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Can Semantic Web techniques empower comprehension and projection in Cyber Situational Awareness?

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"Situation awareness is the *perception* of elements in the environment within a volume of time and space, the *comprehension* of their meaning, and the *projection* of their status in the near future." [3] Endsley's model of SA involves three levels: (1) perception, an awareness of situational elements such as objects and events; (2) comprehension, an understanding of the meaning of situational elements; and (3) projection, an awareness of the future evolution of the situation. Situation awareness, additionally described as Level 2 of the JDL Data Fusion Model, is an essential step towards the safe-guarding of a cyber-infrastructure. To turn this vision into reality, two essential tools are needed: a formal theory of computational SA and a capable implementation framework. Complementing a theoretical basis for a unifying formal theory of computational SA such as one provided by Endsley's model, we believe the Semantic Web provides an ideal implementation infrastructure.

The Semantic Web is an evolving extension of the World Wide Web in which content can be expressed in a format that can be more easily understood and processed by machines, thus enabling the discovery, automation, integration, and reuse of knowledge on a global scale. Semantic Web, with its expressive knowledge representation languages and rapidly maturing standards based technologies can significantly enhance the capabilities associated with three levels of SA.

Level 1, perception, involves an awareness of situational elements such as objects and events through monitoring and entity identification. Sensors are commonly used for such monitoring tasks and software agents used for pattern recognition computations to identify entities. Currently, however, these two operations are often tightly-coupled within a single application. The OGC has recently recognized the Sensor Model Language as the standard representation language for sensor data. SensorML enables the creation of models for sensor machinery (such as SAL gauges), data-processes (such as pattern recognition), and sensor-data (such as video), that can be read by any machine that understands the language. Thus perception, an awareness of situation elements, is unified under a common formal representation, SensorML.

Level 2, comprehension, involves an understanding of the meaning of situational elements through knowledge of the relationships between objects and events. Relationships are the heart and soul of Semantic Web where they are considered first-order entities. The Resource Description Framework (RDF) and Web Ontology Language (OWL), both W3C recommendations, are expressive graph-based knowledge representation languages that provide the ability to effectively represent relationships. The Situation Theory Ontology (STO), modeled in OWL, is the result of extensive research in situation theory and provides a formal language for representing relationships between situational elements. Thus comprehension, an understanding of the meaning of situation elements, is unified under a common formal representation, STO.

Level 3, projection, involves an awareness of the evolution of a situation through logical inference on knowledge in order to predict situational changes. The ability to predict future situational changes requires the ability to represent change and to reason effectively with incomplete knowledge. The representation of change within spatiotemporal dimensions is a subject of much research in both the Semantic Web and Geospatial communities. In addition, the ability to leverage knowledge of previous situations in order to extend the knowledge of current and future situations (using deductive, inductive, abductive reasoning) seems a promising area of research. The Rule Interchange Format (RIF) is a W3C recommendation-track effort to develop a format for interchange of rules in rule-based systems on the Semantic Web. The goal is to create a common interchange format for different rule languages and inference engines.

As stated above, situation awareness is an essential step towards the safe-guarding of a cyber-infrastructure. The steps necessary for realizing computational SA include monitoring and entity identification with sensors, expressing relationships between entities with ontological models, and prediction of future situations with logical reasoning. Computational SA is now within reach, supported by extensive research into the theory of Situation Awareness and the Semantic Web. This talk will present some of our investigations as part of our work on Sensor Data Architecture component of the Sensor Vigilance (SAVig) project to demonstrate how Semantic Web can help a realization of comprehension and projection in Cyber SA.

1. Matheus, Christopher J. et al., *A Core Ontology for Situation Awareness*, In Proceedings of Sixth International Conference on Information Fusion, p.545-552, Cairns, Australia, July 2003.
2. M. M. Kokar et al., *Ontology-based situation awareness*, Information Fusion (2007), doi:10.1016/j.inffus.2007.01.004.
3. http://en.wikipedia.org/wiki/Situational_awareness#Endsley.27s_model
4. Sensor Model Language, <http://www.opengeospatial.org/standards/sensorml>
5. Resource Description Framework, <http://www.w3.org/RDF/>
6. Web Ontology Language, <http://www.w3.org/2004/OWL/>
7. Rule Interchange Format, <http://www.w3.org/2005/rules/>