Some Remarks on Ontology and Information Fusion

Dr. James Llinas
Research Professor, Director (Emeritus)
Center for Multisource Information Fusion
University at Buffalo and CUBRC
llinas@buffalo.edu
Roles for Ontologies in IF Processes/Systems

- Reasonably **reliable a priori Declarative Knowledge** about some domain
  - In the face of domains for which reliable a priori Procedural (dynamic) Knowledge is hard to specify
    - “Weak Knowledge” problems

- As such, they provide a framework that **connects** Entities and Relationships
  - Of fundamental concern for COIN, Ctr-Terrorism, Irregular Warfare re social structures and militarily-significant entity relations

- The **basic construct** of a “Situation” or a “Threat” and thus Level 2, 3 Fusion estimation
Complexities in Distributed and Networked Systems

• In modern Distributed/Networked Systems there are No single points of authority: These systems are collages of Legacy systems—Joint/Multiservice systems—Coalition systems

• Nodal Ontologies for Fusion/Situational Estimation, and Communication-support Ontologies for Inter-Nodal Communications/Data-sharing (eg JC3IEDM)

• Harmonizing NLP Operations and Ontologies within and across such systems

• The issue of Uncertainty in Ontological specification:
  – Probabilistic and Non-Probabilistic Ontologies

• Is there an Inescapable need for Semantic Mediation?
  – Mediator systems well-studied and developed*

• Eg Gio Wiederhold (June 1, 1993). "Intelligent integration of information". ACM SIGMOD Record 22 (2) (This was a major DARPA program)
Semantic Complexity

• **Controlling** Semantic Proliferation/Complexity:
  – Ontologies
  – Controlled Languages
    • Eg Battle Management Language

• **Understanding** complexity drivers in text

• **Measuring** Semantic Complexity
The Association Problem

• The Ontologically-specified World is controllable—the Real Data World is not

• While Ontologies can help in Fusion-based estimation and inferencing problems, the mechanics of exploitation will involve the **associability of Real (uncontrolled) data to (controlled) Entities and Relations** in the Ontologies
  – Semantic similarity, metrics, degree (“hops”), etc
  – Efficient algorithms—eg Cloud implementations
  – PhD-level research

• There is also the issue of “Coverage”—in poorly-understood/known problems, **how does one specify an Ontology that has “adequate” coverage?**
  – Issue of negative information
Summary

• Ontologies **have a useful role** in the design and development of Information Fusion systems

• Questions regarding issues of:
  – **Authoritative control** of semantics in distributed systems
    • Acceptable, optimal methods for mediation
  – **Complexity of semantics**
    • Understanding, measuring, controlling
  – **Association of semantic terms** and complex, high-dimensional semantic structures

• Seem to require further, continuing study to better define best ways to employ ontological information in complex, distributed, large-scale Information Fusion systems and applications