Engineering of Sensor Network Structure for Dependable Fusion MURI

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Objective:

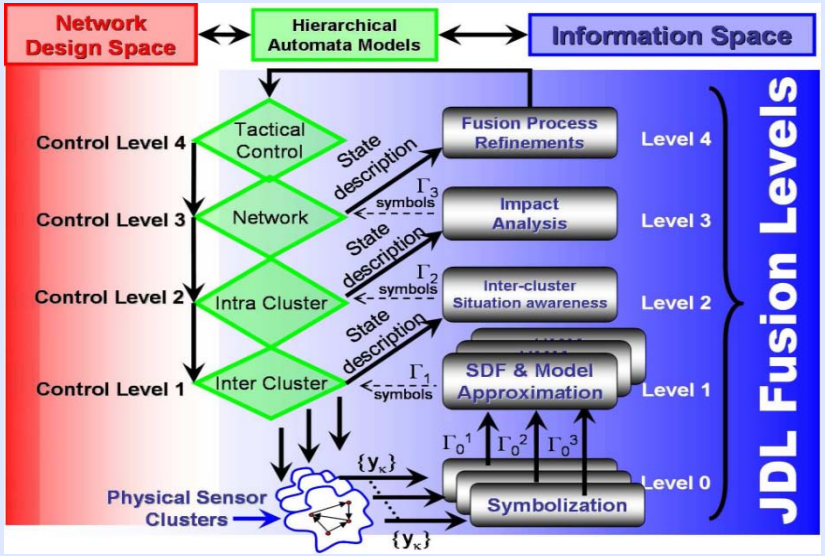
- To develop theoretical foundations and validation to address: (i) proliferation of multi-source sensor data due to DoD's tactical shift to network-centric warfare, (ii) urban area monitoring demands of the Global War on Terror, and (iii) collaboration needs of Future Combat System platforms. The emphasis is on network science & engineering, which enable dynamic construction of sensor networks to support dependable information fusion.

Approach:

- Analytic modeling of sensor networks.
  - Information & Network space modeling.
  - Network adaptation under network structural properties constraints.
- Multi-modal sensor data fusion with composite symbolic data patterns
- Dynamic network control
  - Placement, Coverage, Topology control, Power control, Scheduling & Capacity control
  - Cluster Capacity & Spectral Utilization

Technical Success:

- Designed the InfoNet protocol that delivers control commands for network adaptation
- Defined a new sensor data fusion paradigm in which the sensor network topology is reconfigured to meet evolving fusion needs
- Designed a sensor placement algorithm for polygonal spaces using computational geometry framework



Information, Modeling, and Network Control Hierarchies

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Application / Outcome:

- Total 55 refereed journal and conference publications
- Four patent disclosures
- Collaboration with ARL/SEDD and AFRL with joint publications
- Awards: 2009 IEEE Leon Kirchmeyer Award, eight best paper awards, two chair professorship honors, and three distinguished invited presentations

Payoff:

- Scientific knowledge and methods for objective-driven data fusion for networked operations
- Support of 11 professors, 14 graduate students and post docs
- Fostered collaboration between academia, industry and DoD laboratories with results

Follow on successes:

- Extensible Semantics Based Service Oriented Architecture, funded by Lockheed Martin
- Language-measure-theoretic Multi-objective Optimization for Distributed Control of Tactical Military Missions, funded by ONR
- Networked Sensor Fusion in Safety/Security Critical Tasks and Integration of Cooperative Mobile Robots, funded by Natural Science and Engineering Research Council of Canada

Remaining technology gaps:

- Multi-agent co-prediction (joint distribution) of causal state
- Collaborative statistical learning
- Environmental modeling
- Upper layer command and control