

# Tutorial proposal for Fusion 2008 conference: Introduction to distributed fusion

## ***Basic information***

**Title:** Introduction to distributed fusion

**Presenter:** Pontus Svenson, ponsve@foi.se, Martin Holmberg, mah@foi.se, Swedish Defence Research Agency

**Duration:** half day

**Keywords:** distributed fusion, sensornetworks, non-hierarchical information processing, semantic technology

**Objective:** After the tutorial session, the attendees should be knowledgeable about the basic issues and problems surrounding distributed multi-sensor and information fusion. In particular, the difference and similarities between distributed multi-sensor data fusion and distributed high-level information fusion should be clear to the attendees.

## ***Abstract***

Distributed fusion is one of the most important (and difficult) problems in current fusion research. Distributed fusion deals with fusing the results of fusion nodes, and hence it is very important to avoid double-counting outputs from sensors: the so-called data incest problem must be avoided. In current and future military operations, one of the most important sensors used will be humans, so it is important to consider also human sensors. At a low fusion level, data from a network of sensors can be fused to form a representation of the environment based on data from the whole network. This type of network has attracted considerable attention in the last few years due to the number of applications that can be conceived. Examples include surveillance for military and civilian security applications, environment monitoring, and process monitoring. The challenges of sensor networks from a data fusion point of view include not only regular fusion processes. Also the fact that association, data storage/retrieval, time stamping, etc become more difficult in a distributed network is of uttermost importance, especially when combined with the fact that a limited power supply will reduce the possibility to send data. Some of these challenges have been addressed, while others are still more or less unexplored.

Distributed fusion is also important in higher-level information fusion. Here, the information which we wish to fuse often does not come from sensors or fusion nodes, but has rather been input by humans. This input could take the form of reports entered by soldiers or could be results from intelligence analysis by skilled operators. Semantic technology, as used, for example, in the semantic web, provides some interesting new opportunities for dealing with such information. By using text clustering and text mining together with traditional fusion methods, it is possible to fuse textual information and help users attain a higher degree of situational awareness.

We believe that the combination of both low and high level distributed fusion in the same tutorial will give additional benefits to the attendees. Solutions presented for either level

could be adapted to the other, and knowing about the problems and solutions for one of the levels could lead to new insights on how to tackle the problems in the other.

### ***Detailed outline:***

Relevant past tutorials at Fusion conferences: There have been tutorials on Distributed Robotic Sensor Systems and Decentralized Coordination of Autonomous Sensor Systems at the last two fusion conference. These tutorials, however, do not take the comprehensive view of distributed fusion that will be covered in this tutorial. In particular, they do not deal with higher-level fusion or human sensors.

This topic is of interest to Fusion 2008 attendees because it will enable them to see connections between low and high-level fusion. The tutorial will enable attendees to use semantic techniques for distributed information processing at a high level, and to make design choices for low level distributed fusion!

Some important aspects of distributed fusion are:

1. Can distributed fusion give as accurate results as centralised fusion?
2. Can partial situational pictures from different fusion nodes be fused in order to find attempts to mislead the command and control system?
3. How can the data incest problem be solved?
4. How can situational pictures from geographically distant fusion nodes be fused?
5. In a distributed environment, how can the user be presented with information on which sources that have been used to produce the fused result?
6. Should results obtained from distributed fusion be presented differently to the user than results from centralised fusion in order to increase the interpretability for the user?
7. How can textual information (from soldiers, HUMINT or the web) be fused?

Note that due to time constraints, it will not be possible to go into detail on all of the issues raised above.

### **Tentative outline of course:**

Introduction to fusion. Basic overview of JDL model and fusion. Why fusion?

Uncertainty and how to handle it.

Sensor networks. Sensors used, issues when fusing information, relation to communication issues. Fusion architectures. Data incest problems, Demonstration.

Introduction to high-level information fusion. Knowledge base development/knowledge support. Non-map-based situation pictures. Non-hierarchical information sharing and processing. Using semantic techniques to enable non-hierarchical information sharing and processing. Tentative results from user experiments on non-hierarchical information sharing using semantic MilWiki and text analysis.

### ***Presenter biographies***

Dr Pontus Svenson is a senior scientist and information fusion research manager at the Swedish Defence Research Agency (FOI). His research interests include social network analysis, data and text mining, random sets, situation and threat assessment, and information operations. He currently leads research that aims at providing situation and impact assessment tools to the future Swedish battle groups. He has a PhD in theoretical physics from Chalmers University of Technology, where he has also taught on the undergraduate and graduate levels. He lectures regularly on information fusion and decision support systems at the Swedish National Defence College and has been guest-lecturer for the past three years in the information fusion course given at University of Skövde. At the 2006 ELSNET summer school on Information fusion for natural language processing, he gave a course on Information fusion. During the Fusion 2007 conference, he presented a tutorial on social network analysis. He is the author or co-author of more than 30 papers and unclassified technical reports on information fusion.

Prof. Martin Holmberg is Research Director at FOI and adjunct Professor at Linköping University. His main research interests are in data fusion and sensor networks, where he is responsible for a research group at FOI. He is also the director of a recently started graduate school in Security research and Crisis management. He has many years experience of teaching at undergraduate and graduate level at Linköping University and the Swedish National Defence College. He has published some 50 articles and conference presentations, and also written three book chapters.