



R&D Panel Overview

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ITS



Radar Challenges/Constraints

- Radars can be much more powerful than many communication systems (making them a greater source of interference)
- Radars can be much more sensitive (dynamic range) than many communications systems (making them even more vulnerable to EMI, etc.)
- Airborne radars exacerbate the above given their panoramic view, long reach, and potential for direct line-of-sight (DLOS)
- Radars require relatively very long periods of useable spectrum. Some SAR radars require many seconds of uninterrupted spectrum availability.
- Current radars are highly restricted with regard to waveform selection (operating frequencies, waveforms with good ambiguity properties, etc. Not just any waveform will do!)
- Security constraints associated with military radars. (They can't simply "publish" their specs so others can design around them for example)
- Modern communication systems (especially commercial wireless) have very rapid development cycles (a couple years at most) compared with radar (decade(s)).
- AESA radars typically employ very narrowband antennas relative to communications, severely limiting their ability to change operating frequencies
- **The above implies that solutions adopted for communications, will likely not easily translate to radar in general**





Potential Technology Enablers

- Novel Radar Architectures:
 - Passive radar using signals of opportunity (cooperative or not) .
 - Bi/Multi-Static radar (transmitter can be separated from the receiver which if done correctly could alleviate spectrum crowding issues).
 - Cognitive radar, to include novel control architectures and computational intelligence. This includes “cooperative” architectures in which the radar and other systems communicate with each other.
 - Multi-function radars (combine the function of many disparate radars into a single integrated system, reducing the amount of spectrum required and its spatial footprint).
 - Combinations of the above



Potential Technology Enablers

- Novel Radar H/W:
 - Far more agile (e.g., “digital”) front-end H/W
 - Wide/Multi-band antennas
 - Greater spectral purity
- Novel Radar Signal Processing
 - Adaptive waveforms (channel adaptive) & MIMO
 - Compressive sensing and sparse signal reconstruction
 - Space-time-polarimetric coding

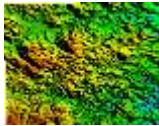
Cognitive Radar*

Knowledge-Aided Processing

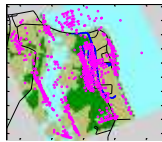
Cell Tower Locations



Terrain

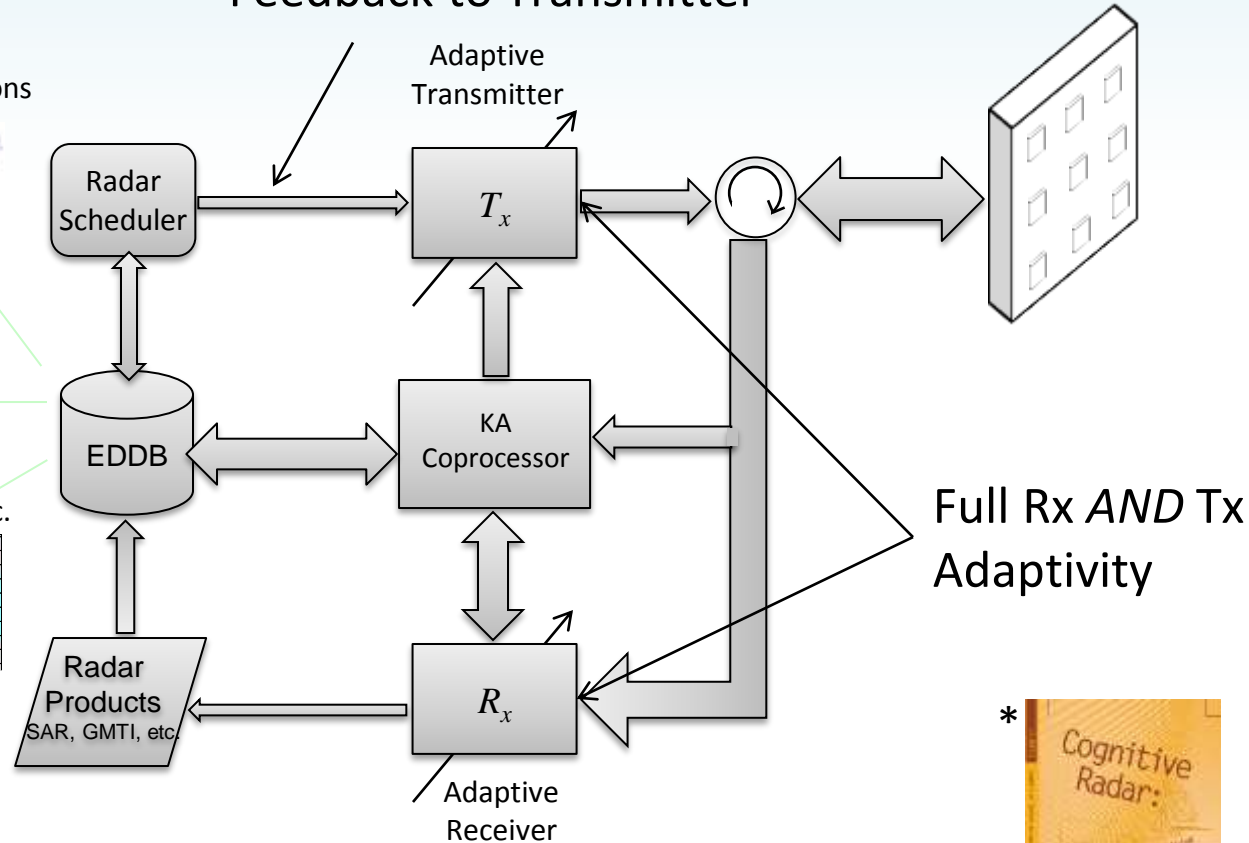


Tracker, etc.

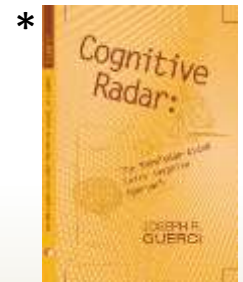


Both endogenous & exogenous sources

Feedback to Transmitter



Full Rx AND Tx Adaptivity





Cognitive Radar

- Attributes:
 - Unprecedented sophisticated adaptivity of both receive and transmit functions
 - Channel adaptive waveforms
 - Interactive channel estimation
 - Real-time access to, and exploitation of, heterogeneous databases, and functional models
 - Knowledge-aided and model based reasoning
 - Networked operation (cooperative operation)
 - Dynamic environmental database



Electronic Protection (EP) Umbrella?

- Suggest augmenting military radar EP requirements with spectrum sharing
 - Need for EP long established
 - Every mil radar has a funding line (more or less) for EP
 - Eliminates the need for creating an entirely “new” set of requirements
 - Next gen EP is much more adaptive and flexible
 - The most “politically” expedient approach



Summary

- Many radar-unique challenges and constraints relative to communication systems
 - Operating behavior and waveform constraints
 - Security constraints
 - Development/deployment timelines
- Promising technology developments
 - A number of promising H/W, S/W, and architectural solutions, but...
 - No silver bullet! Will require combinations of the above and possibly more.
 - Higher degree of collaborative design with international communications enterprise
- Put spectrum sharing under the EP “umbrella”?

