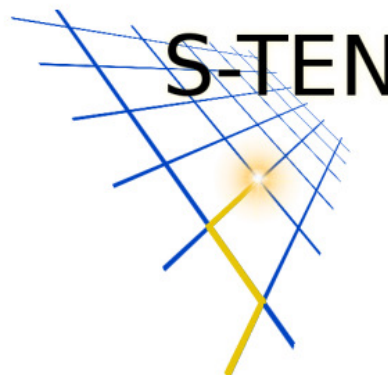


# S-TEN

## ***Intelligent Self-describing Technical and Environmental Networks***

### **ANNUAL REPORT 2006**

[www.s-ten.eu](http://www.s-ten.eu)



#### **Abstract**

*S-TEN's objective is to exploit the "Semantic Web" for scientific and engineering applications, and to provide support for decision makers in a complex and continuously changing environment. This support is based upon the application of rules and process knowledge to measurements, human observations and design information published on the Web. Data acquisition and process control is provided by self-describing devices within a system, e.g. measurement sensors or intelligent subsystems which announce their existence on the Web and which publish data on the Web.*

*The S-TEN project will contribute to international standards by defining standard ontologies for the publication of network information on the Web and defining a methodology for the extraction of ontologies from existing international standards.*

*Innovations provided by the project will comprise:*

- *an ontology which enables a device to announce its existence, position in a network, and the services it provides;*
- *the capturing of human qualitative observations and their publication on the web with respect to a formal ontology;*
- *the development of rules which can be applied to any kind of technical data available on the web;*
- *the linking of STEP and OWL - two worlds which have been apart up till now.*

## **1 Summary of achievements**

Work in the project's first year 2006 has focussed on technology validation and the selection of software tools to be integrated into the S-TEN architecture, especially those concerned with mapping languages, ontology management, standard web services and Semantic Web services, rule and inference engines, agent technology, and RFIDs. In order to define the requirements for the S-TEN demonstrators a generic use case has been developed and documented using UML tools. Initial work on the draft architecture specification was started in September.

In order to define the scope of, and validate, ontologies and methodologies for self-describing devices and technical networks, a set of measurement examples has been developed and implemented in different ontologies.

Further work has been devoted to the linking with design and maintenance knowledge and specifically to the translation from OWL to STEP and vice versa. Within this work a

prototype syntactic translator from EXPRESS to OWL has been set up and the representation of principal classes in OWL has been completed.

Several paths of dissemination have been implemented even in this early stage, e.g. by papers and poster presentations at international conferences and publications. Work on standardisation within ISO TC184/SC4 has started earlier than proposed because of currently running discussions.

The work completed so far provides the basis for the further development of S-TEN core technologies as well as for the specification of the proposed demonstrators.

## **2 Areas of project work** (completed or started)

### ***2.1 Evaluation of technologies and common architecture***

As a first step in the project, an extensive survey of state-of-the-art existing technologies and tools has been carried out and, based on this survey, the most promising software tools for the development of the demonstrators have been evaluated. The survey includes mapping languages, ontology management tools, standard web services and Semantic Web services, rule and inference engines, agent technology, and RFIDs. Those technologies and tools found most relevant for S-TEN, have been evaluated in-depth. In this context, XSLT related tools and engines, web services middleware, rule engines, and a multi agent development environments have been investigated and evaluated in diverse test scenarios. This work was completed in November 2006.

### ***2.2 Application requirements & design of intelligent network and self-describing devices***

Application requirements for the S-TEN demonstrators have been put together in a generic use case study, recorded using the UML tool Objectteering. Initial work on the draft architecture specification was started in September.

With respect to the ontologies and the methodology of self-describing devices and technical networks, a set of measurement examples has been developed and implemented in different ontologies for evaluation. OWL-S seemed to be a promising technology to build a network of self-describing devices integrated into a web environment. However, a test bed has shown that OWL-S concepts and tools are not mature enough to be used for this purpose. Therefore the network will be built using more classical technology (such as legacy web services) with ad hoc semantic enhancements to be developed during of the project.

### ***2.3 Linking with design and maintenance knowledge***

The work on the derivation of a formal ontology from ISO 10303 (STEP) is still at an early stage, and has not yet been separated into a methodology; the automatic or semi-automatic application of the methodology; and validation. Parts of a possible methodology are validated by considering different instantiations of small parts of different STEP Application Protocols.

An early prototype syntactic translator from EXPRESS to OWL has been created. This deals with the schema alone and not with application data. The output from the translator is a set of ontologies – one for each EXPRESS schema. The ontologies are formally correct OWL but miss additional semantics required for inferencing.

A small core subset of ISO 10303 around product and properties have been analysed in great depth about their semantics relevant for OWL. This analysis, which is being simultaneously developed and validated, will become part of the final methodology.

## **2.4 Standardisation**

Work on standardisation has started earlier than proposed due to currently running discussions in ISO TC184/SC4.

The web publication of network data will rely upon ontologies for engineering data derived from international standards. Furthermore, a high level of acceptance of the S-TEN ontologies will be reached by enhancing existing international standards and working closely together with the respective working groups.

Ontologies for measuring data have already been developed in the predecessor project ScadaOnWeb and are being standardised as part of the ISO 15926 family of standards for the process industry, which covers lifecycle data for process plants and are becoming widely used in oil- and gas production.

The S-TEN project will link this work to STEP (ISO 10303). This standard is widely used in the automotive industry, especially ISO 10303-214 'Core data for automotive design'. The aerospace and military industries are also involved with the implementation of ISO 10303-239 'Product lifecycle support', which covers the operation and maintenance of mechanical equipment. Formal ontologies will also be used to record information on AIDC devices (Automated Identification and Data Capture), e.g. RFIDs, and extensions to ISO 21849 to support this are being developed.

## **2.5 Technology outlook and expected innovations**

The S-TEN approach is different to traditional systems because it offers high flexibility and low cost by using standard web technologies:

- the Internet provides the communications infrastructure and serves as database
- the publishing of information and measurements on the Web using standard ontologies replaces the functionality of traditional SCADA systems ;
- rule bases stored on the Web and acting on the Web-published information will provide notification and operator support.

For this purpose the following software packages will be developed to prototype level:

- software that publishes measurements on the Web using a standard ontology;
- software that maintains an index of Web published objects relevant to a particular network;
- software that provides translation between a file of design data in accordance with an ISO 10303 (STEP) Application Protocol and the equivalent data published on the Web using a standard ontology;
- software that enables an engineering end user for create a rule base for a particular application.

Examples for possible applications will be implemented as project's demonstrators as described below. Built on these software applications major innovations are seen in:

- defining an ontology which enables a device to announce its existence, position in a network, the function it performs and the services it provides;
- capturing human qualitative observations and publicise them on the web with respect to a formal ontology;
- developing rules substantial for automated network management systems, e.g. process monitoring and preventive maintenance applications and in
- the representation of design data according to STEP using OWL.

## 2.6 Market prospects and product profile

The S-TEN project will provide the underlying technology for a new generation of Web-based applications applied to technical and environmental networks. The components of these networks are real-world physical objects which are connected together.

Therefore the S-TEN technology will allow advanced process monitoring and alarm systems to be applied to continually changing technical and environmental networks, without the need to maintain a network data warehouse. The S-TEN approach will make the network self describing. Each component of the network will publish autonomously information about what it is, where it is, and what it does on the Web. This approach will make network monitoring and control practical, in new applications.

Major industrial enterprises concerned with network management already have systems with similar functionality offered by the S-TEN technology, although these do not support new features like the capability of the devices to publish their data on the Web. The traditional systems also do not have interfaces to data standard such as STEP and OWL. Initially the S-TEN technology will not compete with traditional systems, but ultimately the S-TEN technology will also have an impact on them. However the S-TEN technology is not appropriate for safety critical applications where a guaranteed short response time and a high level of whole system reliability are required.

Nonetheless for other applications, it is the flexibility and low cost that makes a system based on S-TEN technology practical. Therefore the first take up of the S-TEN technology will be for new applications where a traditional system is not suitable, because of expense, complexity and inflexibility.

## 3 Dissemination and user involvement

The consortium partners initiate measures in parallel with the research activities in order to turn project results into commercial success. These measures include the promotion of the R&D work, the identification of market segments, gathering requirements from these markets, defining products and finally marketing these products.

S-TEN is tracking several ways to raise public interest of the project and ensuring its dissemination even in this early stage. Paper and poster presentations have been accepted on international conferences, publications has been submitted and direct contact to similar projects in the field of semantic web or the envisaged application domains are established.

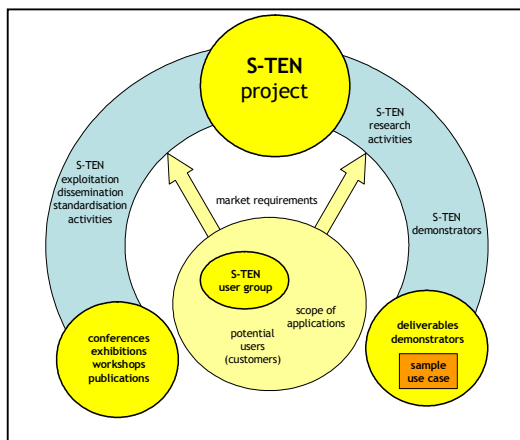


Figure 1: S-TEN exploitation strategy overview

The exploitation, dissemination and standardisation activities of S-TEN project on the one hand, and S-TEN research activities with the subsequent development of the demonstrators on the other, set the framework for applications and potential future customers.

The S-TEN user group is regarded as an important way of getting feedback for the research activities, refining the specification of the demonstrators and determining market requirements. Initial contacts to industrial partners for further product developments have been established. S-TEN has been present in several standardisation workshops and attendance at several international conferences is planned.

## 4 Future work

The S-TEN demonstrators are examples of applications for which the S-TEN technology is more suitable than traditional systems. The demonstrators will verify the suitability of the STEN technology for practical applications and will also be used to explain and publicise the results of the project.

### **Environmental Monitoring:**

For environmental monitoring applications the flexibility of the S-TEN approach is important, because the nature of the sensors and their positions may be continually changing. Also there may be many different actors wishing to access the data. Each of the actors may have their own rules for notification and may require different types of 'operator support'. In this context, the police and fire services are examples of 'operators'.

### **Control of Distributed Resources in Electrical Power Networks:**

For an intelligent network management of distributed power generation (wind farms, small hydro power plants, solar power plants, etc.) the expense incurred in traditional system procurement, and in reconfiguring the system when the network changes, is very significant. The S-TEN technology provides a cost-effective alternative approach.

### **Secondary Control of Electrical Power Systems:**

Secondary control involves manual intervention to deal with fault situations and other operating problems. Many different types of query and notification are required, for which the configurable rule-based approach of S-TEN is especially suitable.

### **Initial Operation and Preventive Maintenance in Electrical Systems:**

A SME does not have the money or expertise to acquire or develop bespoke systems which add additional functionality to industrial automation systems. Off-the-shelf automation systems acquire the information that could be used to support production optimisation and to schedule preventive maintenance, but often this information is not used. The S-TEN technology and simple interfaces will provide a simple way of interfacing with the industrial automation system, querying historic data, visualising the current status of a production network, and defining the rules for scheduling preventive maintenance activities.

## 5 Further information

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### **Public website of S-TEN**

[www.s-ten.eu](http://www.s-ten.eu)