Contrasts in Spectrum Sharing Between Radar and Communications Band

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The Problem

- 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