Executive summary

S-TEN

Intelligent Self-describing Technical and Environmental Networks

www.s-ten.eu

1.1 Abstract

W3C envisages the future of the Web to be a “Semantic Web”, which is an extended web of machine-understandable information and automated services that go far beyond current capabilities.

The objective of this project is to tap these new possibilities for applications in the technical domain, especially to provide support for decision makers in a complex and continuously changing environment. This support is based on applying rules and process knowledge on available data published to the web. The data comprises measurements, human observations and design information. Data acquisition and process control is assisted by self-describing devices installed in the considered technical systems. The technology will be demonstrated by applications in the field of electro-technical systems, decentralised energy systems and environmental measurement systems.

The key standardisation task is to move the current generation of standards for design, engineering and process monitoring data to OWL ontologies, and thus make the appropriate data models available for semantic web technologies.

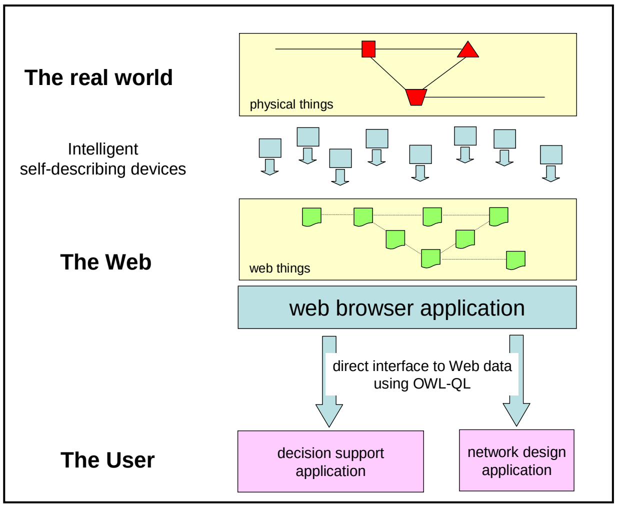

Figure 1: *Diagrammatic representation of the S-TEN approach*

Innovations provided by the project will comprise an ontology that enables a device to announce its existence, position in a network and the services it provides. Also, the capturing of human qualitative observations and their publication on the web with respect to a formal ontology, as well as the development of rules that can be applied to any kind of technical data available on the web are key innovations. Finally the project will link two worlds up to now apart: STEP and OWL.

1.2 Project objectives

S-TEN’s overall objective is to exploit “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 assisted by self-describing devices, e.g. measurement sensors or intelligent sub-systems, installed in the considered technical systems.

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, e.g. ISO 10303 (STEP) and ISO 15926 (Life cycle data for process plant, including oil and gas production). Innovative objectives provided by the project will comprise:

- an ontology which enables a device to announce its existence, position in a network, the function it performs 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, e.g. process monitoring, preventive maintenance and best practise advice for control centre operators
- the linking of STEP and OWL allowing not only to publish network design knowledge created by existing CAD systems and represented using the STEP family of standards on the Web using OWL but also to collect information about self-describing networks published on the Web using OWL, and to represent it using STEP so that it can be visualised by existing CAD systems and STEP tools.

The overall approach towards the S-TEN technology is shown in Figure 1.

1.3 Consortium

The consortium comprises eight partners, both academic and SMEs, from Germany, Lithuania, Spain, Switzerland and the UK:

- Forschungsgemeinschaft für Elektrische Anlagen und Stromwirtschaft e.V. (FGH); Germany (Co-ordinator)
- CAESAR Systems Ltd. (CAESAR); UK
- Cygnus Engineering AG (CYGNUS); Switzerland
- Haute Ecole Valaisanne (HEVS); Switzerland
- Fundación LABEIN (LABEIN); Spain
- UAB LKSoft Baltic (LKBALTIC); Lithuania
- LKSoftWare GmbH (LKSOFT); Germany
- RACOS Technische Informationssysteme GmbH (RACOS); Germany

Note: *RACOS has been taken over by AUCOTEC AG, Germany, in February 2007.*

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1.4 Work performed and results achieved

Within this first yearly reporting period work has focussed on the technology validation and selection, the definition of application requirements, the architecture specification and its hardware implementation as well as on methodological foundation as for measurements and observations and the linking between STEP and OWL data.

The technology validation has been performed with respect to mapping languages, ontology management tools, standard web services and Semantic Web services, rule and inference engines, agent technology and RFID (Radio Frequency Identification). Recommendations have been given for the selection of software tools to be integrated into the S-TEN architecture. Results of this work has been summarised in deliverable D1.1. As to task 1.2 covering requirements for the S-TEN demonstrators a generic use case study based on the UML tool Objecteering has been carried out. First work on the draft architecture specification has been started in month September regarding task 1.3. Further, an evaluation of OPC UA has been carried out (including a workshop) to assess the relevance of OPC UA for S-TEN in general and, more specifically, for S-TEN demonstrators.

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 in the frame of the project. The Jena tools provide a good implementation of SPARQL, which may be a part of this.

The REST (Representational State Transfer) approach to web services is attractive. The ontologies for network object notification are being evaluated for use within a REST environment. The objective is that the ontologies should be equally valid for use with all approaches to web services and also within a legacy OPC environment.

Work package 3 is devoted to the linking with design and maintenance knowledge and here specifically to the translation from OWL to STEP and vice versa. As part of D3.1 ontologies for a core subset of STEP has been defined. With early prototype software the feasibility of bi-directional data exchange between STEP and OWL has been proven. The results have been presented on international standardization conferences.

Work package 4 is devoted to the use of rules for making inferences about the stored knowledge and the measured properties. Within this work, an ontology for the representation of features, a translation software to the selected inference engine (Jena2) and a graphics editor based on the SWRL protégé plug in will be developed. Work has been done for the identification of graphic rule editors and translation of SWRL into Jena2. In particular the results of the REWERSE NOE have been reviewed.

S-TEN is tracking several ways to raise public interest of the project and ensuring its dissemination even in this early stage. An abstract for CIRED 2007 has been accepted and, hence, a full paper has been submitted. Another paper at the SPS/IPC/Drives 2006 Conference has been accepted and a speech has been given there as well as a poster presentation at the ISWC 2006. An article has been submitted for publication within a German magazine; another publication is envisaged in 2007. FGH has introduced S-TEN by giving a poster presentation to the German network “Energy and Communication”. Finally, the Fact Sheet, the project presentation slides and an English flyer were set up. First efforts towards standardisation have started earlier than proposed due to current international discussion. A public website was launched right after kick-off of the project and is developed and enhanced on request by the EC.

The project management has established several information and communication channels within the consortium via email, an internal WIKI-website and multi media telephone conferences. Funds have been distributed and communication with the EC on behalf of the consortium has been provided. Project meetings have been performed three times and internal discussions on a joint dissemination and exploitation body have been moderated. Technical issues have been discussed and potentially resolved within the three meetings of the Technical Committee (TC), within the biweekly telephone conferences and on a bilateral basis where applicable. The same applies to issues concering exploitation. In addition, two workshops on semantic web and OPC UA issues have been organised exclusively for the consortium. A first draft of the plan for use and dissemination has been advanced and is incorporated in this activity report.

1.5 Expected end results, their intended use und possible impact

The S-TEN approach is based upon off-the-shelf Semantic Web software, plus standard ontologies for publishing measurements on the Web, standard ontologies for publishing network design data on the Web and rule bases to provide notification and operator support. Furthermore various software packages will be developed to prototype level within the S-TEN project. Some of them will be put into public domain, others will be developed into commercial products after the end of the project.

The S-TEN demonstrators to be developed within the project are examples of applications for which a traditional system is not suitable:

- 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.
- Control of Distributed Resources in Electrical Power Networks: For the control of distributed power generation, the control systems for conventional power generation are theoretically suitable, but the problem is the expense due to high number of elements in medium-voltage and low-voltage systems. The S-TEN technology will offer a low-cost solution for monitoring distributed electrical resources in these electrical networks.
- 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: SMEs often do not have the money or expertise to acquire or develop bespoke systems that add additional functionality to industrial automation systems. The S-TEN technology 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.

In a long run possible impact is seen in 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, that is 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 as exemplified in the demonstrators and beyond, like in active supply chain management.

1.6 Plan for using and disseminating

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

The S-TEN exploitation activities may provide a marketing platform to the individual partners. In addition a subset of the partners may have common exploitation plans which help to initiate the marketing process of a common product. Therefore one or more early business cases are developed during the project.

The S-TEN approach suggests the use of the Semantic Web and Knowledge Based Systems to facilitate the operation and maintenance of physical networks. It also provides decision support based on measurements, human observation and design data of continuously changing networks. The networks considered are environmental networks, such as river basins, electrical power transmission and distribution networks and industrial automation systems. Ontologies derived from widely used international standards enable intelligent equipment items to announce their existence on the Web. Some equipment items, particularly those involved in measurement and control, contain their own intelligence, and can publish information on the web whereas other equipment items are usually regarded as dumb.

Major industrial enterprises concerned with network management already have systems with the functionality offered by the S-TEN technology. Initially the S-TEN technology will not have any impact upon these traditionally systems.

Moreover 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.

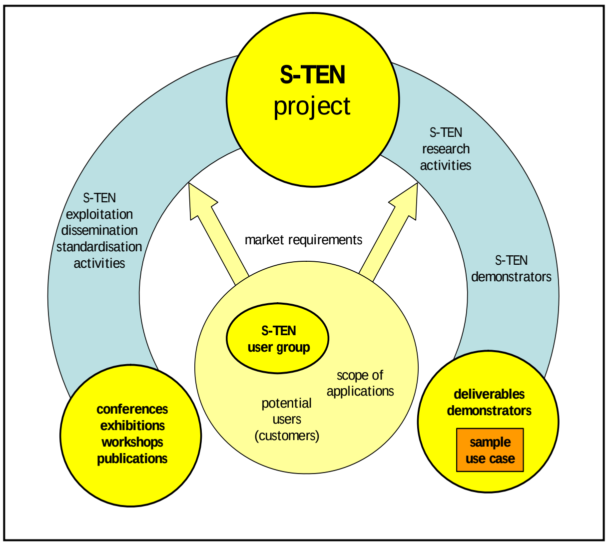

Figure 2: *S-TEN exploitation strategy overview*

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. The S-TEN demonstrators are examples of applications for which a traditional system is not suitable:

- Environmental Monitoring
- Control of Distributed Resources in Electrical Power Networks
- Secondary Control of Electrical Power Systems
- Initial Operation and Preventive Maintenance in Electrical Systems

Figure 2 illustrates the S-TEN exploitation strategy. The exploitation, dissemination and standardisation activities of the S-TEN project on one hand and the S-TEN research activities with the subsequent development of the demonstrators on the other hand set the framework for applications and potential future customers. As a consequence of the exploitation, dissemination and standardisation activities S-TEN will be present at conferences, exhibitions and workshops attracting potential users. A sample use case should convincingly point out the benefits of the S-TEN technology and will introduce the S-TEN technology to third parties by publications and presentations whenever appropriate and should also help to validate the technology.

Often bilateral meetings with potential customers end up with the conclusion: *We (i.E. the S-TEN consortium) have an innovative and capable solution and expect the user to have an appropriate problem*. Early contacts with users should help to identify the problems in advance and then tell the user: *You have a problem, we can solve it and you will make money out of it*. The user group is considered as a key issue in order to get feedback for the research activities, refine the specification of the demonstrators and retrieve market requirements. Therefore it plays a key role within the exploitation strategy.

Initial contacts to industrial partners for further product developments have already been established. S-TEN has been present in several standardization workshops and has attended international conferences.