The Practical Application of Semantic Web Technologies for Situation Awareness

Christopher J. Matheus[1*], Mitch M. Kokar[2], Kenneth Baclawski[2]
Jurek Letkowski[3] and Catherine Call[1]

[1]Versatile Information Systems, Inc.
[2]Northeastern University
[3]Western New England College

The grand vision of the Semantic Web has led to the development of new technologies intended to serve as the groundwork for its eventual realization. Primary among these technologies is the Web ontology language OWL [1] and its more recent extension in the form of the Semantic Web rule language SWRL [2]. These languages are built upon decades of research and real-world experience in the areas of knowledge representation, automated reasoning and rule-based systems. It is fair to say that they represent (in part) the cutting edge of practical technologies for realizing intelligent agents and advanced applications. As such, these technologies are applicable to problems well beyond that represented by the Semantic Web proper. Versatile Information Systems, Inc. is committed to the development of formal yet practical reasoning systems applied to problems in the area of situation awareness and information fusion. Our recent endeavors in this area have been grounded in Semantic Web technologies and have had occasion to stress them to some of their practical limits [3,4,5,6]. In our demonstration we will present the current state of our Situation Awareness Assistant (SAWA) and show how it makes use of OWL and SWRL. We will also present two supporting applications, a consistency checker for OWL documents and a graphical editor for SWRL.

We are developing SAWA as part of a Phase II SBIR research effort funded by AFRL Rome. The focus of this effort is the investigation of methods for formally reasoning about (and gaining "awareness" of) real-world situations. The SAWA system is designed to monitor streams of events marked up as OWL annotations arising from an evolving situation. Its primary purpose is to automatically detect the emergence of relevant higher-order relations among the situation's objects. The relevancy of events, objects and relations is determined relative to a user-defined goal and a corpus of predefined domain knowledge represented in the form of OWL ontologies and SWRL rule sets. To support the process of detecting relevant relations a Relation Monitoring Agent (RMA) translates the relevant OWL ontologies and SWRL rules sets into a Jess knowledge base. This knowledge base is then loaded into a Jess-based reasoning engine, which monitors the stream of relevant events and notifies the system whenever a relevant relation becomes true or ceases to be true for a set of objects. This information is forwarded to the system's graphical user interface (GUI) where relevant events, objects, relations and their

* Please forward all correspondence to Christopher J. Matheus, Versatile Information Systems, Inc. 61 Nicholas Road, Framingham MA 01701 USA cmatheus@vistology.com.

interconnections are visually displayed. One of the features of the RMA is its ability to use a subset of the recently defined SWRL built-ins, which are translated into Jess procedural attachments that call Java methods from a library of XML Schema support code embedded in the OWL parser built into SAWA.

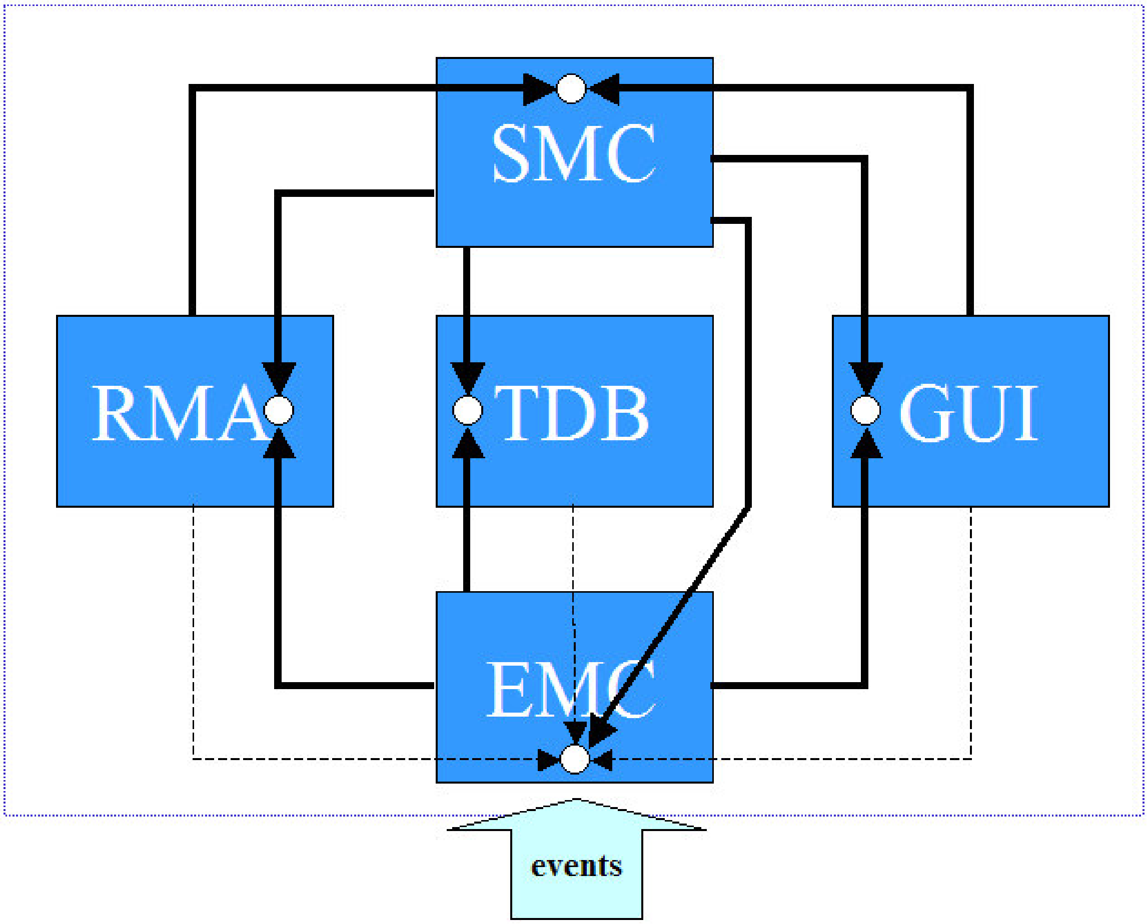

Figure 1. SAWA Component Architecture: SMC = Situation Management Component, RMA = Reasoning Monitoring Agent, TDB = Triples Data Base, EMC = Event Management Component, GUI = Graphical User Interface

In addition to the RMA and GUI, the SAWA system includes a number of other components, as shown in Figure 1. The Situation Management Component (SMC) manages situation sessions and provides general control and communication among the other components. The EMC (Event Management Component) handles the buffering and parsing of low-level events and translates them into appropriate representations for the other components, which subscribe to specific types of EMC event streams. The Triples Data Base (TDB) is used for storing all incoming events as RDF triples and for answering logical and what-if queries using its built-in support for OWL-QL (OWL Query Language) [7]. To simplify query formation, SAWA incorporates a template-based query generation capability within its GUI; this mechanism permits users to choose a predefined, domain-specific, query template and select appropriate values for its variable slots in order to formulate a valid query without understanding the raw syntax of

OWL-QL. In the proposed demo we will show the operation and interaction of the various SAWA components as they respond to a series of simulated events and user initiated queries.

SAWA requires its domain knowledge to be represented in the form of OWL ontologies and SWRL rules. To aid in the development of these knowledge structures we have created two standalone support tools. The first is a consistency checker for OWL called ConsVISor [8] designed to provide users with detailed feedback about the likely causes of detected inconsistencies evidenced as "symptoms". A full paper on the symptom ontology that lies at the core of the ConsVISor reasoning and explanation mechanisms will be presented at ISWC 2004 [9]. Users can access and freely use ConsVISor today as a Web services available at http://www.vistology.com/consvisor. In the demonstration we will show how ConsVISor is used to check and help resolve inconsistencies that arise in the development of the types of ontologies used by SAWA.

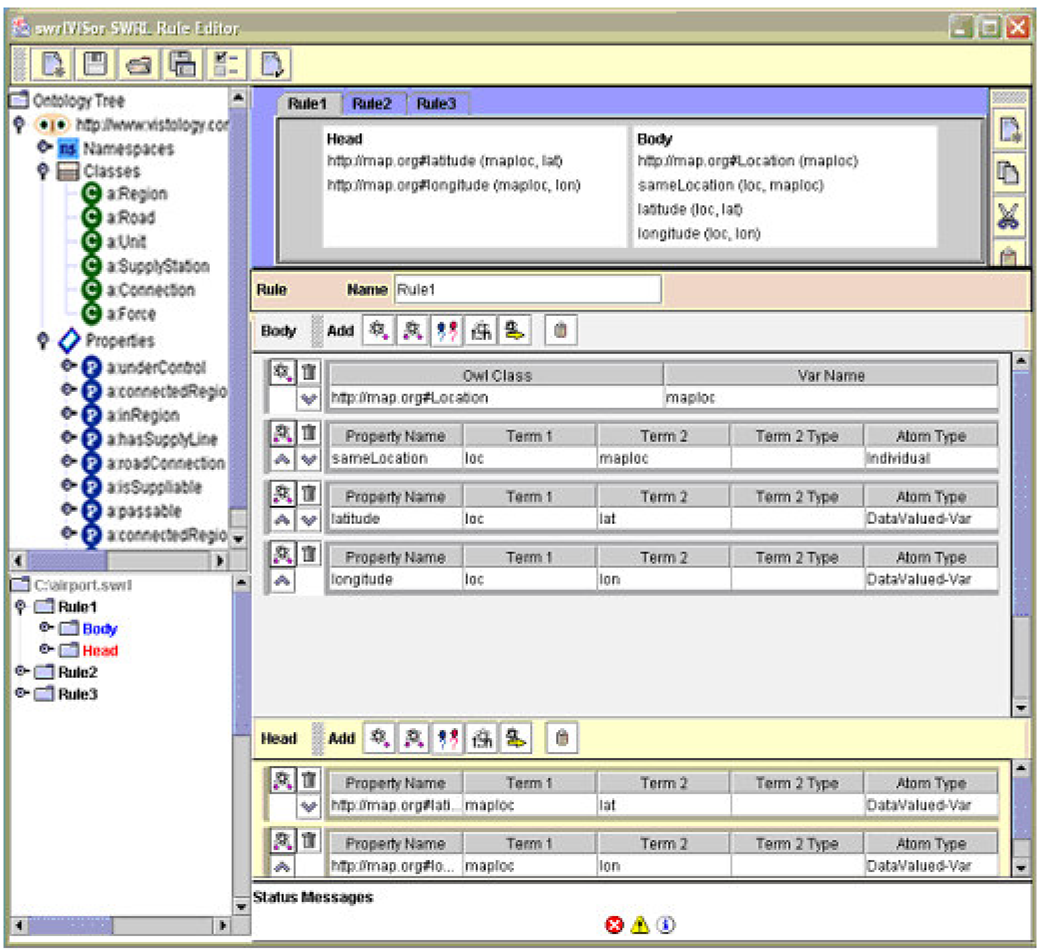

Figure 2. Screenshot depicting the appearance of SWRLeD, a graphical editor for SWRL rules.

The second support tool we plan to demonstrate is a graphical editor for the development of SWRL rules called SWRLeD. This tool is still in early development but it has reached alpha level and is being used to develop SWRL rules. A screenshot of the

SWRLeD editor is shown in Figure 2. SWRLeD currently focuses on the editing of pure SWRL rules and does not support the inclusion of arbitrary OWL DL code (as is permitted by the SWRL draft). The editor does however read in OWL ontologies and encourages the use of ontology elements in the rule components by permitting drag-and-drop between an Ontology Tree containing the elements of all the included OWL ontologies and specific fields in the rule atoms. The editor also uses information defined in the included ontologies about domains and ranges of properties to inform the user of valid values for the terms of both datavaluedPropertyAtoms and IndividualPropertyAtoms. While editing a rule the user is presented with a structured representation of the body and head of the rule and the means to add, remove and modify elements from each. The actual SWRL code represented by the structured representation is displayed as the rule is being edited; alternatively the user may choose to have a more human-readable representation displayed that uses a prolog-like syntax similar to that suggested by the SWRL draft specification (see [2]). Rule sets are currently saved using the XML Concrete Syntax but future versions will support the RDF Syntax and any other representations recommended by the emerging standard. In the demonstration of SWRLeD we will show its use in the actual construction and editing of SWRL rules used by SAWA and provide insight into plans for future enhancements, including the incorporation of consistency checking and rule validation.

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