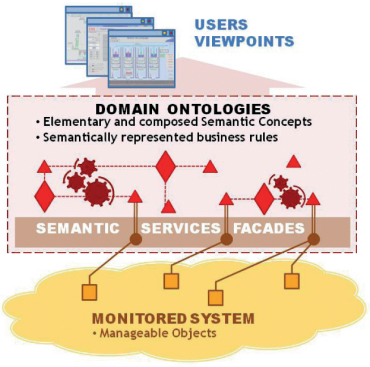
INNOVATION REPORT

Semantic approach offers effective services management for the Internet of Things

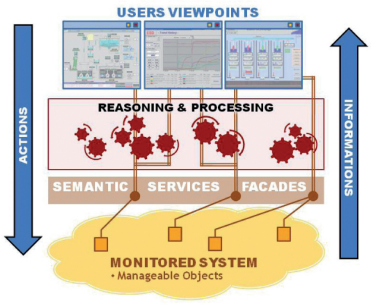
EUREKA

Project leader: Patrick Gatellier (Thales)

The ITEA 2 SEMbySEM project has developed a semantic approach to monitoring and management of all sizes of systems. The results provide dynamic representations of systems as a set of semantically described synchronised views, offering simple and effective control based on the myriad of devices that will be found in the 'Internet of Things'. The core will be made available as open-source software to promote the use of domain-specific semantics for management of large systems in many sectors. Commercial applications are already developing in transport control, virtual manufacture hypervision for building management systems.



SEMBYSEM DESIGN TIME



SEMBYSEM EXECUTION TIME

With the advent of the Internet of things, there is a strong trend toward a world of sensors with many current everyday objects equipped with embedded data and communications capabilities. Services management of the resulting systems will be crucial. With more and more objects able to provide information, it will be essential to have some form of mechanism that makes it possible to control the whole system in a meaningful way.

In this world of sensors, a semantic web offers a practical framework to provide ways to process the huge amount of data they will produce. And, ideally, this mechanism should be user centred. From an end-user point of view, the information provided by a set of sensors is only meaningful within the scope of some end-user activity, targeting a defined goal achievable through a dedicated scenario. This was the starting point for SEMbySEM.

The goal of the ITEA 2 project was the development of generic software allowing the aggregation of information from communicating objects – such as radio-frequency identification (RFID) tags, industrial sensors, servers, simulated objects and devices – and applications such as video acquisition, supervision and IT monitoring systems in an ergonomic form enabling actions by the end-user on these objects and applications. This software allows several actors to obtain an awareness of their working system and perform actions on it.

Defining tools and standards

SEMbySEM defined tools and standards for the management of systems as a coherent set of objects grounded in a semantic abstract representation of the system to be supervised or managed. This abstract representation has two purposes:

1. To isolate the technical issues related to the communications with the various sensors, in a 'façade' layer. This layer transforms the data coming from these sensors into semantic information and allows end-users to focus only on their activity while ignoring the technical details of each sensor; and
2. To work directly on a semantic model of the system consisting of a dynamically-updated ontology plus related business rules. In this way, the multiple sensors data is linked to concepts of the system using a well-defined level of granularity. For instance, sensors will be grouped together if they belong to the same object, or if they are in the same location.

As the systems to be managed are intrinsically dynamic, a new semantic representation was needed to define the ontology and

the business rules. A major requirement in the semantic model is the possible actions on real-life objects, as sensors may also be linked to actuators.

This system needs not only to find out what information is available but also to decide on priorities. For example a machine telling you that your tea is ready needs the sound shut off if you have just received an important phone call. And the mechanism needs to be generic to address the situation where lots of objects are able to communicate and have to be controlled.

As the management system does not know the objects, the first thing needed is some way of describing them. Semantics offer a language to describe the objects. And the objects should be able to store their own description – what they are and what they do. Semantics offer an effective way of doing this – providing normal words that are processable.

Improving quality of service

SEMbySEM started with the management of computer systems where there is an ever-growing need to provide quality of service and understand the kind of service being provided. When running a website for example, the user is interested in the percentage of downtime, not why the system is down. This then needs to be translated into the various sources of anomaly in the system so that they are explicable in human terms. The requirement is for a summary of computer operations in terms of human goals. The resulting system then has to manage the human need directly, not the technical issues.

Ideally, the system should compute in terms of the application with reasoning based on the concepts involved – for example when dealing with a railway despatch system, this should be in terms of trains, carriages, passengers, goods and stations. With existing standards, it is not always certain that these concepts would be maintained across the system and results would be available in computable time.

To be certain that it was always possible to compute, SEMbySEM limited the capacity of the language being used to try and address all the possible problems. This resulted in a specific internal approach called Micro Concept using semantics to describe the systems in terms of an ontology so that it is not necessarily to change the vocabulary on a continuous basis.

Building a dynamic living model

This vocabulary is used to design a living model of the system which at run time is fed with events such as ‘train started’ and ‘train stopped’ and all other activities that modify these properties. This live model of the system can then be queried before carrying out an action. This living dynamic reference of the system being managed is analogous with how the brain sees the body and controls its actions.

SEMbySEM demonstrated that the semantic approach is the most appropriate and versatile way to describe concepts and rules, with the largest consensus on the terms and their meaning. It lets different users define their business model in terms of concepts and rules and define their own representation. These concepts are then linked with their real counterpart to manage them by obtaining information from them and acting on them.

Key outputs of the SEMbySEM project included:

- The **Micro Concept standard** which represent concepts in terms of objects, parameters and actions, and semantic rules based on these concepts;
- The **Semantic Services Facade standard** which connects the concepts to the manageable objects they model;
- The **model studio** which enables the user to define the concepts;
- The **visualisation studio** allowing users to design their own viewpoints; and
- The runtime framework.

Open-source tool to emerge

SEMbySEM proved the efficiency of semantic models for supervision and Internet-of-Things-related technology. The concept was validated by the various partners in a series of demonstrators that included:

- Real-time localisation and tracking of locomotives and goods wagons in rail transport as well as sharing of cargo information and technical data for safety, maintenance and inventory;
- Management of virtual metrology results for metal car-panel production to provide users with highly detailed information on part quality and process performance; and
- Centralised control of multiple building management systems with different software or systems integration configurations to enable mapping of heterogeneous supervisory control and data acquisition (SCADA) systems in a single coherent hypervision system.

The software developed will be published as an open-source tool and the results are already being applied in partners’ own products. Thales has been demonstrating a systems application for a Spanish underground railway network, enabling the automation of decision processes in both normal and abnormal conditions. ARC Informatique will use the results in new, more dynamic generations of its SCADA systems. And Spanish partners will develop the virtual metrology systems for commercial applications in the car industry.

More information: http://www.sembysem.org