requests
    - However, will transmit immediately when channel observed to be free (not a nice network neighbor characteristic)

# Implementation cont'd

- Station's traffic queue is serviced FIFO
  - First viable traffic request is serviced (remote station free, request not in pended state)
  - If link attempt fails
    1. Traffic request is pended for an amount of time
    2. Next link attempt held off for an amount of time
    3. Next viable traffic request is serviced after hold off expires
- When linked, stations will reciprocate traffic requests
  - Stations are courteous, will wait for reciprocal traffic before sending again
- When traffic requests exhausted, stations wait one second before returning to scan

# Model Performance




For illustration only – not for analysis

# Model Enhancements

- PHY model
  - Enhanced linking PDU model incorporating varying SNR profile
  - Link traffic modeled with statistical error distribution profiles
- Traffic model
  - Can enhance with Erlang distributed traffic size/arrival
  - Better yet, model with actual traffic profile
- Can be used to study individual node network behavior
- Refine traffic request service schemes
- Model currently written in C
  - ~45s to simulate 2 hours on Intel i7 ~2.5GHz
  - Port to more substantial simulation environment

# Questions?