GENESIS – A Framework for Global Engineering of Embedded Systems

Catalin Buiu
"Politehnica" University of Bucharest
Bucharest, Romania
cbuiu@ics.pub.ro

Mario Zagar
University of Zagreb
Zagreb, Croatia
mario.zagar@fer.hr

Radu Dobrin
Malardalen Univeristy
Vasteras, Sweden
radu.dobrin@mdh.se

Sylvia Ilieva
Sofia University "St. Kliment Ohridski",
Sofia, Bulgaria
sylvia@acad.bg

Adnan Salihbegovic
University of Sarajevo
Sarajevo, Bosnia and Herzegovina
asalihbegovic@etf.unsa.ba

Tiberiu Seceleanu
University of Turku
Turku, Finland
tiberiu.seceleanu@utu.fi

ABSTRACT

GENESIS is an European initiative involving institutions and persons from older and new EU members, and West Balkan countries. It aims at developing a global network of research and education in embedded systems. The related research will be coordinated in such a way to address hot topics at European and global levels and will concentrate on the fusion of embedded systems and distributed services over the Internet. One of the main objectives of GENESIS is to develop a distributed virtual laboratory to be used in embedded systems research and education and this is described in detail. This paper presents the rationale behind this initiative and the main actions that are proposed to fulfill the educational, and scientific objectives of GENESIS.

Categories and Subject Descriptors

K.3.1 [**Computers and Education**]: Computer Uses in Education—*collaborative learning, distance learning*; K.4.3 [**Computers and Society**]: Organizational Impacts—*computer supported collaborative work*; K.6.1 [**Management of Computing and Information Systems**]: Project and People Management—*systems development, training*

General Terms

Management

1. INTRODUCTION

The term "embedded systems" refers to a large scale of electronic products, with a complex behaviour, which are integrating parts of large systems [2]. More than 99% of today's processors are operated in embedded systems rather then in conventional computers. Embedded technologies are the fastest growing sector in information technology. They are keys to the competitiveness of existing industrial sectors and are leading to the emergence of new markets and business opportunities. The development of embedded systems is essential in many different business domains, including telecommunications, industrial automation, avionics and automotive industries, consumer electronics, in-house intelligent devices, and different type of information systems, web-based and service-oriented systems, such as e-government, e-health, traffic control, etc. In many of these domains European industry has an advantage due to its ability in mastering their complexity.

1.1 The European embedded systems context

European academic and industrial partners noticed the need to strengthen the embedded systems development in Europe. One of the viable responses was the creation of the embedded systems technology platform, ARTEMIS [1] (Advanced Research & Technology for Embedded Intelligence and Systems). One of the main ARTEMIS objectives is to to create the necessary critical mass and co-ordinate research efforts and initiatives across Europe in order to establish and implement a coherent and integrated European research and development strategy for Embedded Systems. ARTEMIS offers the most representative guidelines to follow in any large embedded systems context. The strength of embedded systems and their impact in modern society is obtained not only by embedded systems themselves, but with their interaction and integration in different types of networks, building complex and previously non-imaginable services. Services themselves are in focus of another technology platform NESSI (Networked European Software and Services Initiative) [3]. Some of the NESSI research priorities are: Service-oriented utility infrastructure, Service and System Engineering, Adaptive interactions, Trust, security and dependability. The areas targeted by ARTEMIS and NESSI are of the vital importance not only for highly technological developed EU countries, but in particular for EU convergence areas and WBC. Not only that the technologies addressed by ARTEMIS and NESSI are the main enablers for the rapid advances in industries, new opportunities in creation of new jobs, but also for substantial increase infras-

tructures and support in everyday life, access to information, integration within Europe, and achieving transparency and efficiency in administration and governing the society on all levels. Part of GENESIS core partners and members of the GSC have already established strong links with either one or both European technology platforms (ETP), ARTEMIS and NESSI. The respective programmes will be followed continuously during GENESIS, such that the cooperation within the project is conducted according to the latest trends in the field. Thus, at the end of GENESIS, all the core partners will be already familiarized with the procedures within these organizations and will be able, individually, or in teams, to contribute to and access the programmes defined by these ETPs.

2. GENESIS – GLOBAL ENGINEERING OF EMBEDDED SYSTEMS

GENESIS is an initiative for promoting closer S&T cooperation opportunities between EU, EU convergence areas, and the Western Balkan Countries (WBC) in the field of Embedded Systems. The GENESIS proposal answers to the call objectives by promoting a tight cooperation in the area of Embedded Systems in distributed environment, running on two main tracks: (i) strengthening of S&T potential and (ii) preparations for further development, targeting post-GENESIS activities. The first goal is achieved by common research actions, where student and staff exchanges are the main facilitators; the second goal is achieved through a more complex group of activities, encompassing education, future project preparation, integration in European research environment, connectivity with industrial actors. For the latter, GENESIS will promote local cooperation between industry and academia, in order to sustain the accumulated results through continuous interaction. Thus, a certain "business model" will be developed that will enable local and regional actors to participate with real success chances in European level activities. We also provide "building career" activities that should encourage the young student to stay at home (or returning home) in order to directly participate to the development of their native regions.

The goals of GENESIS will be achieved while acting on two dimensions. First, research activities between partners will be correlated in a way to address topics of utmost importance at the European level. Through the coordinated effort of a large research base, advances in the selected areas are expected to boost the competence of the partners from EU convergence areas and WBC while also strengthening the position of the member state research partners. Secondly, this research effort will be transformed such that educational activities will also take benefits, in order to support a sustainable effect in the future. Both the above tracks of the project will contribute to improve the visibility and capability of convergence and WB area partners. This will further help their position to:

- successfully participate in future european research programmes;

- successfully obtain locally distributed funds for research and infrastructure development;

- become more attractive partners for international and local industry;

- provide attractive working environments for research and educational staff, especially for graduate students, in order to pursue a career in their home countries.

The GENESIS activities will be performed in the scope of the areas targeted by ARTEMIS and NESSI: the focus area of GENESIS is engineering of embedded systems in combination with distributed services: developing, using and controlling embedded systems over the Internet. The focus area includes the following specializations:

- CBD – Component-based development: including development of component models and services, and life-cycle processes

- RTS – Real-time systems; development and modeling of real-time systems and real-time properties

- PBD – Platform based design: Modeling and development of embedded systems platforms including system on chip (SoC) design.

2.1 Concept

The concept to achieve these objectives is designed by the following types of complementary activities:

- Performing common continuous or periodical activities that will ensure continuity and strong engagement between the partners

  - Participation in existing research projects that are of genuine interest for the partners;

  - Planning the new projects that are of strategic interest of the partners;

  - PhD students and younger researchers exchange among project partners and their participation in the research projects;

  - Development of a distributed embedded systems laboratory that will be used in common projects and training;

  - Organization of workshops or special sessions, co-located to international events;

  - Organization of summer schools;

  - Sharing course material or whole courses, and updating courses.

- Increasing the visibility of WBC and EU convergence partners in the EU research and education initiatives

  - Enabling visits at EU research centers of excellences, part of projects and networks of Excellence;

  - Mutual senior staff exchange between the partners in a form of short visits;

  - Establishment of a strong connection between partners from convergence and WB regions with European Technological Platforms

  - Preparation for new proposals for EU calls

- Advancing the infrastructure at WBC and EU convergence partners

  - Recruiting new PhD students;

– Strengthening and extending of cooperation with both local and external industrial partners, and local and regional authorities.

In addition, GENESIS plans to attract a significant number of industrial affiliates, SMEs and larger companies active in the project research areas. We group these companies in the so called *GENESIS Support Club* (GSC). The goal of the GSC initiative is to provide a base for industrial insights on the development of the project, by supplying guidance in research end education corresponding to the specifics of their activities. The GSC will:

- help the development of embedded systems activities on the local and regional level, through an increased interaction between academia and industry

- create or tighten trans-European industry-industry and industry-academic partnerships

- ensure that the research work is addressing industry needs and

- contribute to the development of future FP7 or regional project plans to attract young PhD researchers to industry.

2.2 Core activities

The core activities of GENESIS are:

1. *Infrastructure advance support* - building a local and an integrated infrastructure that will sustain and that will be further developed after the completion of GENESIS. This will be done in a form of development of Distributed Virtual Laboratory for Embedded Systems (DIVILAB). Every site will develop (a new or further develop) a laboratory in which different embedded systems can be accessed remotely over the Internet. All these local laboratories will be integrated in a virtual laboratory which will be accessible for all partners. During the project DIVILAB will be used for research and training activities. After the GENESIS completion DIVILAB will be used by the partners in common and local activities.

2. *Research and education advances* - inclusion of new EU and WB countries in the research activities provided by partners from old EU members and characterized by excellence and strategic importance for EU. This will be implemented by a series of longer stays of young and newly recruit researchers and their participation in the existing research projects, and by short stays of senior researchers, discussing the research strategic directions and participation in the new research initiatives. The second type of activities is related to the increase of regional cooperation. This includes cooperation between new EU and WB countries and will be boosted by mutual short visits and organization of common workshops. In addition to research activities, the same type of advances will be developed in the education area, as a support activity, especially for post-GENESIS developments. DIVILAB and curricula related to embedded systems will be used as basis for these activities. All partners will exchange experience in the education, analyze and compare the curricula and transfer particular courses between themselves. Further, some new integrated courses that use

DIVILAB will be prepared. The intention is that the students from different sites participate together in them. The experience in already existing integrated (bi-lateral) courses will be used.

3. *Preparation for strategic development* - increase the ability of new EU and WB countries to participate in leading research European initiatives and those initiatives that are of strategic importance for the regions in long term. Activities included here are the following. (i) Increasing the research and education relevance for the local industry and society. This includes interaction with the local industry and local authorities. (ii) Increasing the cooperation abilities in order to be better prepared for initiatives of EU regional support. (iii) Increasing the visibility of the research and education excellence. The participants from new EU and WB countries are the leading regional research and education centres, but often not visible in EU because of different political and historical reasons. The activities here will be focused on increasing visibility by participating in international events (joining projects, visiting meeting of network of excellences, participation in the conferences, and organizing workshops and special sessions or tracks in the international conferences). This will be realized in WP6 - Strategic development.

In addition to these core activities, a number of dissemination activities will be performed to increase the visibility and influence of the results achieved in GENESIS. To make the entire project efficient and of high quality, setup activities will define the starting framework of all activities, and the management activities will take care of coordination, staff exchange, successful performance and completion of GENESIS.

In the rest of the paper we describe in detail each of the core activities.

3. DIVILAB

One of the objective of GENESIS is to develop a *distributed virtual laboratory* (DIVILAB) aimed to be used in education as well as in research. The DIVILAB will be an infrastructure that will be shared by the partners during and after the project for research and education purposes. It will facilitate students to use it for various education and research purposes, from development and use of modern technologies, to the research and verification purposes. More specifically, DIVILAB will provide:

- support for monitoring and controlling embedded systems over the Internet

- support for testing applications, services and components that will be developed locally or remotely on development servers, and downloaded to the local devices

- support for transfer of course modules between partners

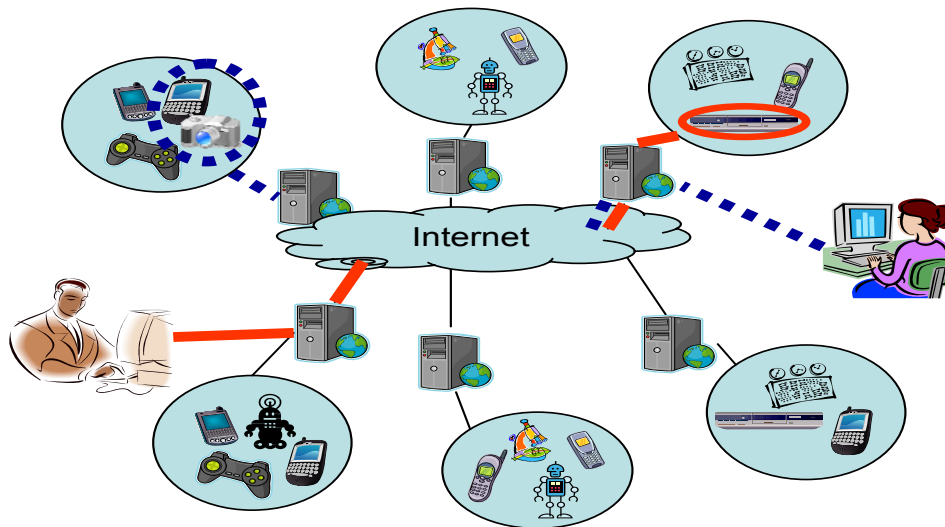- a management system that enables booking and availability of devices.

Figure 1: DIVILAB – overview

Figure 1 shows an overall configuration of DIVILAB. Additionally, every site has its own *local virtual laboratory* (VILAB) (Figure 2) controlling different devices (embedded systems). These devices can be different for different VILABs; In several cases the existing equipment will be used and some additional will be included. The embedded systems are connected to local servers which in their turn are connected to the Internet. The embedded systems and servers provide means for communication over the Internet that enables remote user control of the local devices. In this way, a user located at one site can simultaneously use a device placed in the laboratory of a second site and another device placed at a third site. At each site, a VILAB will include the following

Figure 2: VILAB – overview

modules:

- Target systems (embedded systems - object of interest) and their interfaces to the client

- Server system responsible for the communication to the target systems (over Internet protocols or by emulating classical serial protocols)

- Web technologies (interface) for establishing communication between the client and the particular target – embedded system (over the server system)

- Secure communication from the client to the particular target embedded system

- Reservation system with the appropriate user's database and the timetable.

To build the DIVILAB, based on the local VILAB-s, a number of tasks will be performed while taking into account the extra effort based on the partners total geographical distribution, different target systems, different time zones and local policies.

3.1 Tasks

Specification of the current systems and requirements specification.

Current embedded systems, software components and requirements specification will be defined. The purpose of the overall structure and the benefits of the whole system will be studied. The objectives and the goals will be clarified. Particular tasks activities for the local groups will be assigned. Common protocols will be defined

Setup of local laboratories.

Local laboratories will be analysed and their internal structure adjusted for the global integration. Local repository of the resources and their characteristics will be built. Access to the local repository will be defined as well as the availability and conditions of their usage. Common interface will be introduced, while still maintaining local distinguishing features. Since some of the partners already have embedded systems laboratory and virtual laboratory, the task also includes transfer of technology and solutions between different
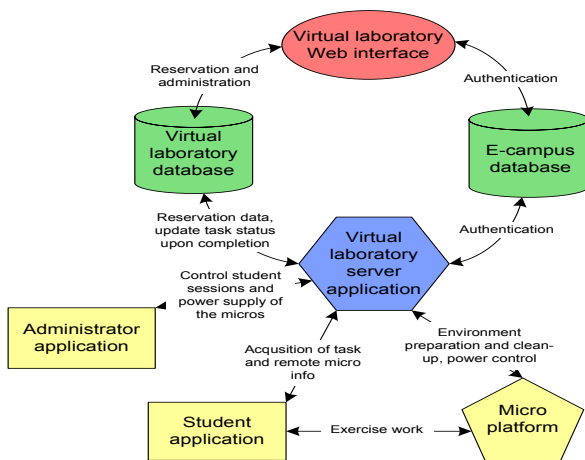
centres. In this way the synergy effects will take significantly speed up the establishment of local laboratories.

Deployment of common distributed integrated development environment.

The overall systems will be deployed, tested and adjusted for the everyday usage. Protocol for future applications integration will be developed. Target embedded systems architectures appropriate for future expansion of the current system and integration of new geographic sites will be analysed.

Building of common management system.

The key factor relevant for the successful running of the distributed remote laboratory is common management system. The global management system will be established with the utilities for the administrators and the utilities for the clients. Security aspects of the management and user communication will be addressed. Also a global usage plan and local supports will be defined and implemented.

4. EDUCATION ADVANCE SUPPORT

The preparation of embedded systems engineers for the next decade is a major challenge for the progress of the new application and solution development. Investigation and production of embedded systems require an increased role of engineering education, as a supportive activity. A major goal is to harmonize the educational efforts within the areas of embedded systems and software engineering among partner universities and to set the grounds for future educational programmes in these disciplines at European levels. Here, we will use the results about current curricula situation at partner sites to transfer specific course modules between the participant sites in order to update local curricula. The lecture material could be lecture slides and scripts, course notes, lab material, design examples and design flows or any other suitable material resulting from the topics of the corresponding thesis.

Not necessarily all material can find its way into educational activities, but it is expected that a large number of course updates are possible to be obtained. The feedback scheme may be quite complex, and it requires a dedicated attention throughout the project execution. The modules - as defined locally, within each partner's curricula, will be updated with state-of-the-art research material, and the course exercises will be offered through the virtual laboratory, making a common exercise pool that is available to local course modules at partner sites. Finally, this effort will provide a plan for development of new common course modules using virtual laboratory.

The change of experience in performing education will be done during workshops and mutual visits, where the researchers will give guest lectures and also analyse the pedagogical, educational and research approaches of the visited partners.

4.1 Tasks

Update of local curricula.

Research results obtained by the partners are yielding more and more material that can be pushed down into the graduate and undergraduate education. In this task, the local curricula at partner universities will be updated with state-of-the-art course material in the areas of embedded systems and software engineering. The course modules will especially follow the established development areas, i.e., distributed environments, systems and platforms, with specific orientation on HW, SW, RTS, etc. Lecture and exercise material will be developed based in the extraction from research results, and the updated courses will be pilot tested in summer schools organized for PhD students. Part of this material will also support development of the DIVILAB. For some of the course topics, it will be possible to construct a complete course based on the material provided by GENESIS. In other areas, however, GENESIS will provide a number of modules that can fit into existing courses. It is the partners' impression that nearly all university professors prefer to gradually update their courses for which reason the module approach seems to be the ideal way forward.

Transfer of course modules.

This task is responsible for transferring of course modules between partners. It will, first, identify the missing parts in local curricula, and, then, transfer courses and/or course modules where necessary. This will enable effective transfer of knowledge between partner sites and lead to the harmonization of educational efforts according to European standards and initiatives. The course module transfer will be closely related to the staff exchange activities, especially upon long visits of PhD students and/or young researchers. Also, smaller course modules will be exchanged through seminars held by senior staff, as well as through common workshops.

Implementation of course exercises in virtual laboratory.

After the provision of basic functions of DIVILAB, this task will select exercises from existing courses that can be performed through a virtual laboratory and implement these in DIVILAB. Software and/or hardware setups at partner universities will be provided and distributed exercises will be offered as parts of local course modules. The exercises shall be performed by students remotely, i.e., students do not need to be present in particular laboratory rooms. Each of the exercises will be developed in such a manner that to correspond with maximum accuracy to a real laboratory experiment. Exercises will be supplemented by a laboratory guide which includes user instructions.

Planning of new common course modules.

Increasing demands on the expertise in industry (to ensure competitiveness) requires higher skills of newly recruited people. Extending the program curricula programs with additional modules will be a natural step into this direction. Hence, this tasks will not only update and transfer existing course modules, but will also develop new common modules using virtual laboratory. This task will will set up an educational roadmap for future education of high-skilled professionals in the field of embedded systems by proposing new course modules to be developed by partner universities.

5. RESEARCH ADVANCE SUPPORT

The goals here is to provide support to advance the research potential of the Convergence regions and WBCs in

relation to the already existing local expertise and needs, and the strategic goals on the European Level by joining the partners with the established research excellence. This will be achieved by, e.g., extensive longer, medium and shorter visits. The partners will join ongoing research projects that are performed at different sites and new projects planned in the nearest future, and extend them according to the identified requirements. In addition to development of methods and tools, the focus within GENESIS will be on the validation and application of the results in industries of the countries of the partners. In addition to research activities in the research projects, the visiting participants will join the research-related activities at different sites: Seminars, internal workshops in which the research strategy are planned, research methodology courses, visits to graduate schools and visits to other universities.

5.1   Tasks

Component-based development processes for Embedded Systems.

The objective of this project is to develop a component-based development process and related it to different development and life-cycle standards. This includes analysis of relation of the CB lifecycle model to different development and life-cycle processes and adoption of these models to the CB lifecycle model. This includes use (and possible adoption) of different workflow and process-oriented tools for provision of process specification with quantifiable parameters that will make it possible to model different activities with respect to efforts and performance, and predict the overall characteristics (efforts, time) of the processes. Further the objective is to study the process of implementing a CB process in organizations in the countries of the partners and abilities to transition the current development process to component-based development process.

Distributed Development Environment for Dependable Embedded Systems.

The work will consist of developing an Integrated Development Environment (IDE) for specification, analysis, development and verification of dependable embedded systems component model. The Integrated Development Environment will be an integration platform that will comprise different existing tools. Parts of the IDE will be used in DIVI-LAB and in this way enlarge the possibility for education and research of utilisation of DIVILAB.

MPSOC and Applications.

This task will address issues in the area of platform based design and multicore processing, with a focus on mobile TV platforms, as application domain. Platforms of interest are multiprocessor on-chip architectures (MPSOC) such as segmented buses and networks on chip. The current ongoing projects target application development, construction of operating system kernels, software and middleware procedures to ease the system design problems on such novel platforms. The project targets the realisation of an integrated tool (AppMap) for application mapping on MPSOC, a first hand research subject at European levels. Means of development are a wide range of modelling languages (UML, VHDL, C, etc) and tools (XILINX, ALTERA, .NET framework, etc). Thus, the activities will benefit of full inclusion

within ARTEMIS topics, given the latest developments in the specific research agenda. The results of the research and tool development will be made available through the DIVI-LAB infrastructure, for a wide employment by the project partners and supporters.

Real-Time multimedia for embedded Consumer Electronics (CE) devices.

Applications executing in heterogeneous, dynamic environments vary their resource demands over time while experiencing the uncertainty of execution environments. Yet, they must be capable to react to changes in the operating conditions and maintain required performance levels, i.e., Quality-of-Service (QoS) must be provided. In this task, the objective is to use real-time methods for adaptive QoS provision suitable for applications running on embedded devices in open environments, such as distributed multimedia applications and mobile computing systems. Real-time admission control and resource reservation mechanisms will ensure that different applications adapt their QoS at run-time according to current state of the system, while fully utilizing the available resources. This calls for the addition of real-time services to standard systems as well as the integration of real-time and non real-time activities on both CPUs and networks.

6.   STRATEGIC DEVELOPMENT

The goals here are concentrating on the placement of GENESIS in the embedded systems research and development landscape. At the same time, for the partners of GENE-SIS this will provide the necessary European integration in the selected domain. Firstly, this work will build up the connection with the GSC, by providing appropriate management and support; secondly, GENESIS will be promoted on the European scenes, by establishing strong connections with current technology platforms active in the ES domain; thirdly, this WP has the important mission to guide the GENESIS partners for the post-GENESIS era, by providing support for the development of future EU or regional proposals. Throughout the actions of this work, all partners are required to be active, to gather, process and disseminate within the consortium the local information concerning ETPs, NCPs, local project interests, graduate programmes, etc. All the WBC and convergence areas partners will participate in the building of local ETP mirror groups.

6.1   Tasks

Local industry cooperation.

The main goal of this task is to build an appropriate and unanimously accepted set of procedures for the interaction between GENESIS core partners and the industrial supporters of GENESIS, the GSC. GSC members, once adhering to support GENESIS, on one hand, and consortium partners, on the other hand, must abide by the general interaction rules specified here, with the goal of achieving the project objectives. Activities to be performed here can be identified as (but not limited to):

- Elaboration of the GSC statute. The statute will define the relations between GSC members, and between GSC and GENESIS. It must also specify guidelines for

continuous support of GENESIS-like activities even after the project has completed.

- Increase cohesion at European levels of industrial partnership, with the contribution of academic partners, and possibly between the industrial partners

- Identification and accommodation of GSC member interests in future regional and European projects, aligning and planning of industrial integration of MSc and PhD students with the support of GSC

Integration in EU initiatives.
This task aims first to provide information and support towards the integration of GENESIS partners into one or both ETPs, ARTEMIS and NESSI, depending on possible affinities with either one, based on existent local research. The subsequent goal is to prepare, with the additional help of the GSC, the project partners to become valuable actors within these platforms, during and after GENESIS. An outcome of this work is the preparation of a study on current status of partners with respect to this type of international cooperation. GENESIS aims to contribute to the creation, wherever applicable, or to the strengthening of ARTEMIS and NESSI mirror groups. An activity will also specify guidelines that will capitalize on the experience of partners that belong already to such mirror groups. While the creation of local ETP mirror groups cannot be a GENESIS-only effort, GENESIS will help to develop a strong connection with other local institutions, especially with the respective National Contact Points (NCP). As a timeline for establishing a specific mirror group cannot be delivered, at this point, GENESIS will assist the partners such that, at the end of the project, at least most of the steps towards the achievement of this goal are covered.

Preparation for the future Involvement in EU projects.
We envisage two ways in which GENESIS will establish the environment that will allow successful evolutions of the partners from convergence and WB areas at regional and European levels. Firstly, GENESIS intends to act as a workshop for the elaboration of at least one FP7 proposal, in the field of ES, where several, if not all of the current project members will join. The task will capitalize on the efforts put in research and education support, and on the local and international industrial links developed during GENESIS. Secondly, GENESIS will contribute to build-up an information infrastructure connecting the participants from convergence and WB countries in order to enable common future activities at regional levels. Initiatives developed by NCPs located in partner countries, which envisage developments with international participation will become important points of interest for GENESIS members. The cohesion built within the consortium, including the GSC, will enable the partners to present strong proposals, with good chances for success in such programmes.

"HomeAttract" programme.
This task builds on the participation of the GSC in the activities of the project. The goal is to attract graduating students to select an academic or industrial career in their home countries. We will dedicate a special attention to the employment of GENESIS exchange students (both PhD and MSc), but not limit our attempts to them. The project aims at strengthening the overall readiness of WB and convergence countries to attract students which not merely finish their studies, but will also have the wherewithal and connections to succeed when they do graduate. The success of this task will strongly rely on the results of GENESIS as a factor of development, and will contribute to the long lasting effects of GENESIS. Means to achieve this have as basis the connections with local industry through the GSC, the experience obtained during the visits at EU universities and the links between these and the local industry / academia. We plan to develop internship procedures that will favor, whenever applicable, the students that graduate, especially those that have been part of exchange programmes (GENESIS or other related projects). The benefits will be two-fold: the employer will take advantage of the increased theoretical and practical expertise of the student; the student will be able to develop him(her)self within a homely environment having the chance to apply the gained knowledge.

7. CONCLUSIONS
GENESIS has fulfilled its first objective, i.e. to identify and put in contact interested individuals and academic centers that are involved in embedded systems research, education and applications. The next step is to contact relevant industrial companies and to further refine the objectives and future activities of the network. Local virtual labs have been identified together with existing equipment and further needs. A next goal will be to attract funds from European as well as local industrial sources. At the same time, more efforts will be put on developing joint educational programs involving Master- as well as doctoral students from all the participating institutions.

8. ADDITIONAL AUTHORS
Sasikumar Punnekkat[1] (sasikumar.punnekkat@mdh.se), Ivica Crnkovic[1] (ivica.crnkovic@mdh.se), Damir Isovic[1] (damir.isovic@mdh.se), Hannu Tenhunen[2] (hannu@ele.kth.se), Ioan Dumitrache[3](idumitrache@ics.pub.ro), Stefan Stancescu[3] (stst@elia.pub.ro), Vasile Lazarescu[3] (vl@elia.pub.ro), Zeljka Car[4] (car@tel.fer.hr), Igor Cavrak[4] (igor.cavrak@fer.hr), Ignac Lovrek[4] (ignac.lovrek@fer.hr).

9. REFERENCES
[1] ARTEMIS. Advanced research & technology for embedded intelligence and systems. *http://www.artemis-office.org/*.

[2] D. J. Jackson and P. Caspi. Embedded systems education: future directions, initiatives, and cooperation. *ACM SIGBED*, 2:1–4, 2005.

[3] NESSI. Networked european software & services initiative. *http://www.nessi-europe.com/Nessi/*.

---

[1]Malardalen University, Sweden
[2]University of Turku, Finland
[3]"Politehnica" University of Bucharest, Romania
[4]University of Zagreb, Croatia