GENESI

D7.3

REPORT ON THE FIRST OPEN WORKSHOP

public

The research leading to these results has received funding from the European Union Seventh Framework Programme under grant agreement Infso-ict n°257916.

Summary:

This document contains the Deliverable 7.3 on the first Workshop held on the 11th of March 2011 in Schiphol, The Netherlands.
It describes the participation to the event, its programme and contents. Moreover, it reports on the user feedback and lessons learnt, as well as on follow-up activities which resulted from the workshop.

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INTRODUCTION

The first GENESI workshop was held in Schiphol, the Netherlands, on the 11th of March 2011, at the business centre of Hilton Amsterdam Airport.
It was addressed to a selected group of potential end-users, with the aim to share with them the approached developed within the project during its first months; to obtain their feedback and validate our approaches with them.

The following companies and research centers were contacted to participate and received information on the GENESI objectives and technical achievements:

StabiAlert B.V, The Netherlands
PTC - Pulse Technology Centre, The Netherlands
Adviesbureau Van Kleunen B.V., The Netherlands
TNO, The Netherlands
Balfour Beatty Rail Ltd, United Kingdom
Sengenia Ltd, United Kingdom
Istituto Nazionale di Geofisica e Vulcanologia (INGV), Italy
Testconsult Ireland Limited, Ireland
Roughan & O'Donovan Consulting Engineers, Roughan & O'Donovan Innovative Solutions, Ireland
Oxand S.A., France
University of Nantes, France
Collins Engineers (Underwater Inspections), Ireland
National Roads Authority, Ireland
Coastway, Ireland
Iarnrod Eireann (Irish Rail), Ireland
Amphora NDT Ltd, United Kingdom
Protezione Civile, Italy

All contacted relevant stakeholders expressed interest in the project and many of them provided useful feedback. Due to conflicting commitments however only representatives from the following entities could attend in person:
PTC - Pulse Technology Centre
Adviesbureau Van Kleunen B.V
TNO
Balfour Beatty Rail Ltd
Sengenia Ltd / Amphora NDT Ltd

INGV

Moreover, project officer Jorge Pereira of the European Commission, DG Information Society and Media, Components and Systems, Embedded Systems and Control, attended the workshop.

Project partners were represented by project leaders as well as operational staff, to assure the highest impact of end-users feedback on the entire project staff.

The complete list of attendees is included below:

PARTICIPANTS LIST	**workshop GENESI - 11th March 2011**
Chiara Petrioli	University of Rome "La Sapienza"
Alessandro Trifiletti	University of Rome "La Sapienza"
alessandro Camillo	University of Rome "La Sapienza"
Ugo Colesanti	University of Rome "La Sapienza"
Gertruud van Leijen	University of Rome "La Sapienza"
Maurizio Martino	Consorzio Treesse
Andrea D'arcangelo	Consorzio Treesse
Nirvana Meratnia	University of Twente
Michele Magno	Alma Mater Studiorum University of Bologna
David Boyle	University College Cork, National University of Ireland, Tyndall Institute
Brendan	University College Cork, National University of Ireland, Tyndall Institute
Daniel Naterop	Solexperts A.G.
Cristian Dall'Oglio	ST Microelectronics
Jeroen Kleef	StabiAlert B.V.
Wessel Koning	PTC - Pulse Technology Centre
Johan van Kleunen	Adviesbureau Van Kleunen B.V
Miodrog Djurica	TNO
David Thompson	Balfour Beatty Rail Ltd
Dr Daniel McPolin	Sengenia Ltd / Amphora NDT Ltd
Giovanni Romeo	INGV
Jorge Pereira	European Commission, DG Information Society and Media, Components and Systems Embedded Systems and Control

1. PROGRAMME

The workshop started with a presentations of the projects objectives and a focus on the two use cases and their requirements, tackled within the project: the La Poya bridge near to Fribourg Switzerland and underground infrastructure in Rome. Thereafter, other scenarios and requirements were discussed and the solutions the project aims to provide with particular reference to architecture and nodes where shown. In the afternoon, several demos were presented, and a panel discussion with participants offered useful feedback to project partners. Finally, a questionnaire was given to the participants in order to get more detailed feedback.
Coffee- and lunch-breaks offered space for many in-depth discussions between participants and project staff, some of which are still continued by bilateral contacts.

The detailed programme was as follows:

Programme

9.30 Welcome and coffee

10.00 Presentation of the project (University of Rome 'La Sapienza', Chiara Petrioli)
10.30 Use scenario I: La Poya bridge at Fribourg Switzerland (Solexperts AG, Daniel Naterop)
10.50 Use scenario II: underground infrastructure in Rome (Consorzio Treesse, Andrea d'Arcangelo)
11.10 *Coffee break*
11.40 Other scenarios and synthesis on identified system requirements (University of Rome La Sapienza, Chiara Petrioli)
12.15 Solutions proposed concerning architecture and nodes (University College Cork/Tyndall, David Boyle)

13.00 Lunch

14.00 Presentation of Demo's:
* Static micro fuel cell (ST Microelectronics Srl)
* photovoltaic/wind harvester (Alma Mater Studiorum-University of Bologna)
* Wireless Sensor Network and integration with commercial sensors (Consorzio Treesse/ University of Rome 'La Sapienza')
* Structural health instrumentation; (Solexperts AG)
* Deployment tool (University College Cork/Tyndall)
15.00 Panel discussion and feedback from end users

15.30 coffee break

16.00 Panel discussion – continuation
16.45 Conclusions
17.00 Closure

Research Projects — Embedded Systems

GENESI

Green sEnsor NEtworks for Structural monitoring

GENESI develops structural health monitoring systems for critical infrastructures such as tunnels, bridges, dams, private and public buildings, providing cutting edge green wireless sensor networks technology

KEYWORDS: structural health monitoring, energy harvesting, wireless sensor networks

First Workshop

11th March, 9.30-17.00
Hilton – Amsterdam Airport Schiphol

Objectives

The first Workshop of the GENESI project is end-user oriented. It aims to share the first achievements and adopted solutions with potential end-users; to receive their feedback and validate our approaches with them.

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10.00 Presentation of the project (University. of Rome 'La Sapienza', Chiara Petrioli
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Information Society — European Commission

This project is co-financed by the EC 7th Framework Programme on Research & Development, and part of the portfolio of the Embedded Systems Unit – G3 Directorate General Information Society
For more information please check:
http://cordis.europa.eu/ist/embedded

2. CONTENTS

We now briefly summarize each talk, briefly sketching the discussions which followed the presentations. Appendix A includes a copy of the presentations which were given. Appendix B is the poster and demo proceedings (i.e. a description of the demos which was provided to participants, and the posters which were presented). Appendix C includes the questionnaire which was provided to end users before the workshop, as the basis for discussion, and feedbacks which were received.

Presentations

Presentation of the project

University of Rome 'La Sapienza', Chiara Petrioli

The first presentation provided an overview of the project motivations and objectives. Wireless Sensor Networks and structural health monitoring were introduced. Gaps in technology which prevents full adoption of WSNs for structural health monitoring were explained, introducing the rationale for GENESI solution, enabling long lasting monitoring in this domain. Selected test-bed scenarios were briefly reviewed, followed from a high level presentation of GENESI advanced enhanced node and system features.

Questions from the audience mainly addressed:
1) Representatives from research centres were stressing middleware research themes might have been more extensively addressed in the project. It was explained that the project stems from extensive contacts with end users. Such contacts have shown that while companies operating in the Structural Health Monitoring (SHM) field are extremely interested in long lasting monitoring and wireless sensor networks technology, as such technologies might enable new application domains and ease operations, they have already developed middleware layers to interface with many different kinds of instruments and developed tools to process and elaborate data. Such SHM systems are proprietary, companies believe simple and robust solutions they have developed is what they are interested in for the next few years. To maximize the possibility of exploitation of the project results our objective has therefore been developing a WSN for long lasting structural health monitoring and interfacing it to several existing SHM legacy systems (the ones developed by the end users partner of the project).
2) Multi-application and multi-authority issues. Another issue which was raised by representatives of research centres was how GENESI system would deal with the fact the network maybe shared by different institutions and applications. It is indeed the case that in typical GENESI application domains different institutions and companies have to access data. Take the example of the underground construction (metro B1 in Rome). Data are processed and validated by the company in charge of structural health monitoring; they are then provided to the construction company, to the authority in charge of controlling the construction works (local government representatives- Roma metropolitane in this specific case), and possibly made available in a summarized version to a large audience (e.g. citizens living in the area). All this implies complex access control rules, which limit access to data (only to some types of data or to coarser/finer grain views of data) depending on affiliation and role, and a data validation procedure. All this is already part of the structural health monitoring systems GENESI technology interfaces to. We simply provide measurements to those systems.
The multi-application issue maybe of interest in some application domains. In some critical phases of construction, based on preliminary contacts with end users, it is unlikely that construction companies will accept to devote the WSN system to something different than measuring critical SHM

parameters. However, when the long lasting monitoring is considered, and the system is in operation, it is true that it makes sense to use a technology like the one provided by GENESI to perform multi-application monitoring. This is an interesting aspect to be accounted for when performing system optimization.
All the following explanations were provided in follow up discussions.
3) Interfacing with real sensors. A major issue which was typically raised by industrial attendees was that some sensors maybe energy consuming. In general the comments were raised based on experience with some commercial products. It was explained this maybe the case but that one of the objectives of GENESI work is to provide smart interfaces to such sensors significantly reducing their energy consumption. An example was given for what concerns vibrating wire strain gauges. This part of the discussion was indeed very interesting. As some of the key techniques for energy-efficient operations were explained ideas started coming out from the end users audience showing that in the majority of cases simple things could be done to reduce the energy consumption of sensors so that they could also be used in a long lasting monitoring scenario.
4) Platform selection. Presentation of GENESI stimulated ideas from the audience of possible uses in different domains: environmental monitoring, seismic events monitoring, monitoring of the railway system etc. Depending on the domain the discussion pointed out that different HW platforms could be of interest with different performance and different energy and cost requirements. These discussions were very interesting and lead to follow up activities from some of the GENESI partners to understand in detail such requirements and see which are the steps needed to extend exploitation opportunities of what done in GENESI. Indeed better energy performance, use of fuel cells, possibility to spend energy only when needed (e.g., radio triggering circuit) were considered very important technological improvements by company representatives. They were interested in exploiting such improvements also in intensive computation and short lasting application domains. Such domains are very different from what envisioned in GENESI. Therefore, while stimulating internal discussion to understand the steps to broaden application of some of the technological results in different domains, such activities have to be considered outside the scope of the GENESI project.
5) System intelligence. Here a twofold approach came out from the discussion. While some members of the audience (some of the research centres, high tech SMEs) were open to self-learning systems and to systems adding intelligence to SHM (wanting to see this work in practice before considering it for exploitation purposes), more traditional companies operating in the field and institutes in charge of controlling data to detect possible hazards raised the point current laws, legislations and current practice make unlikely that in these application domains it is accepted to leave control to the automatic monitoring system. It is at least required that periodic access to data by human beings ensures full operation of the system. Then reasoning by the system can be performed to provide more elaborated data, but access to raw data upon request may still be required in many application domains. These comments will be accounted for in GENESI and require an iterative approach with different levels of intelligence embedded in the system depending on target application.

Use scenario I: La Poya bridge at Fribourg Switzerland
Solexperts AG, Daniel Naterop

The presentation covered a wide range of application domains where structural health monitoring is typically adopted, with associated requirements both in terms of sensing and communication. Risk management procedures were also discussed as a methodology for systematic structural health monitoring. The Poya bridge application scenario was discussed in particular detail. A discussion on the level of intelligence and autonomous operation which is expected to be acceptable for these types of systems concluded the presentation, stimulating discussion with audience.

Use scenario II: underground infrastructure in Rome

Consorzio Treesse, Andrea d'Arcangelo

At Schiphol workshop the TreEsse presentation was on MetroB1 underground deployment scenario. The monitoring sections of Rome underground were described in detail. Each monitoring section consists of strain gauges for concrete, to which GENESI sensor nodes might be applied. The strain gauges for concrete are used to measure the strain, and to define the stress status inside the final lining of the tunnels. Strain gauges for concrete are installed on the steel supporting structures of the precast segments of the tunnel final lining.A typical instrumented monitoring section in gallery has three segments (B, E, G) with 6 strain gauges each. In addition the advantages of GENESI system over existing traditional systems were described: low impact on construction works and real-time information, acquisition and transmission of data in difficult environments (as the tunnel building site), a significant time saving and consequently economic gain, using an innovative, less invasive, monitoring system, which does not require cables installation and installation of data-loggers.
Questions from the audience and follow up discussions mainly addressed:
1) The strain gauge technical specifications and the supply used for strain gauge.
2) The problems of monitoring data acquisition in difficult environment conditions, such as the ones found in the tunnels; the presence of different impacts: dust, humidity, possibly electromagnetic disturbance due to machines and other radio technique, the large temperature range from -10°C to +40°C.
3) The impossibility to lay cables in the installation phase of the concrete segments, because the tunnel boring machine and the presence of its shield and its mechanical parts prevents direct access to the strain gauges data-loggers.

Other scenarios and synthesis on identified system requirements

University of Rome La Sapienza, Chiara Petrioli

Due to time constraints this presentation was skipped and was only provided to interested attendees. Information included in the presentation was provided during F2F talks during the breaks.

One of the reasons why the presentation was skipped was that it had the objective to explain different possible applications of GENESI WSN technology to all the different possible domains in SHM and to different application domains than those covered by the project. Interaction with partners during the first presentations and during off line discussions had already clearly shown that attendees were naturally thinking along those lines. Actually we had almost the opposite problem, with attendees who were trying to apply GENESI technology to any application domain, raising issues on changes of platform features to match very specific needs of application domains different from that addressed in the project. We therefore realized the message of the presentation had already been partially conveyed. From a technical point of view Solexperts presentation had also partially covered material prepared for this presentation. The day before the workshop there was a discussion among project partners on relevant aspects related to system intelligence on which we wanted to get feedback from relevant stakeholders. As a result of this discussion Solexperts revised overnight its presentation, to explain their view of possible application (and required system intelligence) in a variety of SHM domains. This already covered with a field-based experience approach, which turned out to be interesting for the attendees, a good part of the material that had been previously prepared to explain the requirements of SHM domains different from bridge and tunnel monitoring. What was left out was a discussion of application of GENESI technology to different application domains

which was however one of the most discussed topic during the coffee break discussions. Possible applications of some aspects of GENESI results to different domains ranging from environmental monitoring, hydro-geological risk assessment, earthquake monitoring system, to railways system monitoring were discussed. Such discussions confirmed potential of application of GENESI results to a much wider domain than what covered in the project scope.

Solutions proposed concerning architecture and nodes
University College Cork/Tyndall, David Boyle

This talk detailed the analysis of the system requirements based on initial understanding of the application requirements and associated challenges. Leveraging the user-driven approach to the design of the system, the prospective device architecture has emerged. In addition to meeting the high level project goals of designing a green, reliable and robust, portable and interoperable GENESI system, finer details such as the integration requirements of industry standard sensors, sampling and data granularity at the device level are considered. A three layer abstraction of the GENESI node architecture was described. The main layer, consisting of a low-power microcontroller and IEEE 802.15.4 compatible radio transceiver, was proposed to be static, allowing for physical interfacing to the upper "sensor" and lower "smart power" layers. This approach allows a variety of independent experimentation with respect to both sensor and intelligent power options to be undertaken, without the need for altering the fundamental node architecture. Additional system requirements, such as extendible memory and enhanced ADC capabilities can be included as part of the sensor layer, whilst communicable energy information from the smart power unit can be passed to the main layer (using SPI, for example, between the main microcontroller and that present in the smart power unit).

The discussion which followed confirmed the end-user requirement for 16 bit ADC capabilities to achieve the necessary data granularity extends beyond the pilot deployment of GENESI. It was expressed that the choice of the IEEE 802.15.4 standard as the underlying communications protocol was the most appropriate. Concerns emerged as to the ability of the GENESI nodes to detect transient events (such as an impact, tremor, etc.) that may or may not be sensed depending on the duty cycle of the node. Clearly it is understood that this is an application dependent concern. There was some discussion regarding interfacing sensors to the PCB, and potential hazards, but it is understood that the off-the-shelf sensors will be cabled to the interfacing PCB, likely through a metallic casing, and thus should not experience such issues. This will be an area for ongoing experimentation as each sensor is interfaced and characterised.

Presentation of Demo's

Static micro fuel cell

ST Microelectronics Srl

In the Demo session for the GENESI workshop ST presented a miniaturized version of its hydrogen fuel cell. The fuel cell presented was ready to be connected to a hydrogen tank and to the UNIBO power unit for battery recharging and to supply the GENESI platform. In the poster of demo, ST showed the performance of fuel cell and characterized it in terms of voltage, current and power. Moreover some charts showed the comparison with small size and large size cells.
ST received good feedbacks from the invited researchers and companies. People were very interested about the power density of fuel cells which is much more higher that traditional energy storage devices. Furthermore the possibility to charge batteries and Supercapacitors with it, as last energy resource optio,n has been evaluated as a very strong enhancement for system reliability. Most of the questions were about the size of the fuel cell with the hydrogen tanks and about its safety and stability. Several questions were also about the power density of fuel cells and on how many batteries they can recharge with respect the stored hydrogen.

Photovoltaic/wind harvester

Alma Mater Studiorum-University of Bologna

The interest in small size power unit able to supply wireless platform is one of goal for GENESI project. In the Demo, UNIBO presented an harvester unit designed for wireless sensor nodes which is able to harvest efficiently solar energy and it is ready to host wind harvesting. The unit can recharge batteries as well as supercapacitors. The unit provides information about the state of storage devices and about the environmental sources permitting the power platform to adapt the application parameters and to optimize the power consumption. We addressed different configurations using different kind of storages and characterized the system in terms of efficiency.
The feedback from the audience was impressive. The invited companies and research centres were very interested on the opportunity to power electronic devices without the need of traditional storage devices, or at least to deal with electronics which do not strictly depends on batteries. Most of the questions raised were about its features (e.g. electrical characteristics, power delivered, if the perpetual power supply is guaranteed), moreover there were questions about design methodology. Many of the end-users were interested about the possibility to use the power unit for their applications in various scenarios and they were impressed on how much the harvesters are configurable and how easily it can be tailored to specific applications.

Wireless Sensor Network and integration with commercial sensors

University of Rome 'La Sapienza'

The presented demo had around twenty TelosB nodes programmed with an extremely low duty cycle communication protocol which is part of UOR background. Nodes receive an interest from the sink, and convergecast real sensor data back to the sink. To this purpose two nodes where interconnected to two types of strain gauges: a resistive strain gauge and a vibrating wire strain gauge. Both were selected together with Treesse based on their requirements for the tunnel GENESI scenario. The

interface with vibrating wire strain gauge was the one designed in the project for energy-efficient performance, which will also be mounted on GENESI platform.

Questions from the audience regarded the network lifetime which can be achieved by the type of protocol which was running (which represents SoA in terms of energy efficiency). This stimulated discussion also on the current limits and what GENESI is doing to overcome them. Questions also addressed the level of reactivity of duty cycle based approaches. Finally several questions were done of performance and features of the interface we designed to vibrating wire strain gauges.

Structural health instrumentation
Solexperts AG

As typical measurement instruments for SHM surface extensometers, pore water pressure sensors and tiltmeters where demonstrated. This allowed attendees to get a clear idea of off the shelf structural health monitoring sensors and allowed to discuss challenges related to integration of such sensors in the nodes, as well as challenges related to energy requirements.

Deployment tool
University College Cork/Tyndall

Tyndall demonstrated the Tyndall Heterogeneous Automated Wireless Sensors (THAWS) tool. The tool, implemented as a python script, once executed, was shown to generate new binary files and deltas that can be used to reprogram a wireless network from a simple network description formatted using JSON notation. It was shown that a number of parameters (such as sampling rate, PHY channel, network topology, etc.) can be changed effectively, in addition to the possibility of completely changing the underlying code of the running application. Newly generated code updates were flashed to Tyndall 25mm and 10mm layers, based on Atmel Atmega128 and 8051 microcontrollers, respectively, illustrating the functionality of the tool.

The tool generated some interesting and relevant questions, primarily focused on how the tool can be ported to the GENESI platform (based on the MSP430 microcontroller), which will require a thorough examination of the microcontroller (and available compilers (mspgcc, IAR, etc.)), memory structure and bootloader capabilities. A number of questions related to the usefulness and extendibility of the tool to perform a variety of in-network tasks were posed, in addition to the possibility of a GUI based version. Further questions related to possible mechanisms for wireless propagation of code updates throughout the network. These are all considerations that will be taken into account as WP4 progresses in conjunction with the emergent requirements from WP2.

3. LESSONS LEARNT

The audience was asked to answer a long questionnaire which was returned to the project coordinator after a few weeks. Some questionnaires which were returned with non trivial elaboration are included in Appendix D. The questionnaire addressed many different aspects.

Each attendee was asked to identify the application domains part of the attendees background which could benefit from GENESI technology, summarizing the distinguished features of GENESI technology which would make it a winning solution for the given application domain. Attendees

were also requested to identify the missing HW/SW components/features needed to fully address the requirements of real deployments in the specified application domain.

Attendees were also asked to comment on the set of sensors needed to cover the needs of the specified application domain (this was not asked with the idea to cover all the listed interfaces in the project but to be able to draft a roadmap towards wider exploitation of the resulting GENESI technology).

In addition attendees were asked to comment on operational requirements in the identified application domains and on features of the system they believe would be important to make the system accepted by end users and adopted for widespread use. This gave interesting insights on the metrics and features to carefully evaluate when assessing our system performance.

Finally attendees were asked to comment on the set of communication primitives which would need to be supported in the different application domains.

As a result of the many interactions and formal answers to questionnaire received the following lessons were learnt:

- End users found many of the GENESI technologies relevant to different application domains, even outside the scope of the project. For instance they were interested in multi-source energy harvesting, fuel cell technology also for data intensive relatively short term applications. Application domains which were identified relevant include: Large scale infrastructure monitoring; Train bourn condition monitoring; Track/Bridge and Formation condition monitoring; Applications based on geophysical measurements.

- From a practical perspective some important priorities for widespread use have been identified:
    - Dependability is a key factor and requires to ensure availability, full reliability, maintainability, and the required level of performance over time.
    - Robustness should be ensured also in presence of interference and noise. Interference and signal propagation in challenging deployment environments such as those identified for GENESI deployments should be measured and characterized since it is not clear whether having e.g., to communicate through concrete could significantly impair system performance. Simple, robust solutions tailored to the application domains and deployment environments should be envisioned.
    - Generic sensor interfaces and interfaces which enable to integrate in the node different commercial sensors of the same type are a key issue for widespread adoption. Different end users will want to adopt different sensors and different brands for the same type of sensors depending on a variety of factors (trust on brand and performance of the sensor, commercial agreements and partnership, requirements and preference from customers paying e.g. for the construction works).
    - Despite many of the GENESI components appear to be applicable to different, unforeseen application domains, having an operational system able to operate in different application domains will require non trivial customization and extensions in terms of a) supported sensors; b) energy which should be produced by the harvesters (which in some cases should go up to a few watts); c) need to increase the data rate in some geophysical application and to support bursty transmissions; d) level of synchronization and clock precision supported. The consortium felt the project needs

to be focused and target the identified application domain of long lasting structural health monitoring. However, identified extensions are and will be considered for increasing GENESI exploitation and to identify an exploitation roadmap behind the identified application domain.

- Relevant standards also in terms of operational security should be considered depending on the application domain. For instance, there are serious doubts an hydrogen based fuel cell will be accepted to be placed on the line-side of the railways system.
- Despite the project has ambitious objectives in terms of local processing techniques, automatic processing and reasoning which may result in significant system performance improvements it is not clear whether end users in the identified application domains are ready to give control to an automatic system as of today. In general the common feeling of the audience was that engineers and scientists will want to be able to get back to the raw data. There is also an important aspect associated to legal liability in some countries and application domains which may result in the responsible engineer/scientist wanting to have full control and wanting to be able to retrieve and inspect all raw data. What seems to be most promising for immediate use and adoption are simple and smart local processing and compression techniques which save in terms of communication cost and energy consumption without compromising user ability to be in control. It is also possible that not all data are sent, some being communicated only upon request (and stored in case of a request for a limited amount of time). Reasoning and advanced decision support techniques maybe useful in the medium term but keeping the user in the loop and in control.
- Identified primitives truly reflect communication needs of the different identified relevant application domains. Specifically broadcasting is mandatory, and should be complemented by the ability of the gateway to address and configure also specific nodes, wireless programmability and network management are important aspects which should be considered and supported; both event based and periodic convergecasting of data (both measurements and data on the status of the nodes and network) should be supported.

4. ACTIONS TAKEN TO ACCOUNT FOR THE WORKSHOP OUTCOMES

Comments from end users have been very seriously considered and are accounted for in all our on going activities.

WP5 has been refocused and is accounting for the suggestions of leaving end users in control. WP5 is designing simple strategies for local processing and event detection to be used in the short terms and support decision making tools (which leave the user in control) for the medium term.

Dependability is being considered in our design. Characterization of the operational challenges in the GENESI deployment environments is being performed and is taking significant effort now that the first deployment is in place in Rome. It will be extended also to the second deployment scenario in Switzerland.

General sensor interfaces is the approach which is being followed in WP3 to interconnect to the node all sensors of interest to GENESI SHM application scenarios. Solutions for the fuel cell which overcome some of the concerns of the reviewers are being considered.

The wider interest in many of the GENESI technologies (from harvesters to fuel cells to extremely low power communications techniques) expressed by the end users attending the workshop has stimulated extensive contacts with some end users, additional contacts with relevant stakeholders summarized in the following section**.**

5. FOLLOW UP CONTACTS WITH END USERS AND DISSEMINATION ACTIVITIES

Contacts with Roma Metropolitane, ATAC, Finmeccanica have pointed out high interest in long term large infrastructures monitoring, with system requirements well mapping GENESI deployments.

Contacts with Treesse, archaeologists and experts of cultural heritage monitoring have opened new opportunities of application of GENESI system in the field of historical building and archaeological sites monitoring to prevent a variety of risks. Contacts with different Italian archaeological sites have been taken for future system installations.

Follow up contacts with INGV have better defined their interest in GENESI outcomes, which is associated to energy neutral systems (more demanding in terms of raw data transmissions than what currently considered in the project) to low energy consumption robust wireless communication systems for ad hoc installations of mobile sensor networks units.

Contacts with Balfour Beatty Rail Ltd have been followed up, with interest in a commercial system development. Tyndall is in contact with them for possible joint exploitations.

In several dissemination opportunities (at conferences, during EC cluster meetings) high interest on GENESI technology has been expressed by research groups operating on sensor nodes deployments (in the US, Europe and China). In the latter case contacts and expressions of interest were related to both structural health monitoring and cultural heritage monitoring and preservation.

APPENDIXES

A. *Presentations*
   1. Presentation of the project (University of Rome 'La Sapienza', Chiara Petrioli)
   2. Use scenario I: La Poya bridge at Fribourg Switzerland (Solexperts AG, Daniel Naterop)
   3. Use scenario II: underground infrastructure in Rome (Consorzio Treesse, Andrea d'Arcangelo)
   4. Other scenarios and synthesis on identified system requirements (University of Rome La Sapienza, Chiara Petrioli)
   5. Solutions proposed concerning architecture and nodes (University College Cork/Tyndall, David Boyle)

B. *Posters*
   1. H2 Fuel Cells realized by PCB (Printed Circuit Board) Technology (ST Microelectronics Srl, Cristian Dall'Oglio, Andrea Lazzara, Salvatore Leonardi, Roberta Giuffrida)
   2. Smart power unit for green wireless sensor network (Alma Mater Studiorum-University of Bologna, Michele Magno, Davide Brunelli, Luca Benini)
   3. Wireless Sensor Networks for Structural Health Monitoring (University of Rome 'La Sapienza', Alessandro Camillò, Ugo Colesanti, Pietro Monsurro, Chiara Petrioli, Pasquale Tommasino, Alessandro Trifiletti)
   4. Solar energy harvesting systems (University of Rome 'La Sapienza', Chiara Petrioli, Dora Spenza)
   5. Deployment Scenario: Pont de la Poya, Fribourg, Switzerland (Solexperts AG, Daniel Naterop, Holger Wörsching)
   6. Efficiently Reprogramming Heterogeneous Wireless Sensor Networks (University College Cork/Tyndall, David Boyle, Seán Harte, Emanuel Popovici, Brendan O'Flynn)
   7. Collaborative in-network data processing and reasoning (University of Twente, Zahra Taghikhaki, Yang Zhang, Nirvana Meratnia, Paul Havinga)

C. *Demo-descriptions*
   1. Demo: H2 fuel cells realized by PCB (Printed circuit board) technology (ST Microelectronics Srl, Cristian Dall'Oglio, Andrea Lazzara, Salvatore Leonardi, Roberta Giuffrida)
   2. Demo: smart power unit for green wireless sensor network: photovoltaic harvester (Alma Mater Studiorum-University of Bologna, Luca Benini, Davide Brunelli, Michele Magno)
   3. Demo: Ultralow-power Collection Protocol for Wireless Sensor Networks in Structural Health Monitoring applications (Chiara Petrioli, Alessandro Camillò, Ugo Colesanti, Pasquale Tommasino, Alessandro Trifiletti) Presentation instrumentation deployment scenario: Pont de la Poya, Fribourg, Switzerland (Solexperts AG, Daniel Naterop, Holger Wörsching, Hans-Jakob Becker)
   4. Demo: Tyndall heterogeneous automated wireless sensors (THAWS) (University College Cork/Tyndall, David Boyle, Seán Harte, Emanuel Popovici, Brendan O'Flynn)

D. *Questionnaires for end-users*
   1. Questionnaire for end-users (empty)
   2. Romeo
   3. Thompson
   4. TNO