

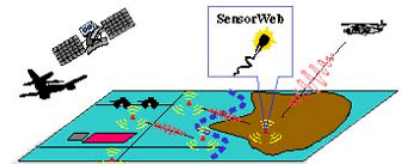
SensorWeb

Data Fusion in Large Arrays of Microsensors

MURI Review Meeting
Introduction/Overview

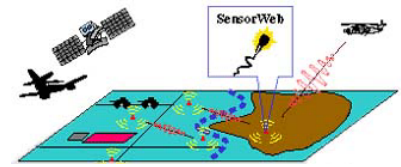
Alan S. Willsky

June 14, 2002



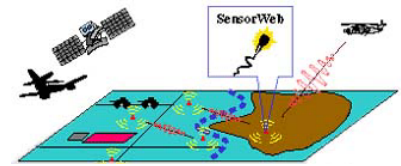
The Day's Agenda

- Introduction/Overview
- Research Presentations
- Summary



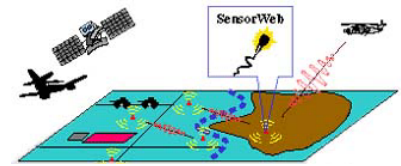
Introduction/Overview Outline

- Setting the stage: Intellectual themes and research concentration areas
- Facts, Statistics, and Such
- What we have heard from the EAB/TAC
- Outline of remaining presentations and how they fit



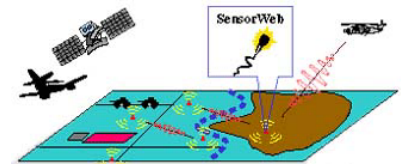
Intellectual Themes

- IT-1: Consistent (or manageably inconsistent) fusion of networked, myopic sensors
- IT-2: Fusion of heterogeneous sensors in unstructured and uncertain environments
- IT-3: Wireless networks, network communication and information theory



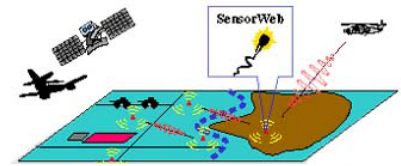
Research Concentration Areas

- RCA-1: (Self-)Calibration
- RCA-2&3: Fundamental limits on fusion, network information theory, tradeoffs in local vs global processing
- RCA-4: Bounds & characteristics of algorithms to ID minimum resources needed to detect, estimate, track...
- RCA-5: Fusion Algorithms
- RCA-6: Distributed Algorithms with guarantees on global behavior (both positive & negative!)
- RCA-7: Create events/data for experiments and demos



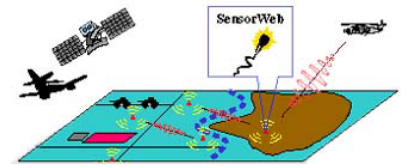
Facts, Statistics, and Such - I

- Funding and Timing
 - Kickoff meeting: 7/17/00, Official start date of 8/1/00
 - Real start date for MIT: 9/1/00
 - Real start date for Princeton/Illinois: Somewhat later
 - Currently we are officially 22 months into this program



Facts, Statistics, and Such - II

- Principal Faculty: Mitter, Willsky, Jaakkola (MIT); Kulkarni, Verdu (Princeton); Kumar (Illinois)
 - Other Faculty: Tsitsiklis, Chandrakasan, Gallager, Grimson, Staelin, Chan, Darrell (MIT)
 - Post-docs, Research Scientists, and Visitors: Cetin, Fisher, Siegelmann, Rabi, Wainwright (MIT); Xie (Illinois)
 - Graduate Students:
 - **Wainwright, Sudderth, Johnson, Tucker, Ihler, Chen, Malioutov, Corduneanu, Bazzi, Chu, Szummer, Fu (MIT)**
 - **Gupta, Giridhar, Baliga, Huang, Narayanaswamy, Plarra, Kawadia, Sreenivas, Rozovsky, Xue (Illinois)**
 - **Reznik, Cai, Wang, Visweswariah, Radke, Sandilya, Predd, Son (Princeton)**



Facts, Statistics, and Such - III

- The Website: <http://sensorweb.mit.edu>

sensorweb.mit.edu -- ARO MURI on Data Fusion in Large Arrays of Microsensors

Page 1 of 1

SensorWeb: ARO MURI on data fusion in large arrays of microsensors

WWW: <http://sensorweb.mit.edu>
 email: sensorweb@mit.edu

Massachusetts Institute of Technology
 University of Illinois
 Princeton University

[Home](#) **Welcome! This site contains information** on the SensorWeb Multidisciplinary Research Program of the University Research Initiative focused on data fusion for large arrays of microsensors.

[About Us](#)

[Research](#)

- [MURI Principal Researchers and Co-investigators](#)
- [MURI Graduate and Post-doctoral Researchers](#)
- [MURI Affiliated Organizations](#)
- [Sponsor Information](#)

[Publications](#)

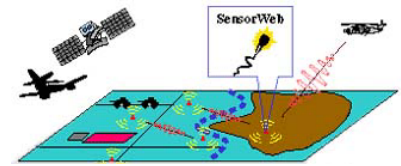
[Events/Highlights](#)

[Resources](#) This Multidisciplinary University Research Initiative was established in 2000 with the goal of providing the intellectual foundations for distributed data and information fusion

[Search](#) among large arrays of microsensors. We are supported by the Department of Defense MURI program through the Army Research Office. The MURI involves 3 universities

[Private](#) and numerous researchers and students. We welcome contacts and inquiries.

Questions and comments to the [webmaster](#). This page is copyrighted by the Massachusetts Institute of Technology and dynamically generated on Monday April 16, 2001.



Facts, Statistics, and Such - IV

Publications

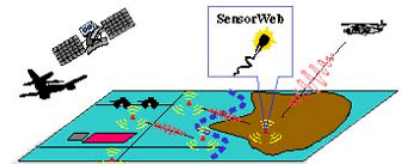
- List in 6/1/02 report lists 82 publications
 - Including invited journal papers by Kumar, Willsky, and by Fisher, et al.)

■ Presentations

- Numerous internal and external talks (see 6/1/02 report and website)
- Significant set of invited, plenary, and keynote talks
- Participation in Battlefield Acoustics and Army Statistics meetings

■ Significant research results in all aspects of our intellectual agenda

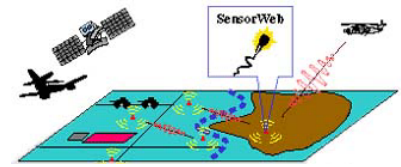
- See 6/1/02 report, talks to follow, summary at the end, website



Facts, Statistics, and Such - V

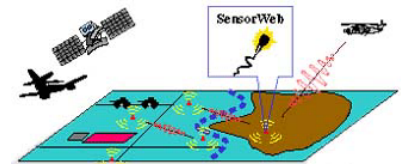
- Industrial and DoD Interactions
 - With PARC (formerly Xerox PARC)
 - Extended visits, Joint Paper, Transition and Experimental Demo within SensIT program
 - With ALPHATECH
 - Transition of network-constrained and information-theoretic fusion methods to several programs (Raptor, DARPA DTT program (with SenTech), DARPA ISP Program....)
 - With Lincoln
 - Seminars at MIT and Lincoln, Continuing interaction with Dr. Michael Zatman, Dr. Gary Shaw, Mr. Peter Boettcher
 - With Draper
 - Participation in workshop on distributed robotics

FSS-VI: Industrial and DoD Interactions (continued)



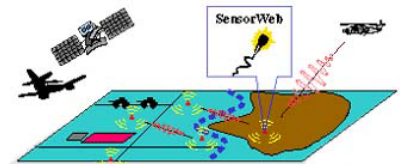
- With Lucent Bell Labs
 - Interactions with Drs. Tom Marzetta and Piyush Gupta
- With BAE
 - Initiation of interactions with two CTA's (with Dr. Mark Falco and Dr. Rachel Learned)
- With ARL
 - Initiation of interactions with Drs. Brian Sadler and Ananthram Swami
 - Interaction/collaboration with Dr. Randy Moses (working under CTA with Dr. Nino Srour)

FSS-VII: Industrial and DoD Interactions (continued)



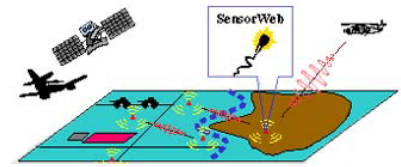
- With SensIT
 - Dr. Fisher's invited talk at SensIT meeting
 - Fisher, et al., invited paper in special issue of IJHPCA edited by Dr. Sri Kumar
 - Transition and successful experimentation in SensIT program (through PARC) of Chu/Mitter research
- With ARO/Army
 - Prof. Kumar serving as panel member at Strategic Planning and Program Review meetings
 - Dr. Wainwright's upcoming presentation at the Army Statistics Meeting (invited by Dr. Wendy Martinez of ONR)

FSS-VIII: Industrial and DoD Interactions (continued)

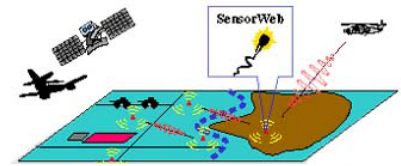


- Prof. Willsky's DoD Activities
 - Air Force
 - Member SAB
 - AFRL/IF and SN S&T Reviews
 - Member, Information Integration Panel for the 2002 AF/SAB Study on Predictive Battlespace Awareness
 - Participant AFOSR-AFRL/IF Strategic Investment Workshop
 - Visits to/Meetings with:
 - AFRL
 - AC2ISRC
 - Blue Flag (Barksdale AFB)
 - C2TIG (Hurlburt AFB)
 - ESC (Hanscom AFB)

FSS-IX: Industrial and DoD Interactions (continued)



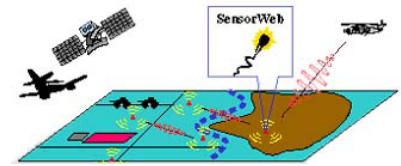
- Prof. Willsky's wanderings (cont.)
 - DARPA
 - Next-generation ATR Workshop (invited participant)
 - DARPA-IXO, IAO, DSO
 - Navy
 - NWDC
 - SPAWAR Systems Center
 - Discussions of Expeditionary Sensor Grid
 - Army
 - Ft. Huachuca (USA Battle Command Battlelab)
 - Ft. Leavenworth (IPB, Army Lessons Learned,...)
 - Boeing (FCS)



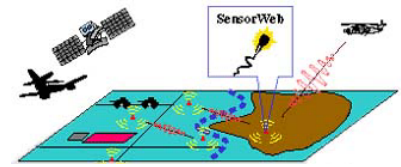
Facts, Statistics, and Such - X

- Academic Interactions
 - Berkeley/Stanford MURI on Decision-Making...
 - Post-doctoral position of Dr. S. Tatikonda
 - Visits by and upcoming postdoctoral position for Mr. Martin Wainwright
 - Interactions thru Alphatech
 - Extended visit by Prof. Verdu
 - Visits/talks at MIT by Dr. Tatikonda, Profs. Jordan, El-Ghaoui, and Ramchandran

FSS-XI: Academic Interactions (continued)



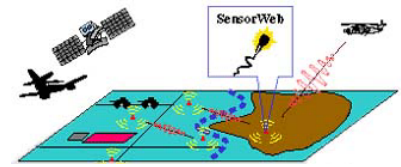
- MURI on Battlefield Visualization
 - Interaction with Prof. Pramod Varshney, initiated by visits to MIT and Princeton
- Ohio State University
 - Collaboration with Prof. Randy Moses, through his work on Sensors CTA
 - Visit/talk by Prof. Moses at MIT
 - Planned extended visit at MIT in 2002-3
 - Collaboration on our IT-2 research
 - Utilization of our network-constrained estimation algorithms in Prof. Moses' work



Facts, Statistics, and Such - XII

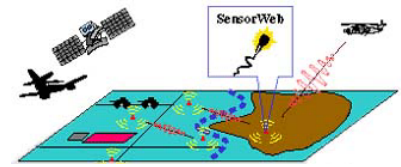
- Other internal activities
 - Regular visits among participants
 - Yearly coordination meeting
 - Multi-university/disciplinary thesis committees
 - Numerous colloquia and seminars
 - Development/offering of two full-semester seminar courses during the 2001-2 AY
 - Graphical models, large deviations,...
 - Network information theory

What we have heard from the EAB/TAC - I



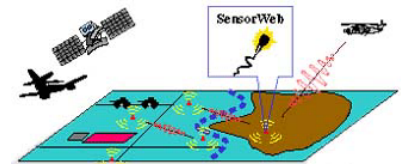
- Standing Questions
 - Time spent on the project
 - We are maintaining/exceeding levels anticipated (Mitter 4 mo., Willsky 3 mo., Kulkarni 2/3 mo., Kumar 2/3 mo., Jaakkola 2/3 mo., Verdu 2/3 mo.)
 - Cost-sharing
 - Substantial for faculty (Schools pay almost all AY time)
 - Even greater for students (**More** than twice as many students involved as are receiving direct support)
 - Plans for handling real data, for demos and/or paths to implementation

What we heard from the EAB/TAC - II

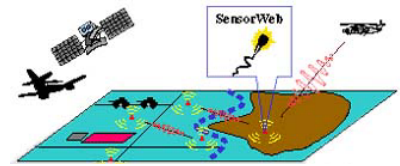


- At the Kickoff Meeting 7/00
 - Integration of individual efforts into the MURI identifying how the MURI research program addresses the Research Concentration Areas
 - Plans for demonstrations, benchmarks, experiments, “early successes,” and transitions
 - Already have had some transitions, SensIT experiments, and other internal experiments and collections of real data
 - Numerous additional opportunities

What we heard from the EAB/TAC - III

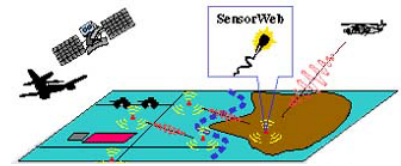


- At the First-Year Review 6/01
 - Positive feedback
 - On technical quality of work
 - On our responsiveness to EAB/TAC feedback
 - List of additional things for us to take under consideration in shaping our research agenda and activities



The List

- Work with other programs (e.g., SensIT, CTA's) and DoD activities
- Correspondence/Data association problems, especially in the context of communication and computation constraints, are of interest
- Make sure to consider the physical layer
 - Power constraints (not just for comms)
 - Make sure work is relevant to myopic sensors
 - Consider more work on RCA-1
 - Account for degradation in acoustic coherence with distance
- Consider mobile sensors and dynamic networks



A Unified View of Our Agenda

IT-2:

Who are we?

Why are we here?

Where's here?

(Cetin, Fisher, Kulkarni)

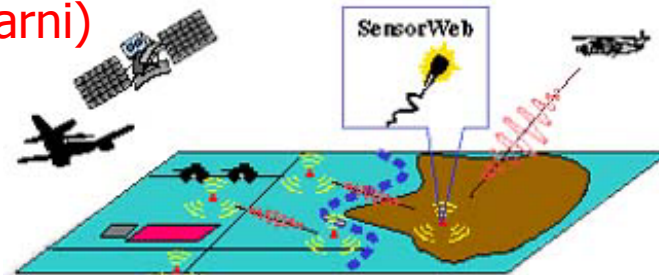
IT-1:

Who do I want to speak to?

What do I want to say?

How do I take what he just told me?

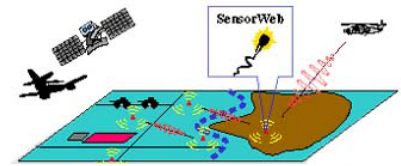
(Willsky, Jaakkola, Mitter/Chu)



IT-3:

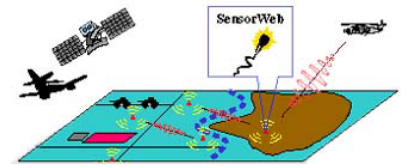
What do you mean deposit another quarter or I'll be disconnected?

(Kumar, Verdu)



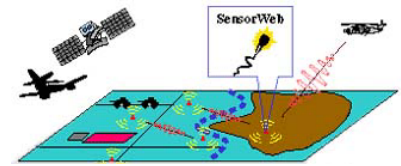
Agenda - I

- 8:15 – 9:00 **Lavery, Willsky:** *Welcome/Overview*
- 9:00 – 9:35 **Kumar:** *Scalability and Information Theory for Networks with Large Numbers of Nodes*
 - IT-3, RCA-2&3
- 9:35 – 10:10 **Willsky:** *Network-Constrained Estimation*
 - IT-1, RCA-4,5,6 (also ties to RCA-2&3)
- 10:10 – 10:45 **Fisher:** *Data Association for Heterogeneous Sensors in Nonlinear and Dispersive Media*
 - IT-2, RCA-1,5



Agenda - II

- 10:45 – 11:20 **Kulkarni**: *Estimating Entropy and Divergence of Sensor Data*
 - IT-2, RCA-5
- 11:20 – 1:00 *Lunch*
- 1:00 – 1:35 **Cetin**: *Optimization-based Approach to Source Localization and Self-Calibration in Distributed Arrays*
 - IT-2, RCA-1 (also ties to RCA-4)
- 1:35 – 2:10 **Jaakkola**: *Stability and Resource Allocation*
 - IT-1, RCA-4,5,6



Agenda - III

- 2:10 – 2:45 **Verdu**: *Optimal Signaling Strategies in Low-Power Networks*
 - IT-2, RCA-2&3
- 2:45 – 3:00 **Break**
- 3:00 – 3:35 **Mitter/Chu**: *Distributed Algorithms for Estimation Tasks in Sensor Networks*
 - IT-1, RCA-4,5,6
- 3:35 – 4:00 **Willsky**: *Summary*
- 4:00 – 5:00 *Government Caucus*
- 5:00 – 5:30 *Preliminary Debrief*