

**International Symposium on  
Advanced Radio  
Technologies (ISART) 2011**



*Information Sciences Institute*  
*Agent of Innovation: from visionary to viable*

**Contrasts in Spectrum Sharing  
Between Radar and Communications  
Band**

**Dr. Preston Marshall**

**Deputy Director, Information Sciences Institute  
Research Professor, Ming Hsieh Department of  
Electrical Engineering**

**University of Southern California**

**Viterbi School of Engineering**

**Marina Del Rey, CA and Arlington, VA**

**[pmarshall@isi.edu](mailto:pmarshall@isi.edu)**



- **Many Comparisons Between Communications and Radar Spectrum Sharing**
  - Largely Invalid due to Fundamental Differences in Compatibility
- **Will Discuss:**
  - Why Comparisons are Invalid
  - Resulting Research Needs



# Why Communications Band Sharing is Unique From Radar Band Sharing

- Fundamental Differences Between the Opportunity to Share Spectrum Between Users (or Why DARPA XG Program Focused on Comms for these Reasons):
  1. Radars are Typically Noise-Limited; Most Comms Have Accepted that they are Interference Limited Already
  2. Highly Directional Antennas Have Very Limited Bandwidth
    - *10-20% for Planar/Dish/Yagi*
      - *Whereas, Multiple Octaves for Omnidirectional Comm Antennas*
    - *Similar Constraints for Amplifiers*
  3. Long Lead time for Deployment -- Investment Driven;
    - *Decades to Modify Mix of Legacy Systems*
  4. Highly non-Symmetric Relationship of Comms and Radars
    - *Comms Can Address Impulsive Signals, but Radar Has Problems with Comm Signal Characteristics*
  5. Sensing Radar Signals Much More Complex than Typical Comm Signals

**More Enabling Research Is Precursor to Development of Effective Sharing**

## **1. Do Not Believe that non-Interfering Operation Viable Opportunity – Must Accept Possibility of Interaction**

- Develop & Validate Radar Waveforms that Are Optimized in the Presence of Various Categories of Comm Signals

## **2. Sensing of Radar Waveforms is Hard due to Integration Time of Sensing Poor Match for Radar Pulse Detection, and Many are LPD**

- May Have to Accept that “Out of Band” Mechanisms are Key -- Need Protocols to Integrate with Other Band Users Collaboratively

## **3. Use Less Spectrum**

- Expand Signal Processing Repertoire as Alternatives to Power and Bandwidth for Range/Resolution/ $P_D/P_{FA}$

## **4. Create Spectrum Alternatives for Dynamic Assignment**

- Broadband Antennas/Amplifiers

## **5. Radars Also are an “Easement” on Adjacent Bands due to Poor Performance of Amps & Front Ends**

- High Power Filters for Out of Band Emissions
- Low Power, Low Loss Filters to Reduce Susceptibility to Adjacent Band Emissions
- Tunable Filters to Allow For Dynamic Selection (Same as Comms)
- High Dynamic Range in Front Ends (no AGC in a Radar, and now (with Comms) in a Multi-tone Environment)

## **6. Specification Practices are Key to This Transition – It Will Not Happen if We Can not Procure it!**

- Learn How to Specify Interference Tolerance
- Make it so that it Shares ECM/ECCM margin, but Does not Add to these Stressing (Side Lobe Cancellation, Coding, ...)
- We Tend to Add Stressing Conditions – Need to Ensure that These Stresses do not Occur During Tactical Operation