Contextual classification of SensorML documents based on Kipling's 5W1H method

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April 17, 2005

1 Abstract

This is an addendum to the proposal "Interactive Multi-Level Situation Assessment in Ubicom Environments". In this proposal we discussed a framework for constructing cohesive representations of shared situations. It does so by extracting contextual cues out of sensordata derived from real-time sensor grids. Its purpose is to augment domain experts in situation assessment through the interaction with the various contextual elements that when combined form a shared situation representation.

This addendum will address the first two research questions posed in the proposal, namely:

1. How can context be derived from heterogenous sensordata?, and
2. How can context be classified within a situation assessment framework?

Both these questions require a clearly defined concept of context for use in situation representation. We discuss the use of Kiplings 5W1H method for describing situations as the primary context classification on which to base our context model.

2 From Kipling to Context

Rudyard Kipling used a set of questions to help assess situations in order to solve problems and immortalised them in the following aphorism[1]:

> *I have six honest serving men*
> *They taught me all I knew*
> *I call them What and Where and When*
> *And How and Why and Who*

The questions who, what, where, when, why and how are known as the 5W1H method and is applied daily in the field of journalism where a good news story should always answer these questions in the first few sentences.

We apply this method to the field of computer science and use it as a basis for an interactive situation assessment system. In this system experts with different objectives and backgrounds can interactively assess a current situation by formulating questions based on this principle. Figure 1 gives a schematic overview of the 5W1H model.

3 SensorML

A situation is represented by its contextual elements. These contextual elements can be obtained by combining sensor data with meta-information and domain knowledge. we treat the six questions of the 5W1H method as

[1] Aphorism: A brief statement containing an important truth or fundamental principle.

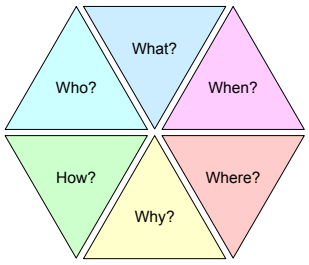

Figure 1: schematic overview of Kipling's 5W1H model.

our primary context dimensions. And classify all sensor data obtained through realtime network grids accordingly. By using SensorML enabled sensors as our primary source and combining it with a domain ontology it becomes possible to construct a multi-level situation description that can be used in real-time interactive situation assesment in order to quickly and efficiently find the solutions needed to resolve a particular situation. Figure 2 demonstrates this concept.

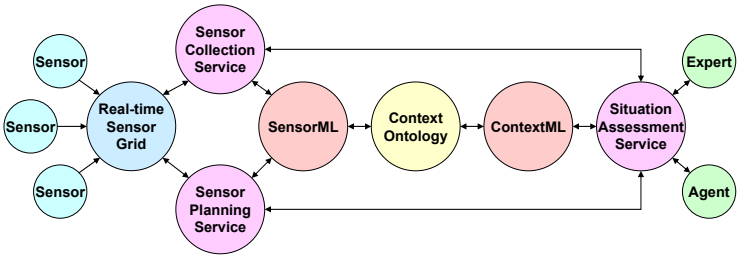

Figure 2: From sensor data to context in situation representation.

SensorML is well suited as the preferred input source for our situation assessment system since it can by applied to virtually any sensor, whether in-situ or remote sensors, and whether it is mounted on a stationary or dynamic platform. SensorML provides the models and XML schema encoding for defining the geometric, dynamic, and observational characteristics of a sensor. SensorML was designed to:

- provide general sensor information in support of data discovery
- support the processing and analysis of the sensor measurements
- support the geolocation of the measured data
- provide performance characteristics (e.g. accuracy, resolution, etc.)
- archive fundamental properties and assumptions regarding sensor

Sensor devices that can dynamically rearrange themselves into real-time sensor grids depending on their circumstances are an excellent source for the aggregation of SensorML documents obtained in a shared situation. Furthermore, sensors using SensorML do not only descibe the data they measure but also themselves and often large parts of their context such as spatial and temporal characteristics. This makes SensorML an ideal candidate for the contruction and population of the proposed context model.

4 ContextML

Fusing SensorML documents allows for the construction of ContextML documents that adhere to the 5W1H principle. SensorML will be analyzed and rearranged into encapsulated sets belonging to the primary context dimensions. Figure 3 demonstrates a more concrete context model based on the 5W1H principle.

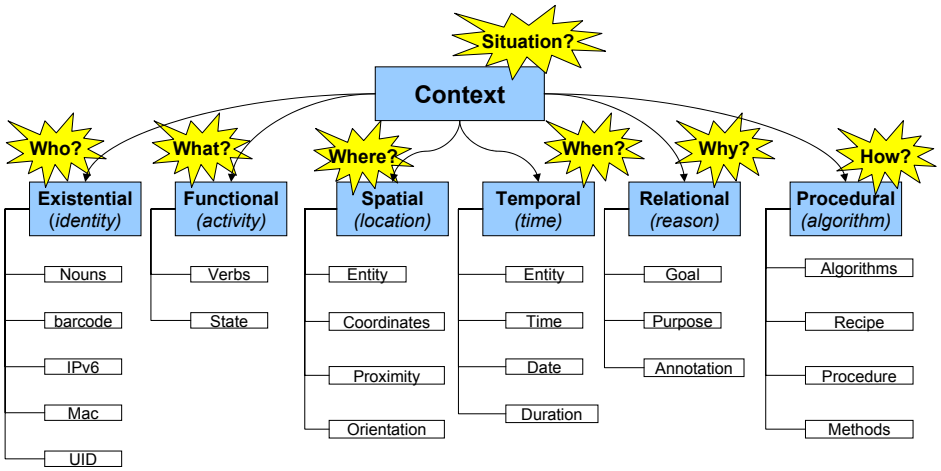

Figure 3: A sample hierarchical context model based on the 5W1H principle.

5 Context Classification and Encapsulation

After contextual elements are extracted from sets of SensorML documents, they will be indexed to their primary context dimension accoring to their 5W1H poperties. Within each context dimension will be defined one or more supertypes from which is a supertype of all possible subtype within that class. For example entities belong to other entites, one timespan or moment is encapsulated by another timespan, etc. This method of type encapsulation allows for a context hierarchy in which it becomes possible to zoom in and out of context and allow for the construction of multi-level situation representations. The exact methods, structure and way of construction of this model is not fully determined at this time and will be one of the main challenges of this research package. Figure 4 shows how elements in SensorML map to a context classification in ContextML, whereas figure 5 demonstrates the concept of entity encapsulation in the context model.

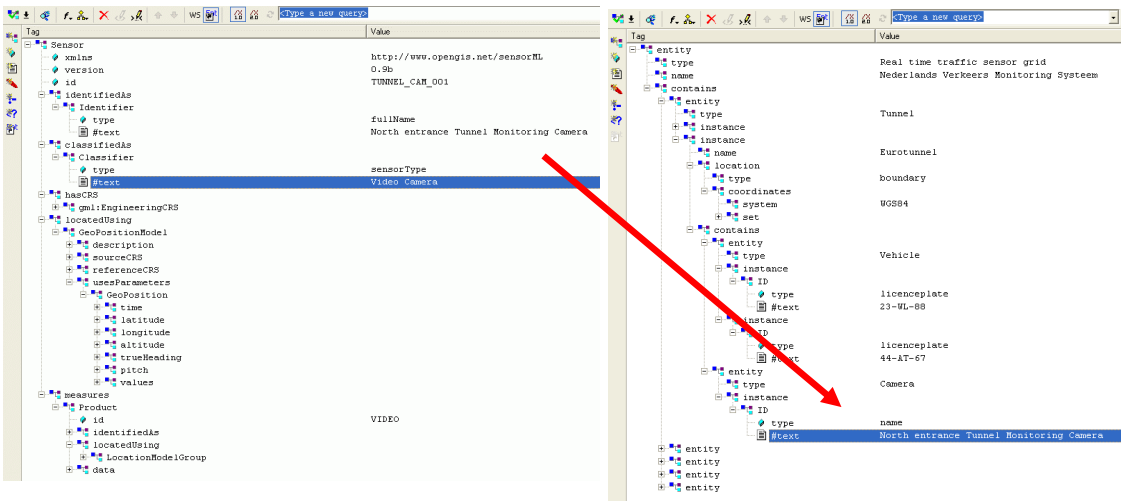

Figure 4: Mapping of SensorML to ContextML.

6 The SensorWeb

The proposed interactive sitation assessment system is a web service that is based on the functionality provided by an extension of the web known as the SensorWeb.

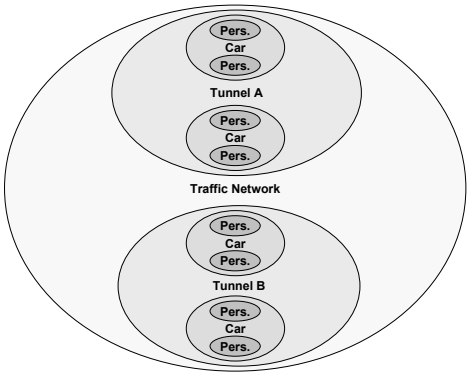

Figure 5: Encapsulation of context elements belonging to the entity class

Just as the Web is based on fairly simple standards, the sensor Web enablement framework is not particularly complicated. By describing sensors using SensorML, anyone can put sensors or sensor data online for others to find and use.

As part of its effort to enable access to Web-resident devices, OGC is creating and testing a framework to maximize the discoverability and interoperability of sensor systems through standard Web-based services. Currently, the framework defines catalog services for discovering sensors and sensor data; collection services for accessing real-time or archived observation data; planning services for tasking sensors; and notification services for providing users the results of task requests or for alerting users of other services of observed phenomena of interest. Additionally, the framework includes standard ways of encoding observation and measurement schema and for describing the geometric, dynamic, and observational characteristics of sensors of all kinds (SensorML).

Adherence to a common schema makes it possible to search for sensors and sensor data with more precision than is available with text searches using a search engine. For example, searching for particular kinds of sensors and data in a particular geographic region, with data collected within a particular time window, will be easy. This has significance for science, environmental monitoring, transportation management, public safety, disaster management, utilities operations, industrial controls, facilities management, and many other activities.