A Comparison with Two Sensor Data Storages in Energy

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A COMPARISON WITH TWO SENSOR DATA STORAGES IN ENERGY

Abstract

Sensor networks are condensed wired or wireless networks for gathering and publishing environmental data. They contain of a large amount of sensor nodes that are linked to each other. Sensor networks produce huge volume of data which needs advanced analytical processing and interpretation by machines. Processing and interpretation of huge volumes of heterogeneous sensor data effects on the length of life time of sensor networks. In this paper we evaluate two known methods, names Semantic Sensor Web (SSW) and Semantic Sensor Observation Service (SemSOS), that stores sensor data in semantically form; annotate sensor data with semantic metadata. In other words we compare two known systems with consumption rate of energy and we show that the more data transfers, less sensor network life time results and SSW consumes less energy than SemSOS.

Keywords

Sensor Networks, Semantic sensor web, SemSOS, SensorML, Sensor data

1. INTRODUCTION

Many sensor network applications that are related to pervasive computing, e.g., monitoring learning behavior of thechildren, senior care system, environment sensing, etc., generate a large amount of data continuously over a long period of time[1,2,3,4]. Often, the large volumes of data have to be storedsomewhere for future retrieval and data analysis. Amount of data transfers in sensor networks effect life time[4]. In this paper we evaluate two known methods and calculate remaining energy of sensor network. The next section describes background studies, the semantic Web technologies and OGC SWE group standards. Section 3 discusses an effort on applying these technologies to sensor networks.Alsoin section 4, we focus another approachthat uses semantic Web technologies and usinga universal language to provide semantic data modeling for sensor networks. Section 5 provides an evaluation of those systems and section 6 concludes the paper and discusses the future work.

2. BACKGROUND

2.1 THE SEMANTIC WEB TECHNOLOGIES

Semantic Web is an extension to the current Web in which the meaningful relationships betweenresources is represented in machine process able formats [4,6,7]. The main idea in the Semantic Webis to provide well defined and machine accessible representation of the resourcesand their relationships rather than simple links as they are offered by the link structure onthe current Web (i.e. hreflinks in HTML). Ontologies are utilized by the semantic Webapplications to offer conceptualized representation of domains and to specify meaningful relationshipsbetween the resources. Ontologies provide common and shared understandings ofdifferent domains. The World Wide Web Consortium (W3C) has defined different standardsfor representing the semantic Web data in machine accessible and process able formats.

The primary technologies for the semantic Web include the Resource Description Framework(RDF), RDF Schema, and the Web Ontology Language (OWL).OWL is based ondescription logic and facilitates construction of ontolgies for different domains. The OWLdata can be accessed by software agents for reasoning purposes and to enablesystems to derive additional knowledge from the represented data. There are commonquery languages such as SPARQL available for the OWL data. There are also widely usedsoftware systems such as Jena [13] and Sesame [14] to deploy and manage the constructed ontologies.

The OWL representation of data enables expression of semantics and meaningfulrelationships between resources and amongst different attributes of complex data.

Ontologies hold a great importance to modern knowledge based systems. For instance, they constitute a powerful tool for supporting natural language processing[1-3], information filtering [4,5], information retrieval [6] and dataaccess [7]. Besides, they also provide a formalism for specifying similarity measureswhich have presented good effectiveness [5,8,9,10]. In figure 1, we can realize procedure of ontology creation.

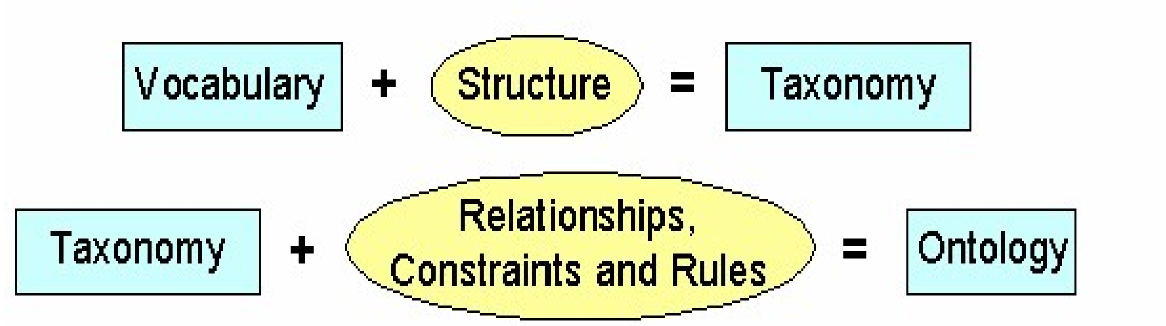

Figure 1: Progression from vocabulary to taxonomy and ontology

In the Semantic Web, the Web Ontology Language (OWL) fulfills this role of a meta-language for ontology development.

2.2 SENSOR WEB ENABLEMENT (SWE)

The Open Geospatial Consortium recently established theSensor Web Enablementas a suite of specifications related tosensors, sensor data models, and sensor Web services that willenable sensors to be accessible and controllable via the Web[4,11]. the core suite of language and service interfacespecifications includes the following:

- Observations & Measurements (O&M) - Standard modelsand XML Schema for encoding observations andmeasurements from a sensor, both archived and real-time.
- Sensor Model Language (SensorML) - Standard modelsand XML Schema for describing sensors systems andprocesses; provides information needed for discovery ofsensors, location of sensor observations, processing oflow-level sensor observations, and listing of task ableproperties.
- Transducer Model Language (TransducerML) – Standardmodels and XML Schema for describing transducers andsupporting real-time streaming of data to and from sensorsystems.
- Sensor Observations Service (SOS) - Standard webservice interface for requesting, filtering, and retrievingobservations and sensor system information. This is theintermediary between a client and an observationrepository or near real-time sensor channel.

3. SEMANTIC SENSOR WEB(SSW):

Semantic sensor web(SSW) is a system that was introduced in [11]. SSW approach presented here, leveragescurrent standardization efforts of the OpenGeospatial Consortium (OGC; www.opengeospatial.org) and Semantic Web Activity ofthe World Wide Web Consortium (W3C; www.w3.org/2001/sw/) to provide better descriptionsand meaning to sensor data. In other words, The SSW is a framework for providingenhanced meaning for sensorobservations so as to enable situationawareness. It enhances meaningby adding semantic annotations toexisting standard sensor languagesof the SWE. These annotations providemore meaningful descriptionsand enhanced access to sensor datathan SWE alone, and they act as alinking mechanism to bridge thegap between the primarily syntacticXML-based metadata standardsof the SWE and the RDF/OWL-basedmetadata standards of the Semantic Web. It used RDFa language to annotate sensor data. Sample Semantic annotation of SWE is shown in the following code.

```
<swe:componentrdfa:about="time_1"
rdfa:intanceof="time:Instant">
<swe:Timerdfa:property="xs:date-time">
2008-03-08T05:00:00
</swe:Time>
</swe:component>
<swe:value name="satellite-data"
rdfa:about="Dayton"
```

rdfa:instanceof="geo:City">
0011000111001111 …
</swe:value>

This example generates two RDFtriples. The first, time_1 rdf:typetime:Instant, describes time_1 as aninstance of time:Instant(subject istime_1, predicate is rdf:type, object istime:Instant). The second, time_1 xs:date-time "2008-03-08T05:00:00,"describes a data-type property oftime_1 specifying the time as a literalvalue (subject is time_1, predicateis xs:date-time, object is "2008-03-
08T05:00:00").

4. SEMANTIC SENSOR OBSERVATION SERVICE(SEMSOS):

It propose a new method that uses smarter data than raw sensor data and accomplish this byleveraging semantic technologies in order to provide and apply more meaningful representation of sensor data. More specifically, they are modeling the domain of sensors and sensor observations in a suite of ontologies, adding semantic annotations to the sensor data.in other words, it represent data in O&M-OWL form.
The following example shows a sample sensor data in the proposed approach:

om:windspeed_1 rdf:type w:WindSpeedObservation .
om:windspeed_1 om:samplingTime om:time_1 .
om:windspeed_1 om:observationLocation om:location_1 .
om:windspeed_1 om:result om:result_1 .
om:result_1 om:value 37 .
om:result_1 om:uom w:MPH .
This example shows winspeed_1 that is type of WindSpeedObservation defined in weather(w) ontology. Related SamplingTime is time_1 and its value is 37 MPH.

5. EVALUATION AND DISCUSSION

We have evaluated the two known methods of sensor data storage (SemSOS and SSW).our evaluation, uses remaining energy parameter for comparison.
Remaining energy means rate of consuming energy during time. Scale of consumption of energy, effects longevity of sensor network, in other words the rate of energy consumption shows how long sensor network can live.
We have done our evaluation with j-sim[15] and protégé 2000 software[13].
Figure 2 shows remaining energy in SSW approach.

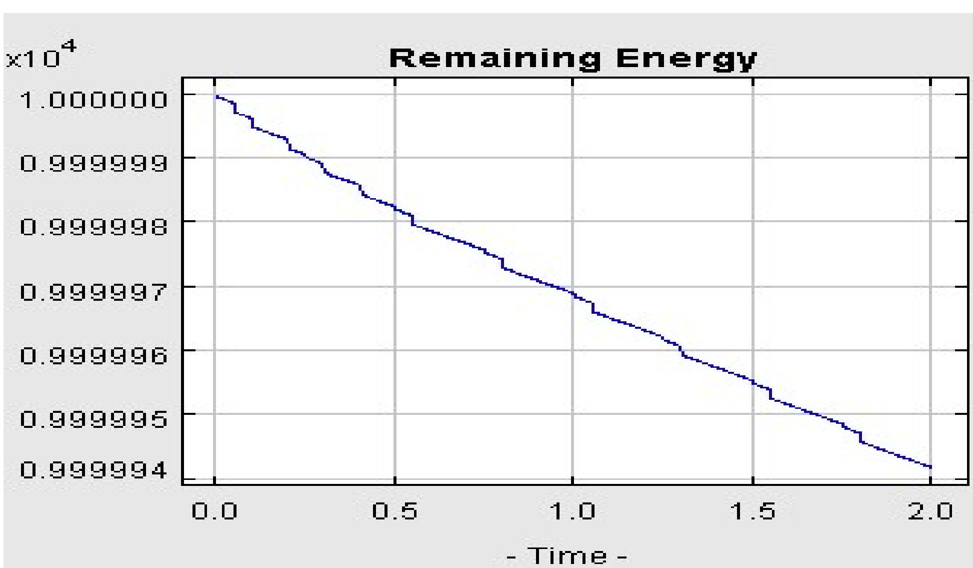

Figure 2: rate of energy consumption in SSW framework

Figure 3 shows remaining energy of sensor network in SemSOS approach.

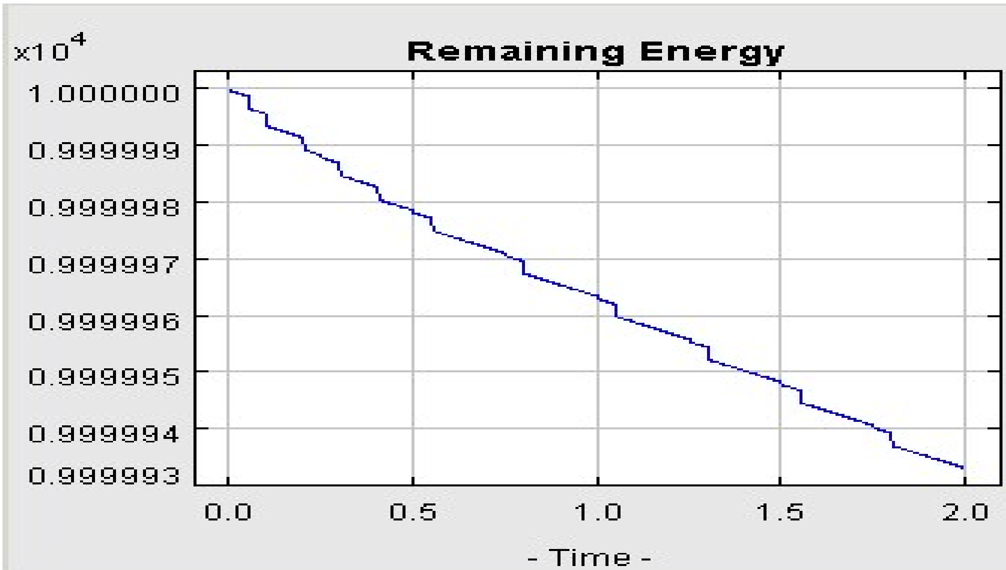

Figure 3: rate of energy consumption in SemSOS Service

As shown in the above figures, we can understand if data sent in ontology form, the rate of energy consumption increases while data sent in SSW approach.In other words, if more data flow in sensor network, life time of sensor network decreases and we see that storing data in ontology form uses more energy that we stores data in SWE+Rdfa appraoch[16,17].

6. SUMARRIES

SSW is a framework that annotates sensor data semantically and can useit for further development of sensor datastorage. So it is important to evaluate this framework with others in variety of parameters.

SemSOS model the domain of sensors andsensor observations in a suite of ontologies, adding semanticannotations to the sensor data, using the ontology models toreason over sensor observations.
In this paper we have compared the proposed systems in sensor network life time parameter and said that the more data transfer less life time results.The amount of data to be sent to the network is essential for the power consumption of the sensors. We showed that transmitting more data requires more energy to transmit. Future works can focus on more evaluation of those frameworks with more parameters like size of data packets exchanged through sensor network.

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