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Performance Control in Wireless Sensor Networks: The GINSENG Project

By C. Srean, University College of Cork (Ireland); J. Sa Silva, University of Coimbra (Portugal);
L. Wolf, Technical University of Braunschweig (Germany); R. Eiras, Petrogal (Portugal);
T. Voigt, Swedish Institute of Computer Science AB (Sweden); U. Roedig, Lancaster University (United Kingdom);
V. Vassiliou, University of Cyprus (Cyprus); G. Hackenbroich, SAP AG (Germany)

Research on wireless sensor networks (WSNs) has mainly been focused on protocols and architectures for applications in which network performance assurances are not considered essential, such as agriculture and environmental monitoring. However, for many important areas, such as plant automation and health monitoring, performance assurances are crucial, especially for metrics such as delay and reliability.

The €4.8 million GINSENG project under the EU's Framework 7 Programme is led by the University of Cork (Ireland) and involves seven other partners: the University of Coimbra (Portugal), the Swedish Institute of Computer Science (Sweden), TU Braunschweig (Germany), Lancaster University (United Kingdom), the University of Cyprus (Cyprus), SAP (Germany), and GALP Energia (Portugal). This is a three-year project that started in September 2008.

The GINSENG project plans a significant advance beyond the state of the art by developing a novel performance controlled WSN targeted for use in a range of industrial environments. In such environments, WSN technology should result in significant savings in deployment and maintenance costs, and offers easy reconfiguration and rapid deployment in adapting to changing business needs. The overall goal of GINSENG is a WSN that will meet application-specific performance targets and will be proven in a real industrial setting where performance is critical.

The GINSENG goal requires several innovations and a fresh approach to WSN research. First, GINSENG adopts a planned approach for sensor node deployment as a basis to enable performance control. In adopting this position we reject the more widely accepted assumption that WSNs are entirely self-configuring and can achieve robustness by virtue of very high levels of redundancy. Such unplanned networks are unsuitable for most industrial and environmental applications, and are unable to offer performance assurances.

The second basis of GINSENG is software components with assured performance, including operating systems that execute tasks within a given time and predictable access to the radio medium by means of a medium access control (MAC) layer that enables access to the radio medium within a certain time bound and protocols for radio medium access. The third basis of GINSENG is a set of algorithms that ensure control with respect to network topology and traffic. These three components enable the deployment of sensor networks with assured performance. Figure 1 depicts the GINSENG approach and its main components.

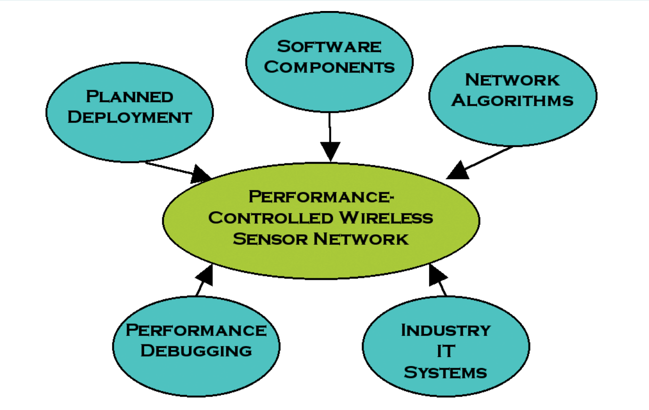

Figure 1. *The GINSENG approach.*

Recognizing the inherent uncertainties of the real world, GINSENG will also provide mechanisms and tools to perform performance debugging of deployed systems.

To encourage exploitation of the research outputs, GINSENG will integrate with industry IT systems, a proposition strengthened by the participation of SAP as a partner. The applicability of the technology developed in GINSENG will be proven by developing a WSN for a real-world application where performance is critical: in the context of an oil refinery run by GINSENG partner GALP Energia, where it will be used to monitor and control industrial processes, safety, and pollution. Large industrial sites such as oil refineries already have complex process control systems in place, but there are many additional points that could provide additional valuable data to optimize processes and enforce safety. Monitoring involves checking the status of key motors, valves, and pumps, and supporting process variables. Currently, signal acquisition and control actions are automatically delivered/provided using wired data communication networks. In many senses this

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Southeastern Europe ICT Stakeholders Gear Up for the Telecommunications/Media Convergence Era

By Kostas Koulinas, Despina Anastasiadou

INA - Southeastern Europe Telecommunications and Informatics Research Institute, Greece

Undoubtedly, Southeast European (SEE) countries (Albania, Bosnia and Herzegovina (BiH), Bulgaria, Croatia, Cyprus, FYROM, Greece, Moldova, Montenegro, Romania, Serbia, and Turkey) have made significant achievements over the past years in the field of information and communications technology (ICT). This is evident in high mobile penetration numbers, competitive development, and increased direct investments in the sector (Fig. 1).

Data reported in the region also indicate that the ICT sector, primarily through telecom revenues, has a remarkable impact on the growth of the regional economies and gross domestic products (GDPs) of SEE countries. It is notable that the ICT share of GDP in Bulgaria and Montenegro currently exceeds 9 percent, closely followed by Moldova, Bosnia-Herzegovina, and the former Yugoslav Republic of Macedonia.

On average, the sector contributes to about 5.2 percent of GDP in the Western Balkan countries (Albania, BiH, Montenegro, Serbia and fYR Macedonia), while Greece and Turkey are showing about 3.3 percent ICT share of GDP, and the EU-25 average is approximately 2.5 percent for the last four years. In parallel, Internet and broadband penetration in the region has been steadily growing, further enabling the transition to the digital economy, improving citizens' lives in different ways (Fig. 2). This would not have been possible without the insightful and timely guidance and assistance provided by the different ICT stakeholders and policy makers.

However, the ICT sector is experiencing significant changes lately, at a pace possibly faster than the policy makers and regulators can follow. This is driven by both supply-side considerations, as next-generation networks (NGNs) become available, and demand-side ones, as end users require more sophisticated services. Key to this change is the convergence of the telecoms, IT, and media sectors. Nowadays we are experiencing a transition from the traditional telecoms operators' business models to companies that offer a full set of services across the whole telecoms-media spectrum. For example, leading SEE regional operators have already introduced in their local markets multiplay packages, such as OTE in Greece with its "All-In-One" package (including fixed, broadband, and mobile services) and T-Com in Montenegro, which recently launched IPTV residential services along with its traditional ones.

Driven primarily by cost reduction (e.g., operating expenditure [OPEX]), operators have already started installing NGN equipment in their networks, such as softswitches and media gateways. This enables migration from vertical silos to horizontal structures, where core and transport layers are basically services agnostic, allowing transmission of different kinds of services over IP. On the other side, pan-European surveys reveal that more than 30 percent of existing subscribers require multiplay packages to be delivered to their households. This is definitely most relevant for the "broadband advanced" countries but also in SEE countries (e.g., Greece, Cyprus, Croatia, Montenegro), where the digital divide is continually decreasing, and consumers are becoming more demanding and requiring low-priced advanced services.

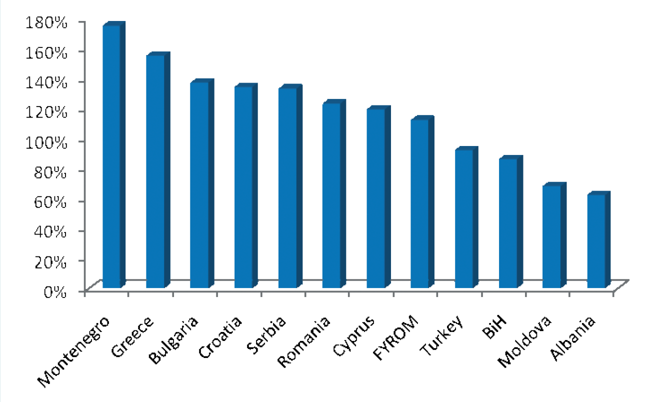

Figure 1. *Mobile penetration in SEE countries, 2008 (source: NRAs, INA SEE ICT Monitoring Review, Research & Analysis Unit).*

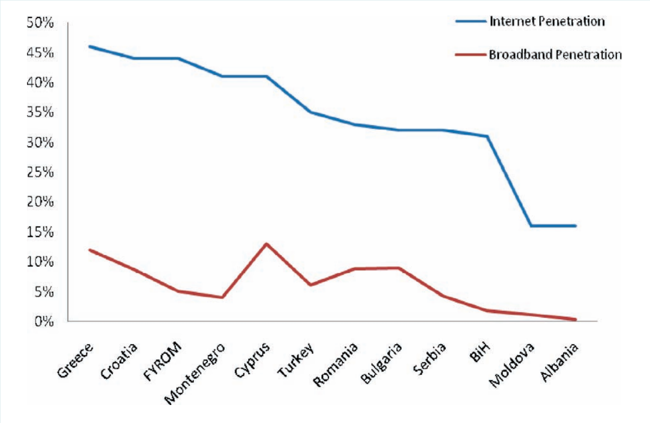

Figure 2. *Internet and broadband penetration in SEE countries, 2008 (source: Internetworldstats, ITU, INA SEE ICT Monitoring Review, Research & Analysis Unit).*

Additionally, in the SEE region the availability of new technologies (e.g., WiMAX, wireless access technologies) and the rapid uptake of mobile broadband have resulted in fast growth of the broadband markets over the past years. Deployed WiMAX networks already exist in Bulgaria, Montenegro, Serbia, the fYR Macedonia, and in pilot phase in Greece.

With regards to policy makers and national regulators, amid the current economic downturn, they are focusing on sustaining and developing a comprehensive regulatory environment that will foster market growth, provide the right incentives to all stakeholders, increase the sector's investments, and enable healthy competition, with the ultimate goal of enhancing consumers' welfare.

With the advent of the migration to a convergent environment, there are three key considerations that are most relevant for national policy makers and regulators. These include review of their economic and social objectives when regulating the market, considerations of regulatory bodies' governance structure, and, finally, re-examination and review of the applied regulatory levers. With regard to objectives, migration to a convergent environment does not necessarily imply that the underlying sector's objectives should be altered in any way. However, some key guidelines expressed by worldwide institutions such as OECD and/or leading NRAs (e.g. Ofcom, Oftel) on light-touch regulation, infrastructure sharing, con-

South-Eastern Europe ICT Stakeholders Gear-Up for the Telecoms/Media Convergence Era (continued)

Country	NRA full name	NRA Acronym	Converged Regulator?
Albania	Electronic and Postal Communications Authority	AKEP	No
Bosnia & Herzegovina	Communications Regulatory AgencyCRAYes		
Bulgaria	Communications Regulation Commission	CRC	No
Croatia	Croatian Post and Electronic Communications Agency	HAKOM	No
Cyprus	Office of the Commissioner of Telecommunications and Postal Regulation	OCECPR	No
FYROM	Agency for Electronic Communications	AEC	No
Greece	Hellenic Telecommunications & Post Commission	EETT	No
Moldova	National Regulatory Agency for Electronic Communications and Information Technology	ANRCETI	No
Montenegro	Agency for Electronic Communications and Postal Service	AGENTEL	No
Romania	National Authority for Communications	ANCOM	No
Serbia	Republic Telecommunication Agency	RATEL	No
Turkey	Information and Communication Technologies Authority	ICTA	No

Table 1. *List of SEE telecommunication NRAs.*

tent sharing, and consumer protection possibly should be taken into account.

One of the biggest dilemmas of all policy makers is whether or not there is a requirement to merge national telecoms and media regulators under a common roof. There is definitely not a "best practice" guideline for this as each country is unique, and each market should be treated in a different way. In the SEE region the majority of NRAs are still traditional telecoms and not converged telecoms/media regulators, as shown in Table 1. The Bosnian regulator is at present the only exception to the rule.

National governments should carefully weigh the relevant advantages and disadvantages prior to making any decisions. Overall, a gradual approach to migrating to a unified telecoms/media regulatory authority should possibly be taken. Lastly, most of the already applied regulatory remedies should be re-examined in light of the changing market and technological conditions. In this regard, SEE regulators have a unique opportunity to leapfrog traditional models, which have not been very successful, and consider remedies that take into consideration the reported convergence of telecoms/IT and media sectors.

Regulatory activities around convergence should also be linked to the current considerations of the so-called "digital dividend," which examines the options arising from the release of spectrum afforded by the digital switchover program. Most SEE countries are expected to turn off any analog transmission by 2012 and accommodate only digital channels in the already occupied spectrum. Potential new services include interactive multiplay fixed and mobile broadband broadcasters, e-service providers, as well as other multimedia service providers.

In summary, the convergence of the telecoms, IT, and media sectors is yet one more sign of the transition to the digital economy, where all citizens, universally, will be able to enjoy ubiquitous, high-speed, and high-quality services. In this regard, regional cooperation is certainly needed; the benefits will be mutual for all alike, whether frontrunners or not. SEE ICT stakeholders are strongly advised to further foster interregional cooperation and collaboration, allowing them to reap the benefits derived from the exchange of views and experiences with regard to market transition in the new era of convergence.

ComSoc EMEA Regional Chapter Chairs Congress

Dresden, Germany, 15-16 June 2009

By Jacob Baal-Schem, Member ComSoc EMEA Board

About once every three years, the IEEE Communications Society holds a Congress of Chapter Chairs in the EAME (Europe, Africa and Middle East) area, which coincides with Region 8.

The RCCC is held in conjunction with ICC, and the former meeting was held in Istanbul, Turkey in 2006. This year the meeting was held in Dresden, Germany, parallel to ICC '09.

Chapter Chairs Congresses provide an occasion to participants to meet ComSoc President, President-elect and VCs, as well as officers involved in Membership and Chapter activities. It also provides the forum to compare activities and to exchange ideas towards future activities, as organizing Distinguished Lecturer Tours or joint meetings and visits.

The 2009 RCCC was organized by ComSoc EAME Regional Director Tariq Durrani; however, he was prevented from coming, and Celia Desmond took over chairing the event.

The program included six sessions, during one and a half days:

- President's session, with greetings and presentations on membership activities

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In Memoriam: Gen Marubayashi

By Han Vinck, University Duisburg-Essen, Germany; Ryuji Kohno, Yokohama National University, Japan

The ISPLC community lost one of its most distinguished members when a Japanese friend of the IEEE Communications Society and the ISPLC community, Gen Marubayashi passed away on February 27, 2009. Gen was born in Shanghai in 1928. After joining NTT in 1953, he worked in the communications engineering field for many years. From 1978 to 1994, he was a professor at Nagaoka University of Technology, where he started research on spread spectrum and power line communications. He established a study group on spread spectrum technologies in the Institute of Electronics, Information and Communication Engineers (IEICE) in 1986, and promoted research and development of spread spectrum and its applications in Japan. From 1994 to 2002, he was at Soka University. He chaired and organized the second International Symposium on Power Line Communications. After his retirement from the university, he continued doing research in PLC and participating in every ISPLC conference. Professor Marubayashi was the recipient of the 2008 TC-PLC Outstanding Service Award for many years of continued leadership in the field of power line communications, for his instrumental role in developing an international PLC community, and for his pivotal contributions to establishing an annual international PLC conference, which has evolved into the IEEE International Symposium on Power Line Communications and Its Applications. Gen was not only a fine colleague, but also a dear friend and an ambassador for research on PLC in Asia. He promoted the development of PLC in the Japanese community, and he also stimulated international cooperation in this area. We will remember Gen's generous personality, and are extremely grateful for all the kindness and friendship he gave during his life.

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Stefano Bregni
Editor

Politecnico di Milano - Dept. of Electronics and Information
Piazza Leonardo da Vinci 32, 20133 MILANO MI, Italy
Ph.: +39-02-2399.3503 - Fax: +39-02-2399.3413
Email: bregni@elet.polimi.it, s.bregni@ieee.org

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Zhisheng Niu, Director of AP Region
Roberto Saracco, Director of Sister and Related Societies

Regional Correspondents Who Contributed to This Issue

Jacob Baal-Schem, Israel (j.baal.schem@ieee.org)
José Maria Malgosa-Sanahuja, Spain (josem.malgosa@upct.es)
Nicolae Oaca, Romania (nicolae_oaca@yahoo.com)
Joel Rodrigues, Portugal (joeljr@ieee.org

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CHAPTER CHAIRS CONGRESS/*continued from page 3*

- Chapters Chairs session, including short presentations by each Chapter Chair present
- Organizational session, discussing finance, marketing, administration, and Society relations
- Membership and meeting session on organizing conferences and increasing membership
- Regional session on Region 8 activities, local activities, and possible Life Members activities
- Summing up session

About 25 Chapter Chairs and Region 8 officers participated in the meeting, which provided an excellent forum for discussions, proposals, and social contacts during meals and coffee breaks.

Summary notes on the RCCC along with various chapter and individual presentations taking place during the two-day Congress will be posted at http://ww2.comsoc.org/about/chapters/rccc

GINSENG PROJECT/*continued from page 1*

hardware solution has proven to work reasonably well, particularly when all the system is planned from the beginning. However, when new actuators and sensors or surveillance systems are required for a given task, and there are no wired data communication networks available, wireless solutions will be a valuable choice, reducing costs and time of implementation.

In that context we propose to explore the need for performance-controlled wireless sensor networks in industry, and to demonstrate the efficacy of the research solutions we derive. In pursuing our scientific objectives, the choice of an application domain will serve mainly to guide and influence the research assumptions, but ultimately the fruits of our research can be extended to other industrial settings where performance-controlled monitoring and safety are particularly important. Wireless sensor networks allow industry to collect information with more monitoring points, providing awareness of the environmental conditions that affect overall uptime, safety, and compliance in industrial environments, and enabling agile and flexible monitoring and control systems. Wireless sensor networks connect critical processes and assets with the systems and experts that can interpret the data or take immediate action.

Industry does not accept additional systems that do not interface with existing equipment; therefore, one of the objectives of GINSENG is also integration with industrial IT systems.