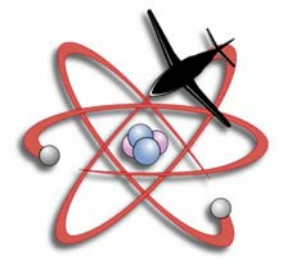


NETEX Program

Networking in Extreme Environments

7 April Phase II Industry Day Workshop

Dr. Bernard A. Schnaufer, Rockwell Collins, Inc.

Rockwell Collins

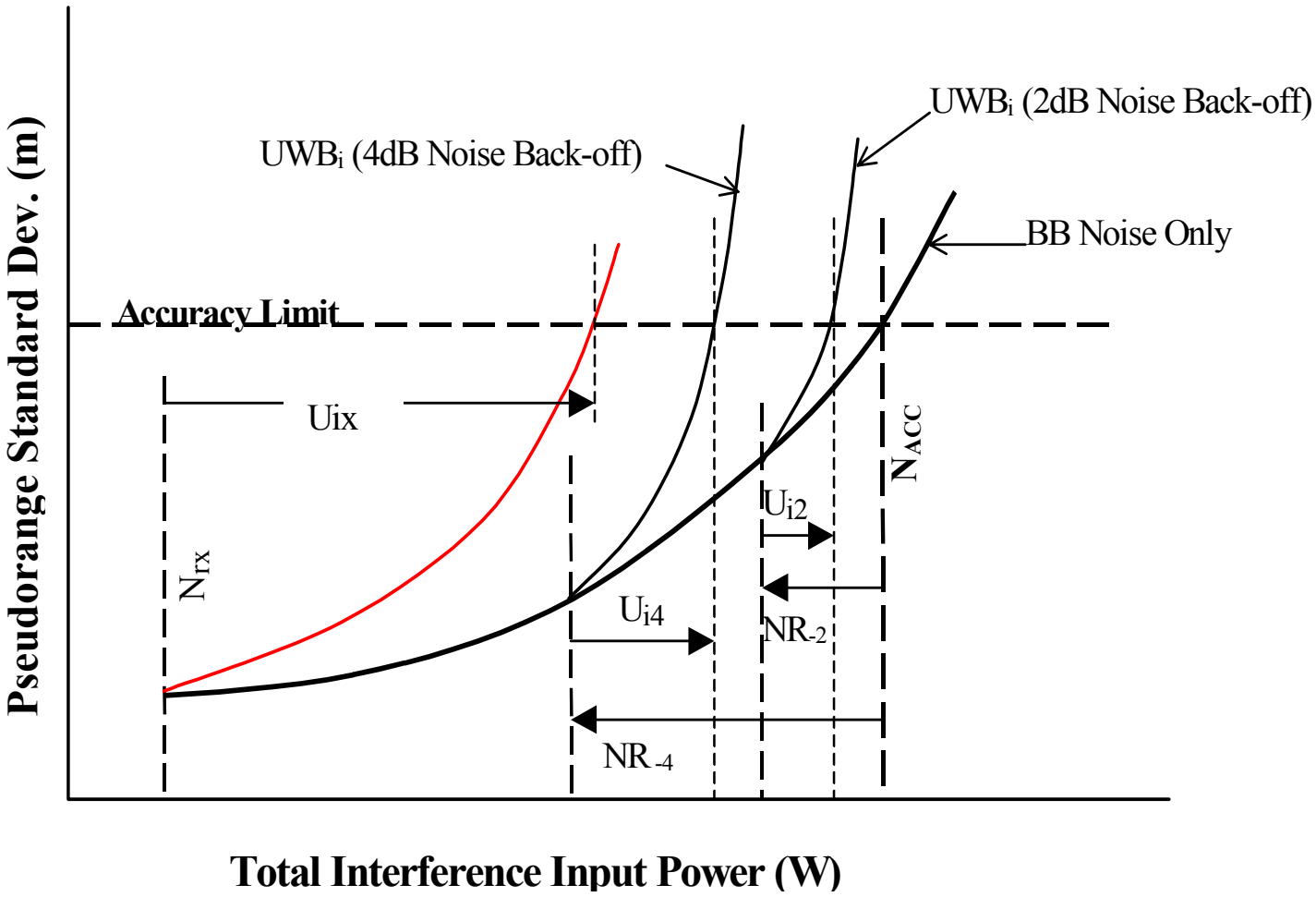
AN/ASN-163 (MAGR) & AN/PSN-11 (PLGR)

- 5 Channel GPS Airborne & Handheld/Vehicular Receivers
  - Frequencies: 1575.42 MHz (L1), 1227.6 MHz (L2)
  - Standard Response: 3-D position and velocity
  - Modulation:
    - pseudo-random BPSK at 10.23 MHz (P-code), 1.023 (C/A-code) MHz rates
    - 50 bps BPSK satellite ephemeris data overlay
  - IF Bandwidth: 25 MHz (nominal)
  - Sensitivity: sufficient to acquire and track GPS SPS and PPS signals (-130 to -136 dBm)

Basic GPS Receiver Test Approach

- For selected receiver parameters, tests determine relative susceptibility of UWB RFI compared to “standard RFI”
- Baseline is response to “standard RFI”
- “Standard RFI” is either broadband noise or CW
- In general, UWB RFI is added to specific fraction of “standard RFI”
- One test condition uses all UWB RFI (no added “standard RFI”) - Master Plan compatibility

Interference Substitution Approach



Interference Substitution Method for Pseudorange Accuracy

Standard Interference Signal is Broadband Noise

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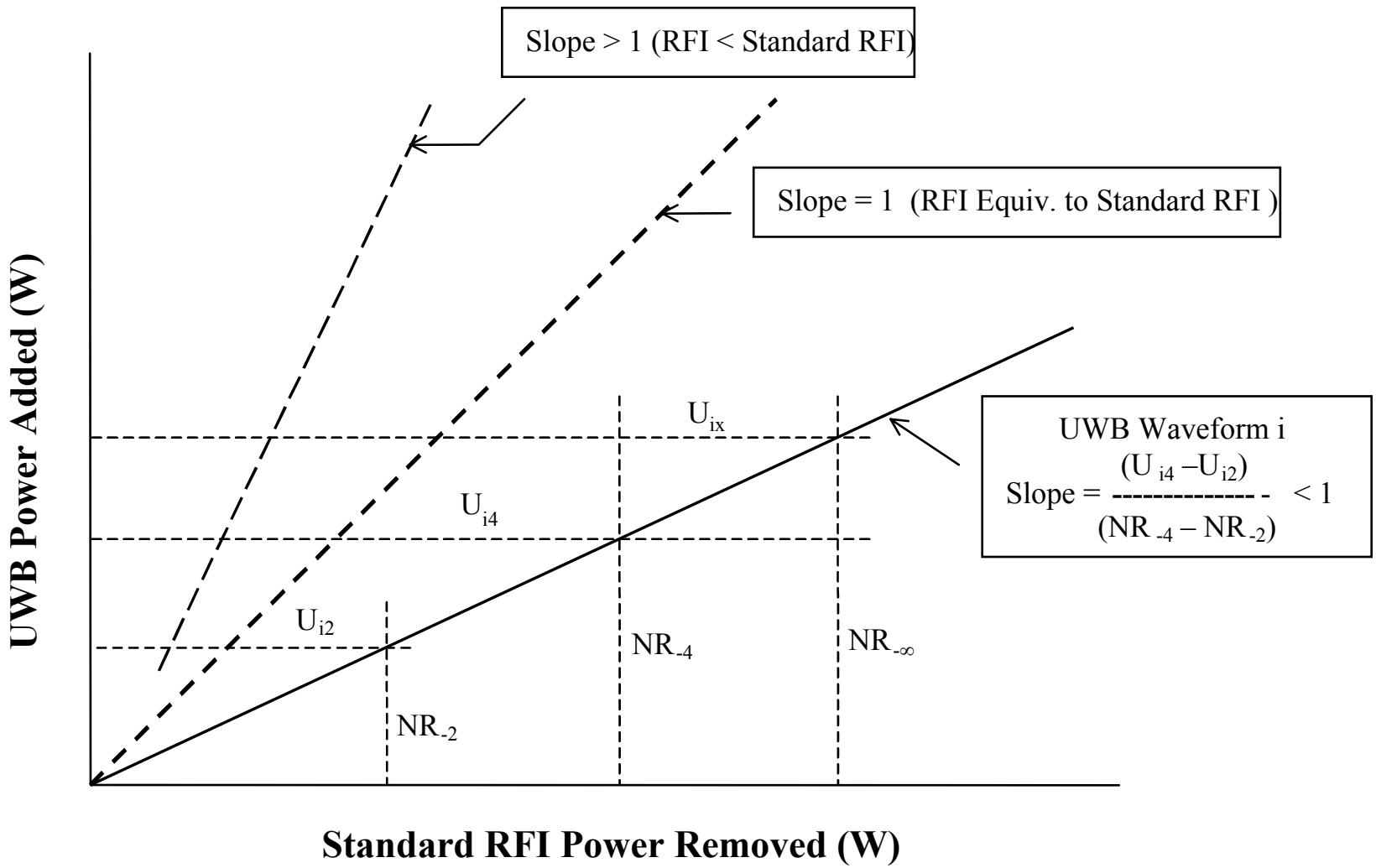
Standard RFI Equivalency Factor



UWB RFI Waveform List for GPS Testing

- 13 UWB waveforms chosen to cover a broad range of waveform types
  - Noise-like
  - CW-like
  - Waveforms typical of UWB communications
  - Dithered
  - Uniform

GPS RFI Tests Conducted

- Test types address primary operating modes of GPS receiver for its primary applications
- MAGR
  - P-code pseudorange (PR) test (Collins/Pax River)
  - C/A-code PR test (Collins/Pax River)
  - P-code position/signal strength test (Collins/Pax River)
  - Time to Direct-P/Y reacquisition (Pax River only)
- PLGR
  - P-code PR test (Collins only)
  - P-code position/signal strength test (Collins only)

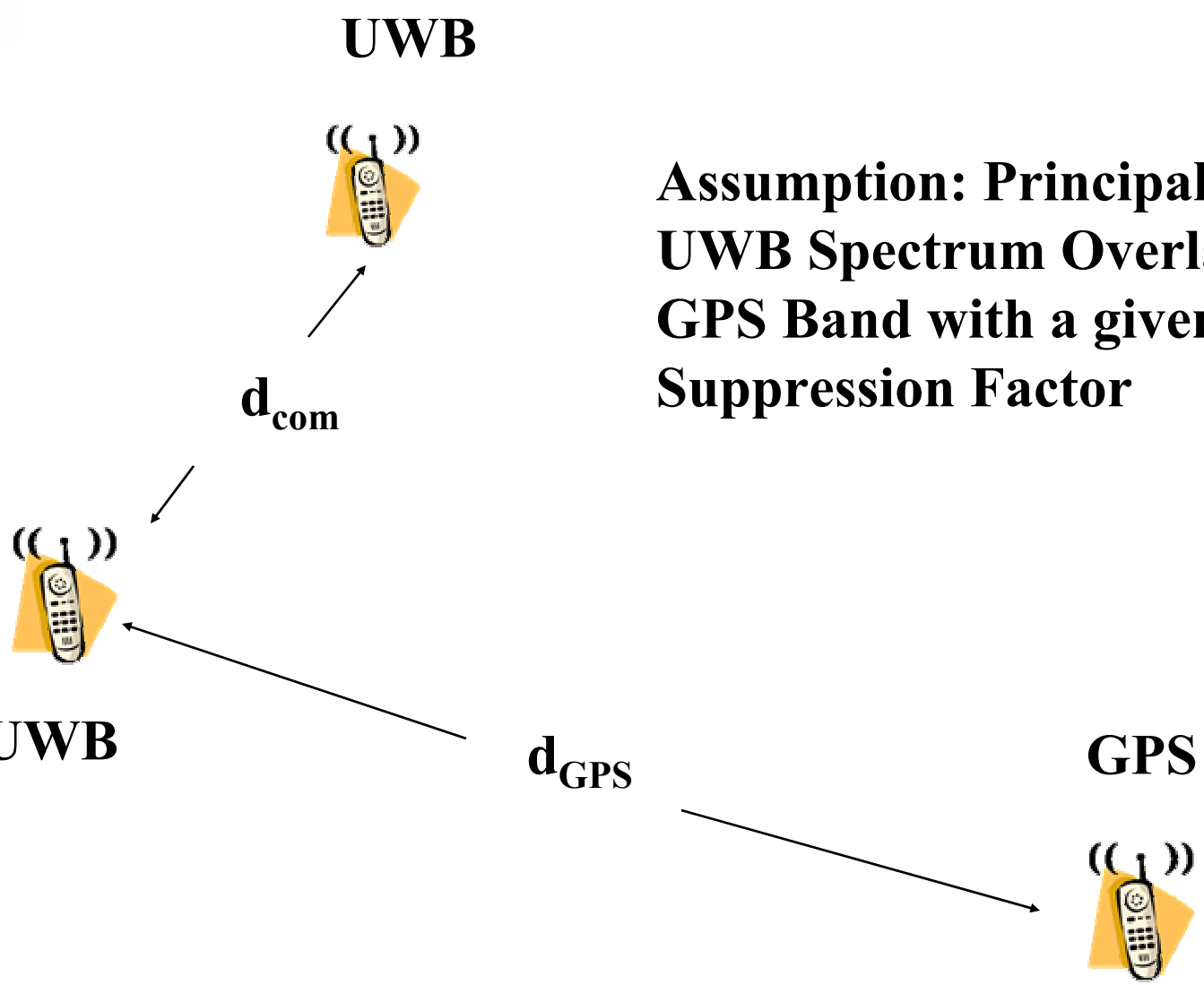
MAGR Tests - Results and Status

- All 13 waveforms have been tested and post-processed for the P-code Pseudorange and Position/Signal Strength tests
- Most waveforms show less impact than white noise
  - However, there are a few notable exceptions
- The comm-like waveforms generally have less impact than white noise but are not among the lowest impact waveforms tested
- For MAGR, C/A-code RFI behavior demonstrated much greater satellite to satellite variation than P-code behavior
- Rockwell Collins' testing results agree substantially with the Pax River results

PLGR Tests - Results and Status

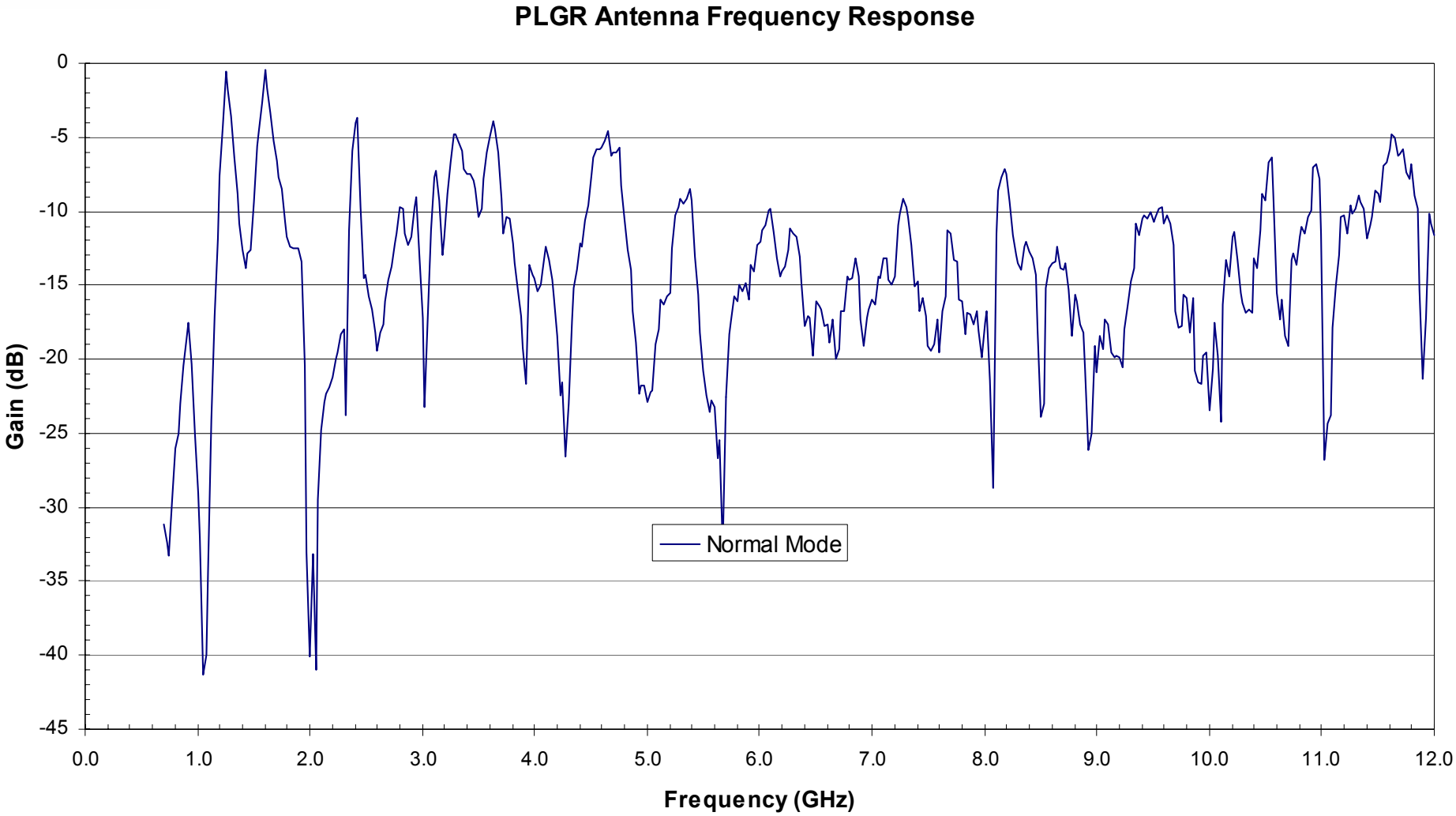
- A subset of the 13 waveforms have been tested and post-processed for the P-code Pseudorange and Position/Signal Strength tests
- Preliminary examination of the data shows similar behavior as MAGR to UWB RFI for most waveforms
  - However, 19.94 MHz Uniform waveform behaves significantly differently for PLGR than for MAGR
  - Some waveforms have greater RFI impact for PLGR than for MAGR
- Equivalence factor plot for Position/Signal Strength Test still needs to be generated

Comm Study Interference Scenario



Assumption: Principal UWB Spectrum Overlaps GPS Band with a given Suppression Factor

PLGR Antenna Study Results



Antenna Study Conclusions

- Antenna gain response provides little attenuation for far out-of-band RFI
- Hence, PLGR front-end RF filtering needs to maintain good rejection for far out-of-band RFI components
  - This performance characteristic still needs to be verified
- Complex antenna impulse response may have unanticipated effect on RF front-end
- Axial mode gain response was even worse than normal mode response

Overall Conclusions

- Most waveforms show less impact than white noise
  - However, there are a few notable exceptions
- The comm-like waveforms generally have less impact than white noise but are not among the lowest impact waveforms tested
- For MAGR, C/A-code RFI behavior demonstrated much greater satellite to satellite variation than P-code behavior
- Rockwell Collins' testing results agree substantially with the Pax River results
- Comm study indicates that large UWB transmitter suppression factor is needed to prevent UWB interference to GPS and maintain reasonable UWB comm range
- Antenna study shows that the handheld unit does not provide much attenuation to far out-of-band interference components that are likely to exist in UWB signals