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WPAN-UWB Transmission Loss Measurements Around/Near A Soldier's Protective Vest*

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- **Transmission loss includes antenna gains**
- **Other propagation considerations:**
  - **Around-body/vest probably "creeping wave"**
  - **Stationary?**
  - **Dispersive?**
  - **Multipath delay spread?**
  - **Doppler spread (probably of no consequence)**

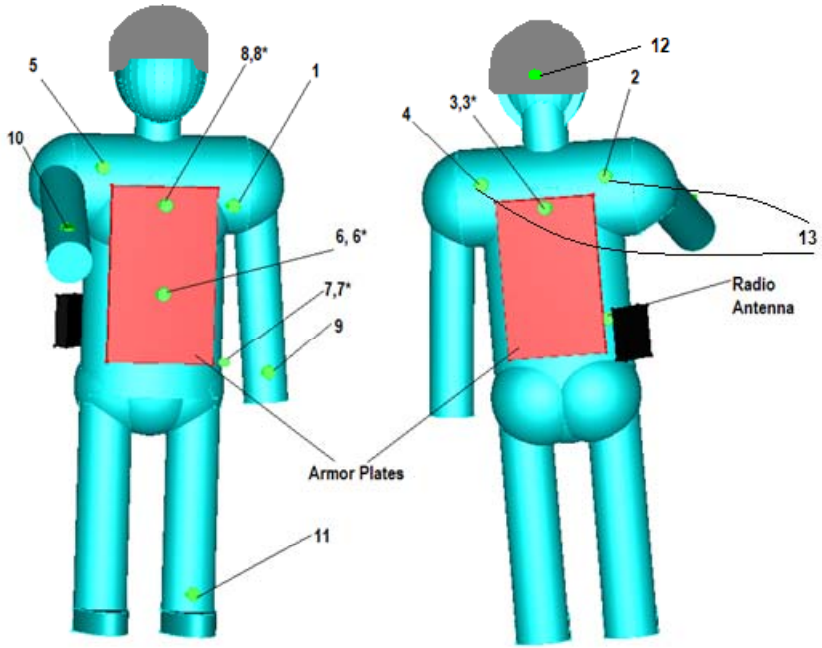
*** Sponsored by U. S. Army Natick Soldier RD&E Center**

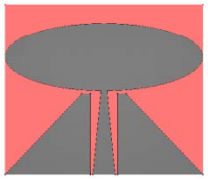
Validity of Narrowband Transmission Loss Measurements

- **Are narrowband measurements valid for UWB bandwidths?**
  - **Answer on page 585 of Pahlavan and Levesque***
  - **$P_{r\ UWB} = P_{r\ NB}\,[1/1-(W/2F_c)^2]$, where:**
    - **P_r = Received power**
    - **W = bandwidth**
    - **F_c = Center frequency**
    - **1.5 dB error for W = 7.5 GHz, F_c = 6.85 GHz**
- **Narrowband measurements reasonable**

* Pahlavan, K. and Levesque, A., "Wireless Information Networks," Wiley, 2005

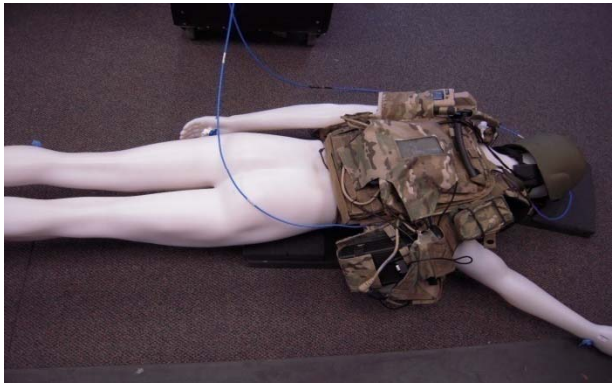
End-Points for Transmission Loss Measurements



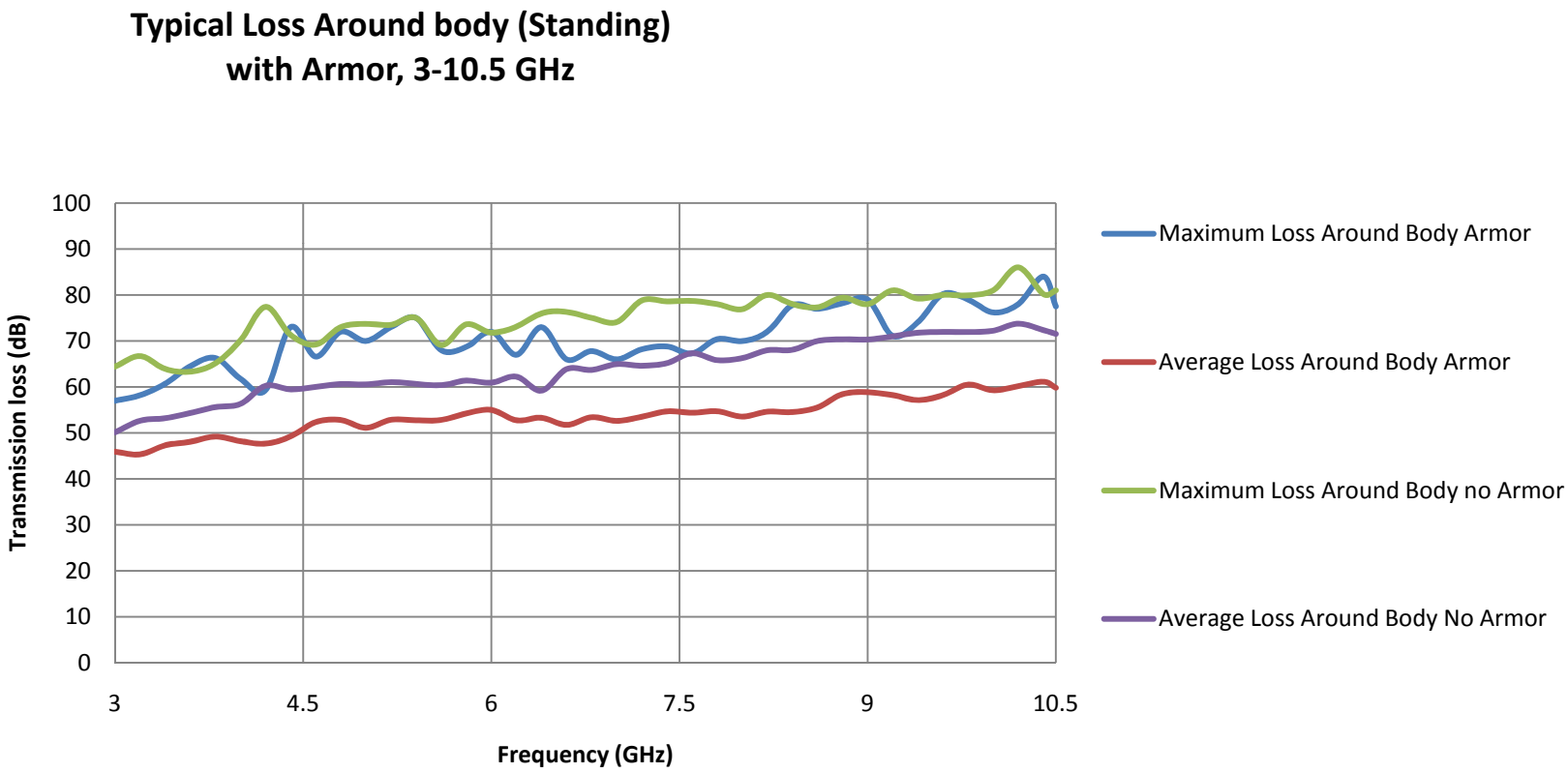


S21 Test Setup

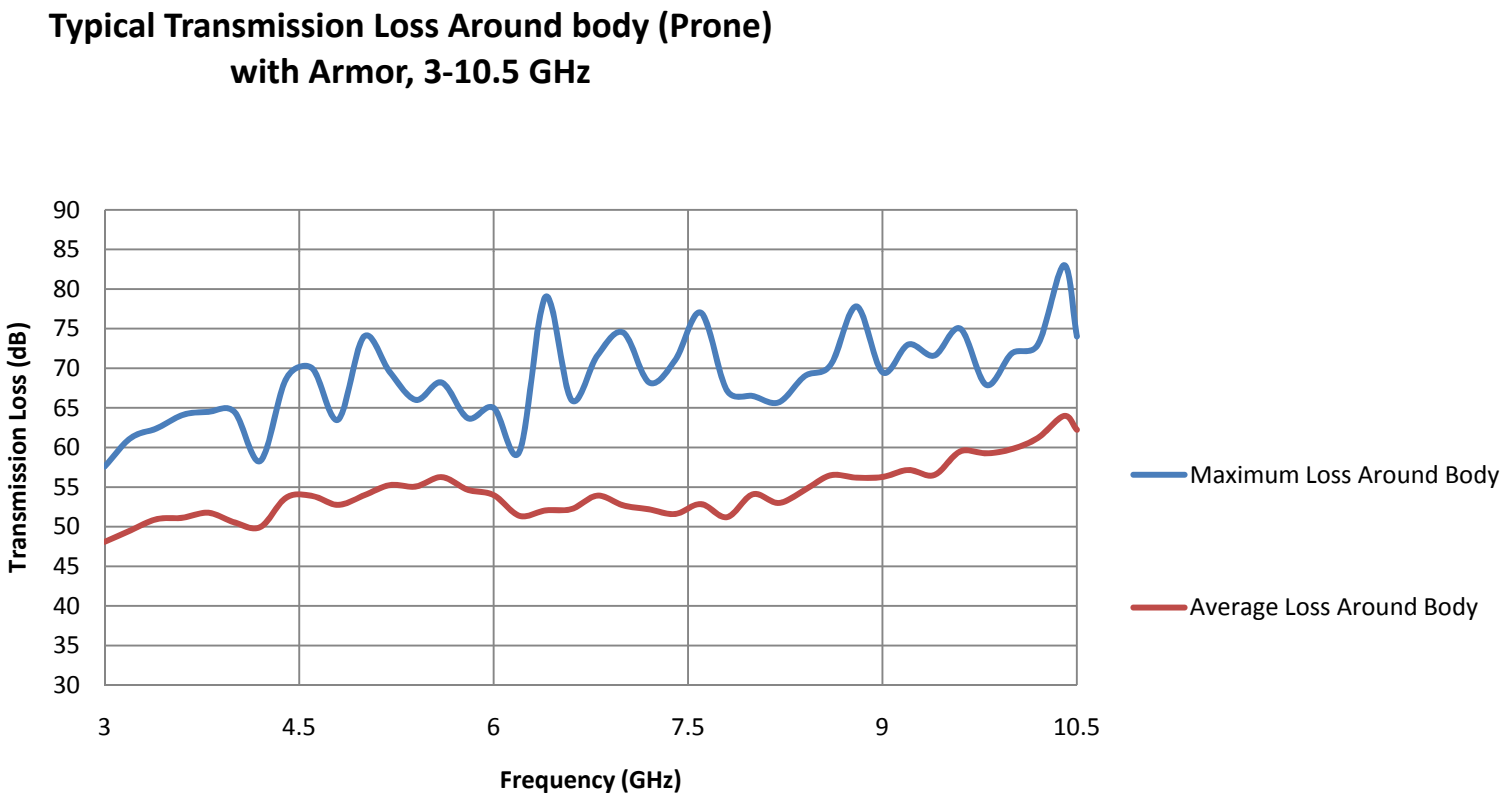
(Agar-gel filled phantom/protective vest/VNA)



Transmission Loss: Standing With/Without Protective Vest

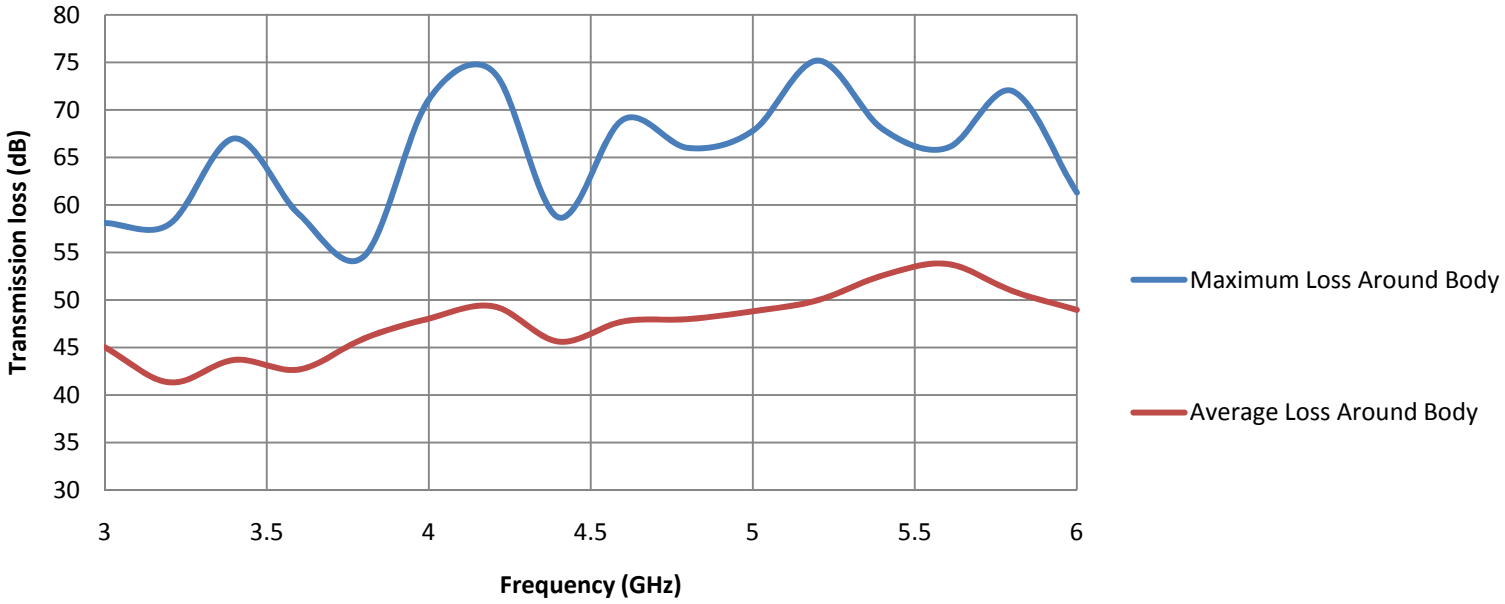


Transmission Loss: Prone



Transmission Loss: HMMWV

Typical Transmission Loss Around body (Sitting in HMMWV) with armor, 3-6 GHz



Transmission Loss: Conclusions

- ≈ 83 dB maximum measured loss
- Less loss with vest vs. nude agar-gel-filled phantom
- Little difference: standing-prone-sitting in HMMWV
- 100% connectivity with COTS UWB dongles between all end-points (some under armor)
- Narrow-band ≈ UWB except for delay spread, etc.
- Continuing measurement campaign:
  - Confirm MegaWave measurements
  - Opportunity to measure channel statistics
  - Will provide accurate and detailed information for system design