

Phased Array Radar Trade-Offs, Performance-Driven Specifications, and "Back-of-the-Envelope" Performance Estimation

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Tutorials Overview:

*These three tutorials (offered as two 45-minute modules per topic) provide a practical overview of fundamental radar design processes encountered in real-world applications. System design processes covered include performing: (i) key radar trade-offs, (ii) derivation of subsystem requirements, and (iii) predicting performance of candidate radar designs. **Radar Trade-Offs** covers some fundamental system trades such as operating frequency and waveform selection. **Performance-Driven Specifications** treats the process of requirements flow down to radar subsystems, such as transmitter power and antenna aperture definition. **"Back-of-the-Envelope" Performance Estimation** touches on approximate predictions of certain aspects of radar performance.*

Tutorial Descriptions:

***Radar Trade-Offs** consists of two 45-minute modules covering some of the common trade-offs necessary to design radars. These include operating frequency selection to enable typical radar functions (e.g., search, tracking, target identification), and operating in various environments (e.g., clear, clutter) and missions (e.g., early warning, air and missile defense). Approaches to waveform selection for these same cases are also described. These include trading off modulation types and use of single and multiple-pulse waveforms. Additional trades cover receiver operating characteristics (ROC), search design, and tracking architecture selection.*

***Performance-Driven Specifications** consists of two 45-minute modules which treat defining requirements necessary to specify radar subsystem functions and performance. First, radar range equation-driven requirements for parameters such as peak transmitter power, transmit and receive antenna gains, and noise figure, etc., are covered. Next, requirements driven by operating in clear, clutter, and interference-limited environments are described. Waveform-driven aspects of system design such as A/D sampling rate and matched filter requirements are also described, as well as those driven by necessary*

clutter and interference cancellation including amplitude and phase errors, channel-to-channel mismatch, and phase noise specifications.

"Back-of-the-Envelope" Performance Estimation consists of two 45-minute modules which describe "back-of-the-envelope" performance predictions necessary to support initial assessment of candidate radar designs. Areas covered include estimation of system-level performance metrics such as detection, tracking, interference mitigation, and clutter cancellation. In addition, assessment of the performance of certain radar subsystems is also treated. Aspects covered include predicted range (time) sidelobes as a function of antenna and receiver errors and estimated interference cancellation as limited by channel-to-channel mismatch and passband ripple.

Instructor: Tom Jeffrey



Tom Jeffrey is a Senior Engineering Fellow at Raytheon Integrated Defense Systems (IDS). He has over thirty years of broad experience in radar systems engineering covering all phases of design and development, including the development of initial concepts, system-level requirements, radar architectures, hardware and software subsystem requirements, and detailed signal and data processing algorithms. Tom has led systems engineering teams, developed systems engineering training and serves as a mentor to systems engineers at Raytheon.

He is currently system architect for the Air Force Space Fence system, was previously system architect for the Cobra Judy Replacement (CJR) radar program, and has consulted on various missile defense radars for both terminal and forward-based ballistic missile defense systems. Tom was Technical Director for the Navy High Power Discrimination (HPD) radar, a shipboard X-band TBM defense radar. Earlier, Tom was responsible for the initial allocation of mission and system requirements to hardware and software sub-systems for several missile defense radars, including those for tactical and strategic applications that evolved into today's THAAD and SBX radars.

Tom teaches several radar-related courses at Raytheon on intermediate and advanced radar, adaptive processing, architecting methods, including the Systems Engineering Technical Development Program

(SEtdp) that trains prospective chief engineers and technical directors. He is a Senior Member of the IEEE and a member of INCOSE. Tom has authored more than a dozen papers on various radar-related topics and the recent book "Phased Array Radar Design – Application of Radar Fundamentals" published by SciTech. He received his BSEE from the University of Connecticut and the MSEE from Syracuse University. His hobbies include playing and collecting guitars, writing songs, hiking, bicycling, and running. Tom lives in Sudbury, MA.