

## ***Implementation and Application of PHD/CPHD Filters***

### **PRESENTER:**

Ronald Mahler, Lockheed Martin MS2 Tactical Systems, ronald.p.mahler@lmco.com

### **ABSTRACT:**

In recent years the Probability Hypothesis Density (PHD) filter and its generalization, the Cardinalized PHD (CPHD) filter, have received increasing international attention. In part this is due to the fact that these filters (1) are of linear complexity in the number of targets, (2) estimate target number directly from the measurements even in the presence of significant background clutter and/or closely spaced targets, (3) entirely avoid traditional measurement-to-track association, and (4) are extremely fast and simple when implemented using Gaussian mixture techniques.

This tutorial will be based on Chapter 16 of the book *Statistical Multisource-Multitarget Information Fusion*. It will address the following areas: (1) introduction to finite-set statistics (FISST); (2) introduction to the PHD/CPHD filters; (3) particle-system implementations of the PHD/CPHD filters; (4) Gaussian-mixture implementations of the PHD/CPHD filters; (5) representative applications of the PHD/CPHD filters; and (6) future R&D issues. Item (6) will include a discussion of the possibility of PHD/CPHD filters for "nonstandard" multitarget measurement models.

### **Bio:**

Since 1991 Dr. Mahler's research has been focused on data fusion, expert systems, multitarget tracking, sensor management, nonlinear filtering, random set theory, and conditional event algebra. Since 1994 his primary work has been based on "finite-set statistics," a mathematically rigorous random set-based extension of ordinary statistics to multitarget, multisensor problems. He has applied this theory to develop a unified, probabilistic approach to data fusion, and has transitioned this work into a number of DoD applied R&D projects. This work includes a unified expert-systems theory, and a fundamentally new paradigm for multitarget detection and tracking called the "PHD/CPHD filter." His research is being pursued by other research teams in several nations, including Australia, Britain, Canada, Finland, Germany, Italy, Spain, and the U.S. The Swedish Defence Research Agency (FOI) has mounted a serious effort.

Since 1995 he has authored five dozen papers, two books, and one monograph in such subjects, including ten journal papers. His latest book is *Statistical Multisource-Multitarget Information Fusion*, published by Artech House Publishers in March 2007. He was principal organizer, co-chair, and proceedings co-editor (Springer-Verlag 1997) for an Aug. 1996 scientific workshop on random sets, jointly sponsored by ONR, USARO, and LMTS. He has been invited to serve on technology planning workshops for AFRL/IF, BMDO/POET, SPAWAR SSC, and for the Electronics Division of the Army Research Office, and as a reviewer of the DARPA Dynamic Data Base (DDB) project.

He has been invited to speak at many conferences, universities, and DoD labs, including Harvard, Johns Hopkins, the University of Massachusetts (Amherst), the USAF Institute of Technology, SPAWAR Systems Center, the USAF Correlation and Tracking Symposium, the IEEE Conference on Decision and Control, the SPIE AeroSense Conference, and the National Symposium on Sensor and Data Fusion.

In particular, he has given an invited two-day tutorial in February 2002 at the International Conference on Information, Decision, and Control (Adelaide, Australia); a half-day invited tutorial at the 2002 International Conference on Information Fusion (Annapolis); a one-hour invited tutorial at the IEEE Workshop on Multitarget Tracking (Madison WI); an invited tutorial in the Jan. 2004 IEEE Aerospace and Electronic Systems Magazine; and a plenary keynote presentation at the 2004 International Conference on Information Fusion (Stockholm).