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ERCIM NEWS

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Special theme:

Smart Energy Systems

Also in this issue:

Keynote
Smart Energy Systems – A European Perspective by Ariane Sutor, Siemens AG

Joint ERCIM Actions
PaaSage – An €8.4 Million Investment for Bridging Clouds

Research and Innovation
A Projector as Mobile Visualization Device on an Assistive Robot

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Next issue
April 2013, Special theme:
Mobile Computing

Smart Energy Systems – A European Perspective

The European Union has adopted ambitious energy and climate change objectives to be achieved by the year 2020: greenhouse gas emissions should be reduced by 20% while the share of renewable energy is to be increased and energy efficiency to be improved by this amount. Furthermore, the EU has made a long term commitment to cut emissions by at least 80% by 2050.

So far the current strategies are unlikely to achieve all 2020 targets; whilst the goal to increase the share of renewables seems to be attainable, we are likely to fail on the improvement of efficiency. Also, the strategies in place seem inadequate to meet the longer term challenges. Use of renewable energy is still limited because the development of efficient energy transport is lagging. The internal energy market is still fragmented and needs improvement regarding transparency, accessibility and choice. Fragmentation of national regulation limits companies to act on multi-national markets and sets barriers to fair competition. The EU must take urgent action to select the right tools to make the energy change happen and to move towards a sustainable energy future.

The current situation exhibits a number of major challenges. Large-scale renewable energy generation is currently largely based on wind, and plants may be installed far from existing power infrastructure, thus connection to the grid can present a challenge. Owing to the inherent variability and weather dependence of energy production and the limited capacity for energy storage, balancing supply and demand becomes also far more difficult.

The deployment of distributed energy resources can mitigate the uncertainties connected to large plants and at the same time exploit the potential of dispersed resources, although the integration of distributed energy resources is extremely challenging both from a market and a technical point of view. Decentralization supports scalability and robustness and facilitates access to the energy market for prosumers, thereby

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EIT ICT Labs "Smart Energy Systems" Action Line Leader

supporting changes to consumer behaviour and social acceptance. It is imperative that consumers understand and trust the process and receive clear benefits, eg energy savings, more transparent billing and a business case for electric vehicles, heat pumps and smart appliances. Demand response is also a central theme where consumers' load reductions are aggregated to offer flexible services to other stakeholders in the electricity system.

One key to the integration of intermittent and dispersed renewable energy and to increased energy efficiency is the introduction of Smart Grids. In addition to building new lines and substations, it is essential to make the electricity system smarter through the introduction of Information and Communication Technologies (ICT). Smart Grids can be described as advanced electricity networks enabling two-way exchange of power and information between suppliers and consumers based on the introduction of intelligent communication, monitoring and management systems. An open and secure ICT infrastructure is at the core of the implementation of the Smart Grid. Interoperability, data privacy and security thereby play a crucial role. Currently a convergence towards proven communication standards and industry best practices is observed, eg Internet Protocol communication.

For smart grids to exhibit their full potential the realization of physical infrastructures is needed as well as new business models and regulations. There is a critical need to adopt a European energy policy to overcome the fragmentation related to national and regional policies. Management bodies at EU level include the Directorate Generals for Energy and for Research (DG ENER, RTD) and the Joint Research Centre JRC.A recent update of the European Strategic Energy Technology Plan (SET Plan) describes the strategy to accelerate the development and deployment of cost-effective low carbon technologies. Other related bodies include: the Smart Grids Task Force SGTF on European regulation and standardization, the Smart Grids European Technology Platform ETP providing the European strategic research agendas SRA 2020 and 2035 as well as industry driven consortia like ENTSO-E and EDSO of European transmission and distribution system operators respectively. The European Institute of Innovation and Technology (EIT) is an institution of the EU with the mission to increase European sustainable growth and competitiveness by reinforcing innovation capacity. Within EIT ICT Labs the action line Smart Energy Systems drives European innovation for smart energy systems regarding user involvement, business models and ICT-enabled infrastructures and mobilizes a strong network of industrial partners, research institutes and technical universities.

A large number of European-level research, demonstration and deployment projects focusing on the development of smart grids are currently underway. Most projects are supported by FP6 and FP7 but many, including the Portuguese National Strategic Reference Framework (QREN), the Spanish Centre for Industrial Technology Development (CDTI) and the German funding program "E-Energy", also benefit from substantial national co-funding. A major part of future funding will be included in the upcoming Horizon 2020. The European Commission funds a whole series of different issues concerning the implementation of smart grid technologies. Large investments are foreseen to extend existing grids to cope with the intermittent nature of renewable sources, eg new lines, additional capacities but also balancing area extension, re-designed market mechanisms and storage integration. Research projects are addressing the problem of distributed energy resources, with a focus on online coordination of distributed generators and storage devices such as electric vehicles to enhance grid stability and optimization of energy resources.

Smart, sustainable and inclusive growth for Europe includes a shift in our energy policy leading to increasing renewable resources and improved energy efficiency. Smart Grids are the key enabler to achieve the policy objectives and to maintain a leading European technological and competitive position. In addition to new technologies, real pan-European regulations and markets are required. To this end, it will be paramount that partners from industry, research institutes and universities continue to join forces.

Ariane Sutor

2 **Editorial Information**

KEYNOTE

3 **Smart Energy Systems – A European Perspective**
by Ariane Sutor

JOINT ERCIM ACTIONS

6 **PaaSage – An €8.4 Million Investment for Bridging Clouds**
by Pierre Guisset

6 **Formal Methods for Intelligent Transportation Systems - A track at ISOLA'12**
by Alessandro Fantechi, Francesco Flammini and Stefania Gnesi

7 **Paweł Parys Winner of the 2012 Cor Baayen Award**

SPECIAL THEME

This special theme section "Smarty Energy Systems" has been coordinated by Carl Binding, IBM Research Lab, Switzerland and Han La Poutré, CWI and Utrecht University, the Netherlands

Introduction to the special theme

8 **Smart Energy Systems**
by Carl Binding and Han La Poutré

Invited articles

10 **Development of the European Virtual Smart Grid Laboratory**
by Kai Strunz and and Christian Wiezorek

11 **Forecasting the Conditional Dynamic Elasticity of Electricity Consumers**
by Pierre Pinson and Henrik Madsen

12 **Putting Neurons in the Smart Grid**
by Bram Vonk, Robert de Groot and Han Slootweg

IT for smart grids

14 **Smart Energy Consumption Feedback – Connecting Smartphones to Smart Meters**
by Markus Weiss, Friedemann Mattern and Christian Beckel

15 **Meter Data Management for Smart Monitoring Power Networks**
by Agustín Yagüe, Juan Garbajosa and Mercedes Lopez-Perea

17 **Designing and Simulating Smart Grids**
by Jennifer Pérez, Jessica Díaz and Eloy González

18 **Smart Management of Renewable Energy for Green Transport**
by Raffaele Bruno, Luca Valcarenghi, Molka Gharbaoui and Barbara Martini

20 **Real-Time Visualization of MV/LV Energy Alarms on GIS Web Applications**
by Christophe Joubert, Vicente Monrabal, Miguel Montesinos and Carlos Sánchez

21 **Using Wireless Smart Meter Networks for Power Quality Monitoring**
Joel Höglund and Stamatis Karnouskos

Supply/demand coordination

22 **Smarter Energy: Opportunities and Challenges**
by Olle Sundström, Fabian Müller, Carl Binding, Bernhard Jansen and Dieter Gantenbein

24 **Smart Demand-Side Response at Home**
by Armin Wolf, Thomas Luckenbach and Mario Schuster

25 **Market Garden: A Scalable Research Environment for Heterogeneous Electricity Markets**
by Felix Claessen, Nicolas Höning, Bart Liefers, Han La Poutré and Peter Bosman

27 **The Power Trading Agent Competition**
by Wolfgang Ketter and John Collins

28 **A Model-Free Flexibility Management System at KU Leuven and VITO**
by Stijn Vandael, Bert Claessens, Tom Holvoet and Geert Deconinck

29 **Demand Side Management for Multiple Devices**
by Albert Molderink, Vincent Bakker and Gerard J.M. Smit

31 **The Gamification of Agent-Based Smart Grids**
by Radu-Casian Mihailescu, Matteo Vasirani and Sascha Ossowski

32 **A Marketplace-Based Approach to Demand-Side Management in the Smart Grid**
by Luigi Briguglio, Massimiliano Nigrelli, Frank Eichinger, Javier Lucio Ruiz-Andino and Valter Bella

Smarter buildings

34 **Using an Intelligent Management System for Smart Residential Storage Systems**
by Vicente Botón, Máximo Pérez, Adolfo Lozano-Tello and Enrique Romero

35 **The Last One out Turns off the Light - Optimizing the Energy Efficiency of Buildings**
by Lutz Ehrig and Danilo Hollosi

36 **Ambient Intelligence for Energy Efficiency in a Building Complex**
by Giuseppe Lo Re, Marco Ortolani and Giuseppe Anastasi

Security

38 **Secure Smart Grids or Say 'Goodnight Vienna!'**
by Florian Skopik, Paul Smith and Thomas Bleier

39 **Preparing for the Smart Grids: Improving Information Security Management in the Power Industry**
by Maria Bartnes Line

40 **Cybersecurity in the Smart Grid**
by Magnus Almgren, Davide Balzarotti, Marina Papatriantafilou and Valentin Tudor

41 **CoppEnd – A Security System for Power Equipment**
by Dimitrios Serpanos, Athanasios Safacas and Dimitrios Stachoulis

Green IT

43 **PowerAPI: A Software Library to Monitor the Energy Consumed at the Process-Level**
by Aurélien Bourdon, Adel Noureddine, Romain Rouvoy and Lionel Seinturier

44 **Smart Energy Management for Greener Supercomputing**
by Mohammed el Mehdi Diouri, Olivier Glück and Laurent Lefèvre

Novel energy forms

45 **AI4B: Accountable IT Infrastructures for Optimizing Supply Chains in Bioenergy Symbiotic Networks**
by Theodore Dalamagas and Antonis Kokossis

47 **Hydrodynamics-Biology Coupling for Algae Culture and Biofuel Production**
by Olivier Bernard, Jacques Sainte-Marie, Bruno Sialve and

RESEARCH AND INNOVATION

This section features news about research activities and innovative developments from European research institutes

48 **A Projector as Mobile Visualization Device on an Assistive Robot**
by Paul Panek, Christian Beck, Georg Edelmayer, Peter Mayer and Wolfgang L. Zagler

49 **ATLAAS-P2P: A Two-Layer Architecture for Approximated Search in Peer to Peer**
by Ranieri Baraglia, Patrizio Dazzi, Matteo Mordacchini and Laura Ricci

50 **Epeerdemics: A Peer-to-Peer Simulator Targeting Epidemic-Based Protocols**
by Patrizio Dazzi and Emanuele Carlini

51 **gRecs: Exploiting the Power of Data Mining Techniques for Efficient Computation of Group Recommendations**
by Kostas Stefanidis and Kjetil Nørvåg

52 **Utility-Theoretic Ranking for Semi-Automated Text Classification**
by Giacomo Berardi, Andrea Esuli and Fabrizio Sebastiani

53 **A Radio Telescope of the Superlative**
by Ton Engbersen

55 **The Green-Wake Project Targets both Air Traffic Security and Airport Throughput**
by Sébastien Lugan and Benoit Michel

EVENTS, IN BRIEF

56 **International Workshop on Information Technology for Energy Applications**
by Paulo Carreira and Vasco Amaral

57 **ERCIM/EWICS/Embedded (Cyber-Physical) Systems Workshop 2012**
by Erwin Schoitsch

57 **Announcements**

59 **In Brief**

PaaSage – An €8.4 Million Investment for Bridging Clouds

by Pierre Guisset

ERCIM, together with 13 European partners, has launched PaaSage, a major research initiative with the goal of developing an open and integrated platform to support model based lifecycle management of Cloud applications.

Cloud solutions are currently still insufficient and require a high level of expertise on the part of the developer and the provider to properly exploit the capabilities offered by Cloud technologies. Cloud infrastructures are not standardized and porting an existing application to a Cloud platform is still a very challenging task, leading to a strong interdependence between the client application and the Cloud platform. Developing once and deploying on many Clouds is not a viable proposition as things stand. This is the challenge that the PaaSage consortium will address. PaaSage will deliver an open and integrated platform to support both design and deployment of Cloud applications, together with an accompanying methodology that allows model-based development, configuration, optimisation, and deployment of existing and new applications independently of the existing underlying Cloud infrastructures.

"PaaSage will provide the relevant means to significantly improve programmability, usability and performance of Clouds beyond current state of the art approaches", says Keith G. Jeffery, scientific coordinator of the project. "We have to admit that European industry is lagging behind in business creation and development on the basis of Cloud computing technologies", adds Pierre Guisset, project coordinator, "Our objective with PaaSage is to develop the tools that will enable European small and large businesses to take a leading position in exploiting Clouds. Typically a business will be developing its in-house server cluster to an in-house Cloud to obtain benefits of elasticity and eco-friendliness. However, when elasticity needs to extend beyond the in-house environment to a public cloud there are interoperability problems and provider proprietary solution constraints. These will be overcome by PaaSage".

PaaSage is a collaborative research project co-funded under the ICT theme of the 7th framework programme of the European Union. In particular, PaaSage addresses the findings highlighted by the Commission's Cloud Computing Expert Working Group. The total investment amounts to €8.4m, of which €6.3m is funded by the European Union. PaaSage started on 1 October 12012 and will last 4 years.

Links:
http://www.paasage.eu/
http://cordis.europa.eu/fp7/ ict/ssai/docs/future-cc-2may-finalreport-experts.pdf

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Formal Methods for Intelligent Transportation Systems - A track at ISOLA'12

by Alessandro Fantechi, Francesco Flammini and Stefania Gnesi

The ERCIM Working Group on Formal Methods for Industrial Critical Systems (FMICS), organised a track at the 5th International Symposium on Leveraging Applications of Formal Methods, Verification and Validation (ISOLA'12), held in Crete on 15-18 October 2012, to address the application of formal methods to model and analyze complex systems in the context of Intelligent Transportation Systems.

The term "Intelligent Transportation Systems" (ITS) refers to Information and Communication Technology as applied to transport infrastructure and vehicles with the aim of improving transport outcomes such as transport safety, transport productivity, travel reliability, informed travel choices, social equity, environmental performance and network operation resilience. ITS is becoming increasingly important as novel driverless/pilotless applications are emerging.

Based on discussions held by the ERCIM Working Group on Formal Methods for Industrial Critical Systems (FMICS), a track was organized for the ISOLA'12 Conference to address the application of formal methods to model and analyse complex systems in the context of ITS. In fact, modelling and analysis activities are very important to optimize system lifecycle in the design, development, verification and operational stages, and they are essential whenever assessment and certification is required by international standards.

The contributions to the theme "Formal Methods for Intelligent Transportation Systems" addressed three distinct aspects. The first was a general perspective on the introduction of formal methods in the development process of safety-critical systems focusing on model-driven verification techniques, both for functional and non-functional system properties. In particular, the expected impact of a novel software development guideline for safety-critical systems (namely, the avionic DO178-C standard) was evaluated. For the first time, that standard specifically includes formal methods as one of the preferred development and verification techniques.

The other contributions related to two categories of systems in the railway domain, which, owing to their complexity, pose several challenges to current software and system development techniques. The first category addresses driverless metros that integrate several subsystems within complex architectures, which are geographically distributed, featuring strict dependability requirements. The second category is represented by railway interlocking systems: here the complexity lies in the geographical layout of the tracks, points and signals that can be found in stations or in railway yards. Within this context, a particularly challenging problem for current model-checking technology is to automatically verify that interlocking logics designed by railway engineers actually satisfy safety properties (eg, two trains will never be assigned conflicting routes) for medium to large stations.

The lively discussion that took place during the workshop on railway interlocking systems touched on topics such as:
- possible ad hoc optimisations for symbolic model-checking, by means of specific re-orderings of BDD (Binary Decision Diagrams) variables;
- logical and physical distribution of the interlocking control logics;
- the increasing complexity due to the integration and interface of interlocking systems with other signalling systems;
- verification of legacy relay-based interlocking systems which are strictly related to the topology of the controlled layout.

We believe that, despite the limited space available in the program of the track, the contributions succeeded in giving a good overview of the state-of-the-art and of the hard-to-solve open issues, as well as proposing significant directions for the future research in this field.

Link: http://www.cs.uni-potsdam.de/isola/isola2012/

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Paweł Parys Winner of the 2012 Cor Baayen Award

ERCIM has selected Paweł Parys from the University of Warsaw as the winner of the 2012 Cor Baayen Award for a promising young researcher in computer science and applied mathematics. In a tight competition Paweł Parys was chosen from 21 excellent candidates from all over Europe as an exceptionally gifted young researcher.

ERCIM president Keith Jeffery (left) presents the 2012 Cor Baayen award to Pawel Parys.

Paweł's main fields of interest are algorithms and computation theory. In his young career, Paweł's research has already led to two extraordinary results in very different fields such as linear time evaluation of XPath and higher-order pushdown automata.

The XPath (a language for addressing parts of an XML document) evaluation problem is important in practice, in particular for the performance of Web browsers which generally include XPath evaluators. These evaluators are often quite inefficient, in many cases running in exponential time (in relation to the size of the query). In his groundbreaking work, Paweł devised a system for evaluation of XPath in time linear to the size of the document. Until recently, this was widely believed to be impossible. The improvement is dramatic for XML documents with billions of nodes, such as the DBLP database, for example.

In his research on higher-order pushdown automata, Paweł could prove that collapse increases the power of higher-order pushdown automata, which was a major open problem (pushdown automata are used for instance in theories about what can be computed by machines). Higher-order pushdown automata are like pushdown automata, except that they can use stacks of stacks, or stacks of stacks of stacks, and so on. They appear naturally when modelling the behaviour of recursive higher-order programs in functional languages. The question "does a recursive higher-order program behave correctly for all possible inputs?" can be recast as a question about the language accepted by a deterministic higher-order pushdown automaton. One of the most important open problems in this area was about the equivalence of two models: deterministic higher-order pushdown automata, and deterministic higher-order pushdown automata with the so-called collapse operation. It has been conjectured that the collapse operation gives more power to the automata. In a series of papers, including two STACS papers and a paper accepted by LICS 2012, Paweł Parys has proved this conjecture. This settles an important, and technically difficult, open problem.

Although Paweł Parys just finished his PhD in January 2012, his work has already been recognized with best student paper award at PODS 2009 (the top database theory conference), the Witold Lipski Prize for Young Researchers in Computer Science 2011 (an award for the best young Polish computer scientist). He was also the recipient of a "Start" stipend for young researchers awarded by the Foundation for Polish Science in 2012 as well as several achievements in programming competitions.

For more information about the ERCIM Cor Baayen Award, see http://www.ercim.eu/activity/cor-baayen-award

Introduction to the Special Theme

Smart Energy Systems

by Carl Binding and Han La Poutré

Modern, industrialized, society is heavily dependent on ubiquitous, cheap energy, which we expect to be readily available, not to be polluting, and to be convenient to use.

Since the invention of the steam engine by James Watt, this paradigm has lead towards tremendous improvement of life quality in the developed world, and developing countries eagerly aspire to similar energy standards.

However, the price of this hunger for energy is increasing. Fossil fuel resources such as oil or gas are becoming harder to explore, even leading to environmental disasters as with the Gulf of Mexico oil-platform, recently. Exploration of shale gas ("fracking") causes negative environmental impact, beyond the well-known CO_2 problematics. Besides the sheer availability of fossil energy, associated CO_2 emissions have caused wide-spread concerns about impacts on climate and on human health (fine particle emissions).

Another kind of fossil fuel energy source, namely uranium-based nuclear fission, has been explored for about 50 years. It is CO_2 neutral, but has additional risks and thus costs associated with its operations. More importantly on a longer time scale, the nuclear waste disposal has not yet found a satisfactory answer. Furthermore, nuclear fission is a large consumer of water for reactor cooling, which is considered a negative environmental impact.

It is against this background that concerned citizens, industries, and their political representatives have shown increased interest in the use of renewable[1], natural, energy resources. These are mainly represented by solar energy, be it in the form of photo-voltaic or simple heat, and by wind power. Other energy forms are based on bio-mass, wave energy, and of course the traditional hydro-power electrical generation plants.

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[1] *The term "renewable" being somewhat imprecise as it is the solar fusion process – which has a long, but finite, life time, that keeps the wind blowing and the sun shining.*

An important challenge of wind and solar energy is their stochastic nature. Traditionally, power generation has been planned based on predictions of the aggregated energy consumption (load). Since wind and solar energy are hard to plan, their availability is uncertain. Hence, this fundamentally changes the traditional electrical power engineering equation of “generation follows load” into the challenge of “load must follow generation”.

In addition, new devices are appearing more and more in our energy ecosystem, which will influence its characteristics. For example, electric vehicles and heat pumps are characterized by heavy power consumption exceeding those of past domestic devices, but at the same time these new devices allow for the storage of energy. And micro-CHPs (combined heat and power) allow for efficient generation of power in addition to heat. These developments give new control problems to be tackled, but also open up new ways of handling our power systems.

In this special theme of ERCIM News, we are happy to present a wide spectrum of ongoing research activities which attempt to address today's energy dilemma.

Better building design and technology is seen as a path forward to further decrease the volume of energy consumed – always a good idea when a resource becomes scarce. In the same spirit, we see approaches to make better use of transportation means by giving the end-user tools to select a convenient yet ecological means of transportation.

The intelligent power grid is another large theme. By this, we understand a more optimal usage of existing power grid resources to minimize waste as well as to align demand with renewable energy generation. This amounts not only to a large control and optimization problem, in the form of market-based approaches and automated demand side management, but needs to be associated with a large communications and computer infrastructure. This, in turn, causes ample security concerns summarized under the notion of “cyber security” which is addressed by several of the ongoing projects.

A system as large as the electrical power grid – an example of which is the European ENTSO-E grid which ranges from Europe's North all the way to its far South and even Northern Africa (spanning 24 countries and 400 million users) – cannot be rebuilt in a short time, given the tremendous costs involved and given today’s often vocal opposition to power grid projects in many countries. Simulation, addressed in some contributions, thus also plays a role in planning and designing the future power grid.

The ultimate power users, however, remain individuals. How can we motivate humans to use energy in a more efficient way? We have included some papers describing how to make the end-user more aware of his or her power usage and the use of game theory to effectively tie the end-user into the energy markets of the future. The challenge will be to make the end-consumer price conscious – for a commodity whose generation and transport only costs percents of a family’s budget.

Use of bio-mass is addressed in an interesting project which uses algae for energy production as well as the issues arising with wide-spread exploration of bio-mass.

The challenges ahead are huge. Fundamental science has found solutions to many of the smarter energy issues. It is the large scale deployment in a cost-effective, safe, and environmentally sound manner which has to be addressed. Ultimately, the choice is ours: how much are we willing to reign in, respectively reconsider, our energy household of the future and how much are we ready to spend on more effective use of energy.

We hope that several of the projects presented here can make a contribution on the route to a sustainable energy system, which is, as the British physicist David JC MacKay terms it, “without the hot air”.

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Development of the European Virtual Smart Grid Laboratory

by Kai Strunz and and Christian Wiezorek

The transition towards increasingly renewable energy systems calls for novel techniques of operation and control in response to the changing power transmission and distribution networks. A Smart Grid is expected to efficiently manage supply and demand of electricity. Electric networks will become more intelligent, bringing the worlds of IT, communications and energy systems closer together than ever before. The EIT ICT Labs, one of the Knowledge and Innovation Communities (KIC) at the European Institute of Innovation and Technology (EIT), are strongly supportive of work in this area. Founded in 2008, EIT aims to create synergies between education, research, and innovation. It promotes the systematic development of international networks and clusters of excellent institutions, universities and industrial research centres in Europe. Six nodes of the EIT ICT Labs across Europe coordinate different thematic topic areas. The action line "Smart Energy Systems" – located at the Berlin Node – addresses the above-mentioned synergies of ICT and energy systems.

One of the activities coordinated within "Smart Energy Systems" is the European Virtual Smart Grid Laboratory (EVSGL). This activity develops a virtual lab integrating the expertise and capacities of each partner's lab resources, thereby creating a platform with a wide-ranging application field in terms of information exchange and personnel involvement (see Figure 1). Involved are highly renowned universities such as KTH Stockholm, Imperial College London, TU Delft, TU Berlin and excellent research centres such as the Technical Research Center of Finland (VTT), the Dutch National Research Institute for Mathematics and Computer Science (CWI), the German Research Center for Artificial Intelligence (DFKI), and several institutes of the Fraunhofer Gesellschaft. Industry partners, including Ericsson and Siemens, also participate. Each partner contributes its expertise in its particular field to joint projects. As a key project, the setup of the virtual laboratory consists of three sequential stages:

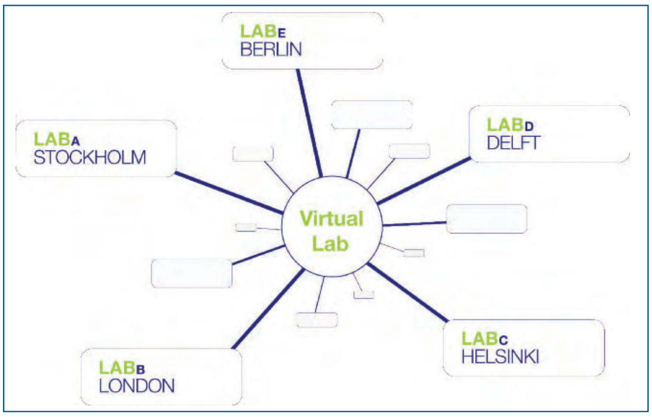

Figure 1: the European Virtual Smart Grid Laboratory

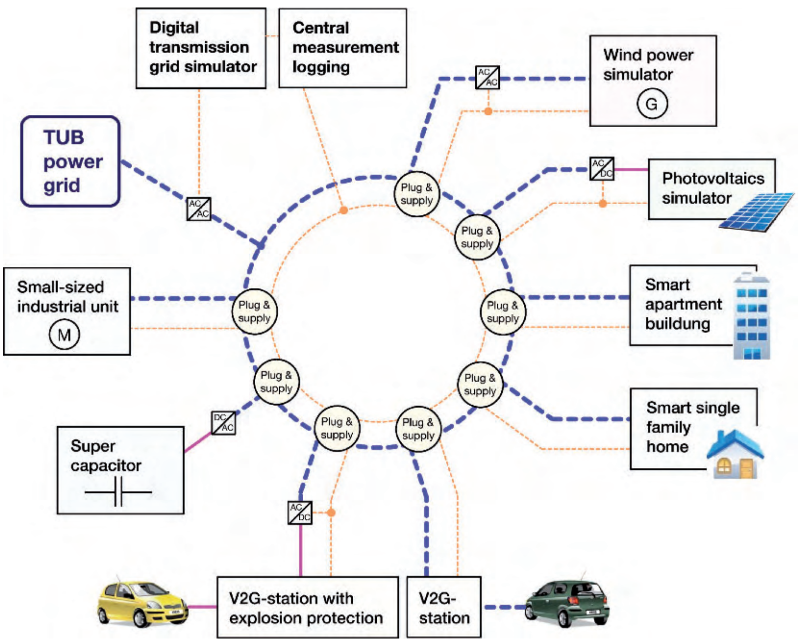

Figure 2: the Smart Grid Laboratory at TU Berlin

- Initialization stage: In the first stage, the fields of competences of each partner are discussed and put into context with those of the other partners to identify complementary expertise.
- Connection stage: During the second stage, the technical groundwork for the connection of the involved labs is laid. Demonstrators prove the functionality. At the end of this stage, first experiments at the labs can be observed by partners from remote sites.
- Implementation stage: Within this stage, the successfully implemented network will be used to run the Virtual Smart Grid Lab.

The European Virtual Smart Grid Lab activity is led by the Chair of Sustainable Electric Networks and Sources of Energy (SENSE) at TU Berlin [1]. At SENSE, the Smart Grid Laboratory at TU Berlin has been established, integrated within EIT, and first presented at the 3rd IEEE PES Innovative Smart Technologies (ISGT) Europe 2012 conference from 14 to 17 October 2012 in Berlin [2]. The laboratory comprises real power hardware with a low voltage distribution feeder integrating different load, storage, and generation components (see Figure 2). Various smart control schemes are applied. This includes operation in the form of a microgrid. In addition, a real-time digital simulator serves for reproducing a possible connection to the transmission grid. A main scope of study of the TU Berlin Smart Grid Lab is the integration of renewable energy and electromobility into the power system.

The physical structure of the lab is shown in Figure 3. The plug-and-supply interfaces to which resources can be connected are marked in green. Starting from the feed-in, the ring connects a solar photovoltaics (PV) simulator shown in blue. It consists of a commercially available inverter and a solar panel emulated by a controllable electronic amplifier. Loads are shown in yellow. A single family home and an apartment building consist of both off-the-shelf appliances such as dishwashers, refrigerators, and boilers, and electronic loads. A small industrial unit is represented by different electronic loads capable of providing machinery load profiles. Two electric vehicle-to-grid (V2G) charging stations are shown in cyan, one of which is for e-bikes. The simulator for a distributed wind energy conversion system consists of a motor-generator unit. The protective container allows for the integration of battery, super capacitor, and cache control testing [3], [4], as indicated in purple. As a part of the Virtual European Smart Grid Laboratory, the installation will support the development of Smart Grid solutions in Europe and beyond [2].

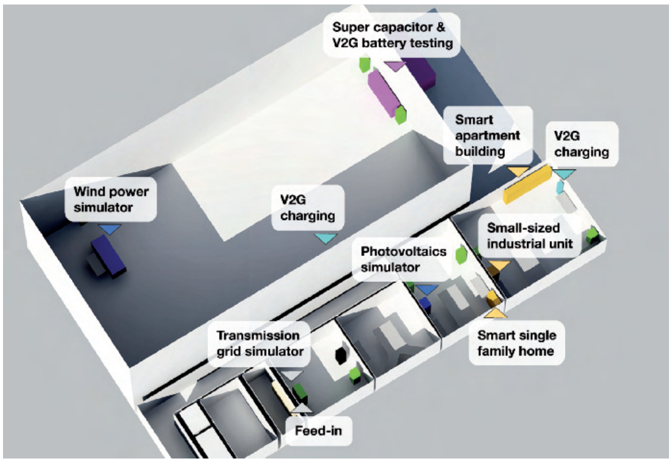

Figure 3: the physical structure of the lab

References:
[1] TU Berlin SENSE: http://www.sense.tu-berlin.de
[2] IEEE PES ISGT Europe 2012: http://www.ieee-isgt-2012.eu
[3] K. Strunz, H. Louie: "Cache energy control for storage: Power system integration and education based on analogies derived from computer engineering", IEEE Transactions on Power Systems, Vol. 24, No. 1, pp. 12-19, February 2009
[4] H. Louie, K. Strunz: "Superconducting magnetic energy storage (SMES) for energy cache control in modular distributed hydrogen-electric energy systems", IEEE Transactions on Applied Superconductivity, Vol. 17, No. 2, pp. 2361-2364, June 2007

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Forecasting the Conditional Dynamic Elasticity of Electricity Consumers

by Pierre Pinson and Henrik Madsen

In the development of smarter energy systems, it is vital that we maximize flexibility of consumer demand. To this end, it will be of utmost importance to be able to predict the potential of electricity demand to respond dynamically to varied signals.

Some countries aim to be deriving almost all of their power from renewable sources in the relatively near future (Denmark's timeframe, for instance, is 2050). With greater integration of renewable energy generation, demand flexibility will become ever more important in supporting smart energy systems. This will translate to a paradigm shift, from a system where demand drives generation to a system where renewable energy generation may influence demand patterns. In practice this requires enhancing, and taking full advantage of, the potential flexibility of all electricity consumers, including domestic households.

In contrast to large industrial consumers, for which direct bilateral agreements may be made and used on an ad-hoc basis, domestic consumption is a far greater challenge to manage owing to the large number of individual households, their distribution, the state of the art in ICT (Information and Communication Technologies), the effectiveness of economic incentives, behavioural effects, etc. A number of research and demonstration projects are investigating these factors, including the iPower project in Denmark, funded by the DSR-SPIR-program (project number: 10-095378, see link below).

Regardless of how demand flexibility is to be enhanced at the household level (electric heating, cooling, electric vehicles, etc.), identifying intelligent ways to alter demand patterns is a stochastic optimization or control problem, comprising a whole challenge in itself. This question will depend, to some extent, upon the time scales considered (and corresponding mathematical formulation), engineering considerations - for instance related to ICT capabilities, but also on philosophical aspects of design. The two main approaches currently under study are (i) direct distributed control, and (ii) the "indirect control approach" based on price signals. The latter takes advantage of the elasticity of consumers, ie the adaptation of consumption in response to varying electricity prices. Price signals are to be sent daily for optimal task assignment (bulk heating, washing machines, etc.), but also adapted in real time so as to take corrective action supporting the optimal matching of generation and consumption. In this indirect control by price setup, the stochastic optimization or control problem translates to issuing optimal price signals to be broadcast to groups of consumers whose consumption levels are to be influenced.

With this objective in mind, the core, and most crucial, aspect is to identify and be able to predict how small consumers respond to varying prices. We refer to this as the conditional dynamic consumer elasticity. It is conditional since the potential to affect the timing, and maybe even the magnitude, of the flexible part of the load is clearly a function of external conditions. If considering space heating for instance, outdoor temperature, as well as the settings of the local heat controller, will directly impact the potential demand response to prices. Similarly in the case of electric vehicles, the demand response potential will vary as a function of the time of the day when more or less electric vehicles may be plugged in and their batteries made available for demand response. In parallel this response is dynamic as most consumption patterns cannot be deferred indefinitely: batteries of electric vehicles need to be charged at some point before they are to be driven, while households need to be heated so as to keep indoor temperature at an acceptable level.

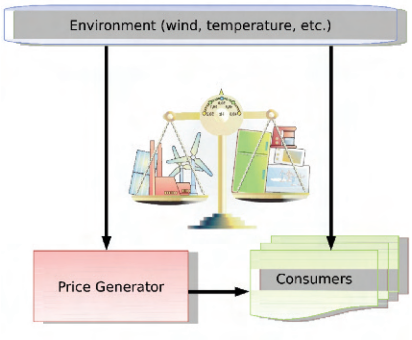

Figure 1: A conceptual view of the balance between electricity production and consumption, as influenced by the external environment and controlled through a price generator.

As a final point, this conditional dynamic elasticity of electricity consumers may smoothly evolve with time, owing to changes in consumption patterns, appliances and their functionalities, etc. As a consequence, one needs to employ a bottom-up approach and use empirical data for the identification of appropriate models, adaptive estimation of their parameters, and continuous monitoring of forecast quality. The quality of such forecasts will be paramount since this data will directly impact the reliability of potential demand response. An unreliable demand response would make this an inefficient solution compared with alternatives, such as using storage or expensive conventional generators, possibly even magnifying the fluctuations that we are aiming to dampen. Ideally, these predictions should be of probabilistic nature, in the form of scenarios, so as to fully describe the range of potential responses from the aggregation of household consumers to be influenced.

Link: http://ipower-net.dk

References:

[1] O. Corradi et al: "Controlling electricity consumption by forecasting its response to varying prices", IEEE Trans. Power Syst., May 28, 2012, http://dx.doi.org/ 10.1109/ TPWRS.2012.2197027
[2] D. Hammerstrom, et al: "Pacific NorthWest GridWise Testbed demonstration projects – Part I: Olympic Peninsula project", Tech. Rep., Pacific NorthWest National Laboratory, PNNL-17167, October, 2007
[3] J. Torriti, M.G. Hassan, M. Leach: "Demand response experience in Europe: Policies, programmes and implementation", Energy, 35(4), pp. 1575–1583, 2010, http://dx.doi.org/ 10.1016/j.energy.2009.05.021

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Putting Neurons in the Smart Grid

by Bram Vonk, Robert de Groot and Han Slootweg

The collaboration between Eindhoven University of Technology and Dutch Distribution System Operator, Enexis, results in a direct implementation of scientific ideas and models in real world systems and faster feedback of data for analysis or validation. This is illustrated by the Smart Storage Unit: A grid connected battery in a residential area of 240 houses including photovoltaic generation and heat pumps, controlled by an artificial neural network based forecaster.

The Smart Storage Unit (SSU) is the result of a pilot project for development and deployment of a centralized storage unit in the low voltage (LV) distribution network. The system is built around a lithium-ion battery system consisting of four separate strings, each with a capacity of 58 kWh, having a total capacity of 232 kWh and a nominal battery voltage of 720 V. the total system is capable of storing approximately 1.2 hours of the installed watt-peak PV output in the neighborhood. The goals set for the Smart Storage unit include:

- Increase of self-consumption (of the photovoltaic (PV) generated energy)
- Increase of reliability (in autonomous operation acting as a back-up unit)
- Maximization of utilization of local infrastructure (common feed-in at peak consumption of the households: peak shaving)

In order to achieve these goals, the SSU is equipped with an advanced control system capable of controlling battery state-of-charge conform pre-specified objectives and conditions (Figure 1).

The SSU is installed into an LV-grid in the Etten-Leur area, part of the Enexis distribution grid in the South of the Netherlands. The network connects 240 households, of which 40 have locally

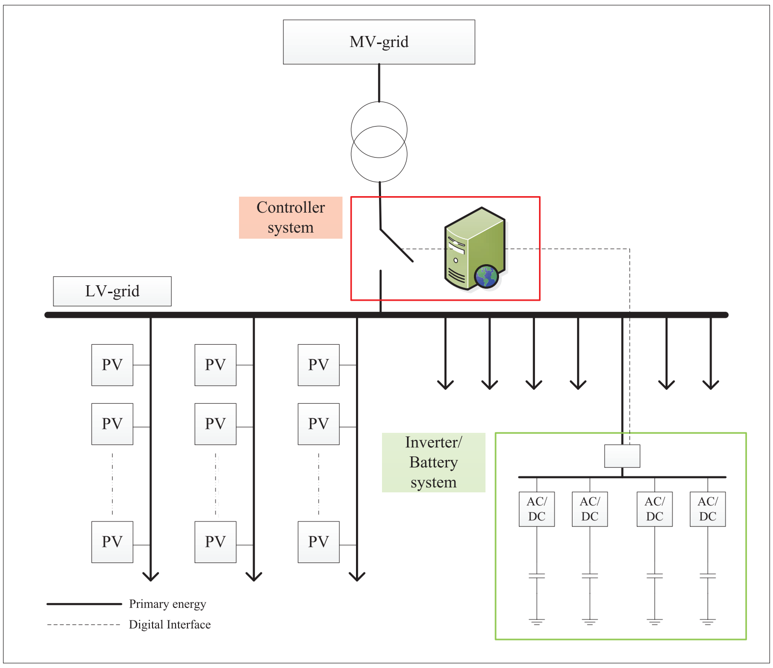

Figure 1: Schematic view of the grid with the SSU-1

Figure 2: the SSU in the residential area

installed PV systems with a total output of 186 kWpeak. The LV-grid is connected to the upstream medium voltage (MV) network through a 400 kVA transformer (0.4 / 10 kV), with an average peak-load measured at 385 kW.

To ensure proper operation, the SSU should be able to predict the future power demand of the residential area, since that determines when and with which rate the battery is charged and discharged. This is not only necessary for peak shaving operations or for the optimal use of locally generated energy, but also for autonomous operation when the SSU is disconnected from the main grid. A fully charged battery system is not optimal in this case, since the residential area contains so many PV panels that in summer there are times when energy is in surplus. With a full battery this would cause the PV inverters to shut down and the irradiated solar energy would be wasted. This “short-term load forecasting” is done by a forecaster with an artificial neural network (ANN). These mathematical networks consist of nodes called neurons that collect and sum incoming signals from other neurons and evaluate the result by a transfer function [1]. The advantage of using an ANN is that the forecaster can be trained online by using previous energy demands and matching input data (eg wind, temperature, solar irradiation) from the residential area. In this way, the forecaster adapts itself to a new situation in less than two weeks. On a neuron level this training means simply adjusting the connections between the neurons. Since energy consumption on Saturday and Sunday is different than that of workdays, two different ANNs are used for the weekend and workdays.

An important issue regarding ANNs is the selection of appropriate input variables and training sets. The input variable selection for the forecaster is based on the mutual information theorem as described by Shannon. The mutual information is the amount of reduction of uncertainty of one signal by another signal. In this case, the latter is a possible input variable of the system and the former is the output of the forecaster. An advantage of this approach is that it also recognizes non-linear relations between signals. To avoid selection of variables that contain the same information (which may be encoded differently) the partial mutual information is used. With this approach several weather forecast variables are selected as inputs as well as the realization of energy demand from the previous day.

At the start of every forecast the system looks into a database containing data from the last two months, and selects the five sets of training data with the input that most resembles the current input [2]. These sets are then used to train the ANN and specialize it to the current situation to make an accurate load forecast [3].

The developed forecaster will be implemented in the near future in the SSU. In the current version a simpler control algorithm is implemented, but the SSU is designed in such a way that new controller components can be installed, tested, evaluated and improved without much effort by using the SSU’s internet connection.

References:

[1] H.K. Alfares and M. Nazeeruddin: “Electric load forecasting: literature survey and classification of methods”, International Journal of Systems Science, vol. 33

[2] T.M. Peng et al: “Advancement in the application of neural networks for short-term load forecasting”, IEEE Trans. Power Syst., vol. 7

[3] B.M.J. Vonk et al: “Improving short-term load forecasting for a local energy storage system”, in proc. UPEC 2012

Links:

http://energyacademy.org/article/69/smart-storage-to-counteract-intermittency-problems

http://www.emforce.nl/index.php?page=smart-storage-eng

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Smart Energy Consumption Feedback – Connecting Smartphones to Smart Meters

by Markus Weiss, Friedemann Mattern and Christian Beckel

"Smart" information and communication technologies can contribute to a more thrifty use of energy. By connecting smartphones to digital electricity meters, we can process electricity consumption data and provide household-specific feedback. Bringing users into the loop then enables them to learn about their personal consumption-related behaviour and optimize it in order to conserve energy.

Domestic electricity consumption is continuously increasing and now accounts for about one third of the total electrical energy produced in Europe. Many individuals would be interested in saving energy (and thus also carbon dioxide as well as money), but they lack information on their consumption. Indeed, feedback on household electricity usage is typically only provided by monthly (or even annual) utility bills and therefore remains opaque to most households. Few people know how much electricity they consume, and even fewer have any idea how much electricity they use for a particular purpose (eg lighting). And even those who do have a fair understanding of their consumption patterns rarely receive guidance about the changes that would have the biggest impact on their electricity bills.

Fortunately, emerging "smart" information and communication technologies can help to make electricity consumption visible to individuals [1]. For instance, next-generation digital electricity meters ("smart meters") enable detailed electricity consumption information to be captured, processed, and communicated at frequent intervals (eg once per second). As smart meters are replacing traditional electricity meters in large parts of Europe, there is now a unique opportunity to realize comprehensive consumer feedback systems that consist of much more than mere remote metering applications.

At ETH Zurich we seized the opportunity offered by this development. Within the eMeter project we connected smart meters to smartphones [2]. As they are almost always connected to the Internet and within reach of the user, using smartphones to visualize electricity consumption eliminates the need for costly in-house displays. The resulting system not only fits unobtrusively into the home environment, but also provides fine-grained electricity consumption information in real-time, enabling occupants to better understand their electricity consumption.

Figure 1: Live visualization of current household electricity consumption

Figure 2: Measuring the standby power of a specific household appliance

The sensing and feedback system we developed consists of three loosely coupled components that are responsible for data acquisition, data handling, and data visualization. The first component consists of a state-of-the-art smart electricity meter that monitors the total household load. We extended the meter's functionality by incorporating a gateway module implemented on an embedded computing device equipped with flash storage and a WiFi communication module. This matchbox-sized gateway module also holds the second component of our system, a web server with a database. It manages the recorded metering data, performs data analysis, and handles incoming requests from the user interface. The carefully designed user interface, which forms the third component of our system, is realized as a mobile phone application on Android, iOS, and Windows Phone platforms.

Occupants can easily familiarize themselves with their electricity consumption and obtain feedback in real-time by using the following smartphone application functions:
- a live visualization of current total electricity consumption (see Figure 1)
- a historical view of electricity consumption over time (also indicating the resulting costs)
- a measurement function to interactively measure the consumption of any switchable electrical appliance in the house
- a household-specific recommendation service on how to save energy. Most notably the latter two functions provide users with the simple feedback advice they require in order to ultimately conserve energy [3].

The measurement function (see Figure 2) allows users to break down their consumption and learn how much a specific household appliance or device consumes. To perform a measurement, the user activates the process by pressing the start button on the smartphone application and then turns a device on or off. Within seconds, the measurement algorithm then determines and displays the electricity consumption of the device together with information on its energy efficiency and possible energy saving tips.

The recommendation service analyzes the captured electricity consumption data. It provides feedback that is individually tailored to the household and explains how its consumption relates to that of comparable households. It does so by computing the household´s standby power as well as the consumption of cooling appliances (ie fridges and freezers) based on their characteristic quasi-cyclic load curves.

Our eMeter prototype was used in several households in Zurich for more than a year. Study participants reported that their energy-saving knowledge substantially increased thanks to the system. However, the application's usage rate dropped over the course of the experiment once the participants' initial curiosity had been satisfied. Owing to this phenomenon, which is well known in the scientific community, concepts are required that motivate users to be involved with the system over an extended period of time.

In a follow-up project, we are currently investigating algorithms to automatically generate enhanced household-specific saving recommendations. Inferring occupancy from smart meter data, for instance, enables us to provide feedback on how much electricity a household consumes when no one is at home. Using methods developed in machine learning and data mining, we are further investigating ways of generating a pie chart that shows the contribution of each relevant appliance to the overall consumption bill. To validate our algorithms relative to "ground truth", we equipped six of our test households with additional sensors that measure electricity consumption at individual power outlets and reliably determine when occupants are at home.

The eMeter system demonstrates that smart ICT can collect, analyze, and present valuable real-time data on electricity consumption without costly additional hardware. It provides guidance (for example in the form of household-specific recommendations) that is crucial for occupants who want to conserve energy. Transforming our prototype, or at least parts of it, into a real product is the next logical step. We are cooperating with smart meter manufacturers and electric utility companies to work towards this goal.

Link:
www.vs.inf.ethz.ch/res/show.html?what=energy

References:

[1] F. Mattern, T. Staake, M. Weiss: "ICT for Green – How Computers Can Help Us to Conserve Energy", in proc. e-Energy 2010, ACM, pp. 1-10.
[2] M. Weiss, T. Graml, T. Staake, F. Mattern, E. Fleisch: "Handy feedback: Connecting smart meters with mobile phones", in proc. MUM 2009, ACM.
[3] M. Weiss, C. Loock, T. Staake, F. Mattern, E. Fleisch: "Evaluating Mobile Phones as Energy Consumption Feedback Devices", in: P. Sénac, M. Ott, A. Seneviratne (Eds.): MobiQuitous 2010, LNICST 73, pp. 63-77, 2012.

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Meter Data Management for Smart Monitoring Power Networks

by Agustín Yagüe, Juan Garbajosa and Mercedes Lopez-Perea

The electric power distribution and commercialization scenario is evolving worldwide, and electricity companies, faced with the challenge of new information requirements, are demanding IT solutions to deal with the smart monitoring of power networks. Two main challenges arise from data management and smart monitoring of power networks: real-time data acquisition and big data processing over short time periods. We present a solution in the form of a system architecture that conveys real time issues and has the capacity for big data management.

Electric power distribution markets worldwide are evolving, and power companies are demanding solutions that help them manage real time problems more efficiently and safely, whilst facilitating the integration of real time information into all corporate applications. These requirements present new data management challenges, which must be addressed by smart grids [1] with their capacity for smart metering and real time monitoring [2]. Smart grid management requires dealing with huge amounts of data including data collected from smart meters and other devices connected to the power network. The enormous volume of data scales up the data management to a Big Data issue [3]. Currently, data are acquired from meters throughout the day, and analysed "off-line" in time-constrained periods (quarterly, hourly, daily and monthly). Consequently, electricity companies are demanding IT solutions to deal with the smart monitoring of power networks and, in turn, to be able to respond to the current market energy needs in real time. However, there are two main challenges behind the smart monitoring of power networks: real-time data acquisition and big data processing in a short period time. We present a solution: a system architecture that conveys real time issues and has the capacity for big data management.

The company Indra Software Labs (ISL) and the research group SYstems and Software Technology (SYST) of the Technical University of Madrid (UPM) are working in close collaboration on the ITEA2 project IMPONET to deal with these challenges. IMPONET has developed a flexible platform that allows the continuous monitoring of the network with real time or quasi real time data processing and the configuration of the customer consumption profile to monitor its evolution and to make decisions based on its information.

The IMPONET platform includes components/modules for the remote control and smart metering of distributed energy sources and mobile energy consumption (eg electric vehicles) by using smart devices and following the

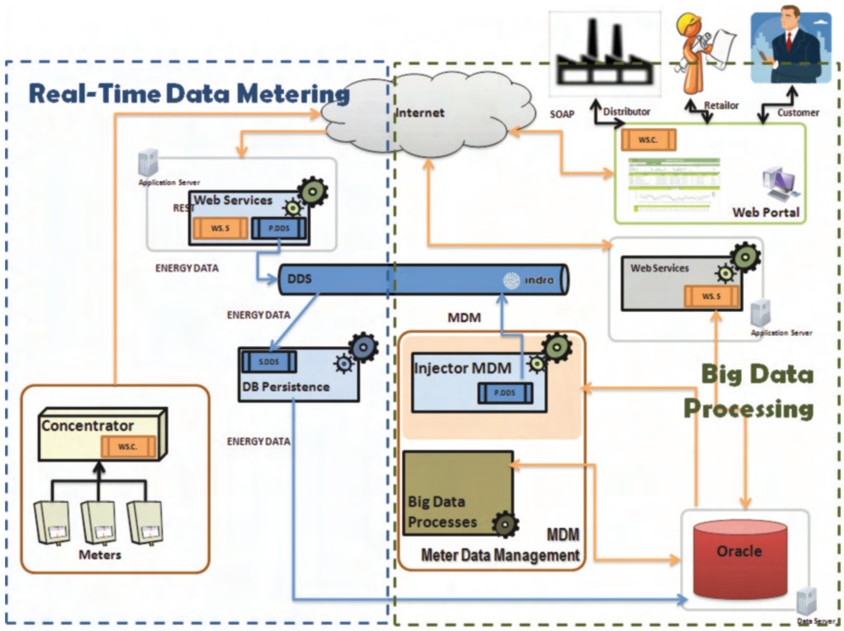

Figure 1: IMPONET Data Management Platform

Service-Oriented Architecture (SOA) approach. To provide this functionality, these components/modules have the capacity to respond in real time to the massive amounts of information that will be received from the network and to store them, as well as the signals that will have to be transmitted to the devices in the field.

The data metering is achieved with a powerful communication bus based on the standard data distribution service (DDS), a real-time publish-subscribe paradigm, and the storage of information into a real-time database (see Figure 1). The DDS bus serves as a coordinator for the rest of the components/modules of the platform to guarantee the real-time capability. The big data processing has to be performed in such a way that the massive amounts of information extracted from smart meters can be processed on time (see Figure 1). Big data processing has been addressed by using Hadoop and Oracle Berkeley DB Non-SQL database. Hadoop Map-Reduce provides parallel and distributed data processing with Non-SQL approach. This implementation has been validated through different smart grid scenarios obtaining the promising results of storing and processing around 150 M measures in less than three hours.

The information processing involves handling raw data to obtain optimal data by performing two operations: (i) validation of meter data according to an established validation formula, (ii) calculation of the best available energy data from different sources for a measuring point, magnitude and period of energy data. This information is then provided to the customer, the retailer and the distributor from different perspectives, enabling different stakeholders to analyse the results from their own particular point of view (see Figure 2).

Link:
IMPONET: Intelligent Monitoring of POwer NETworks:
http://www.innovationenergy.org/imponet/

References:

[1] S. Massoud and B.F. Wollenberg: “Toward a Smart Grid”, IEEE P&E Magazine 3(5), 2005
[2] J. Byun et al: “A smart energy distribution and management system for renewable energy distribution and context-aware services based on user patterns and load forecasting”, IEEE Transactions on Consumer Electronics, vol. 57 , nº.2, 2011
[3] S. Madden: “From Databases to Big Data”, IEEE Internet Computing, vol.16 nº.3, 2012.

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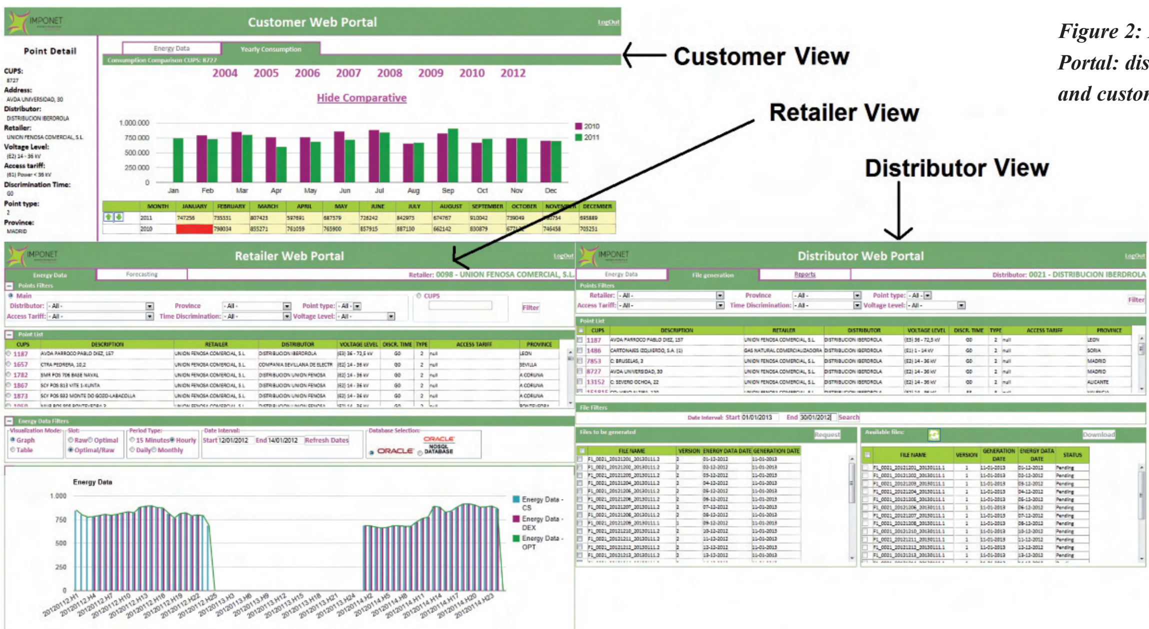

Figure 2: IMPONET Web Portal: distributor, retailer and customer views

Designing and Simulating Smart Grids

by Jennifer Pérez, Jessica Díaz and Eloy González

Growing energy demands and the increased use of renewable energies have changed the landscape of power networks leading to new challenges. Smart Grids have emerged to cope with these challenges by facilitating the integration of traditional and renewable energy resources in distributed, open, and self-managed ways. Innovative models are needed to design energy infrastructures that can enable self-management of the power grid. Software architectures smoothly integrate the software that provides self-management to Smart Grids and their hardware infrastructures. We present a framework to design the software architectures of autonomous Smart Grids in an intuitive domain-oriented way and to simulate their execution by automatically generating the code from the designed autonomous smart grid architectures.

Power networks are undergoing continuous change due largely to increased power consumption and the availability of renewable energy. These changes require the evolution of power networks towards new software architectures of control and operation. These software architectures will soon enable great improvements to the automation and distributed communications of power networks.

Smart Grids [1] promote the integration of traditional and renewable energy resources, with new elements in a distributed, open, and self-managed way. This requires innovative models for energy infrastructure and the self-management of the power grid [2], whose openness and distributed nature requires a shift from the current centralized infrastructures towards more distributed ones. Such a shift would ensure the scalability of smart grids and enable the management of autonomous operations throughout the power network. As a result, it is vital that we address both the definition of self-management policies and the design of the software to be deployed throughout the different devices of the Smart Grid. The design of this software layer involves constructing the Smart Grid software architecture and establishing the autonomous behaviour of the grid. This autonomous behaviour has to define the properties that are going to be monitored and their acceptable values, as well as the policies that have to be followed and automatically executed at run-time.

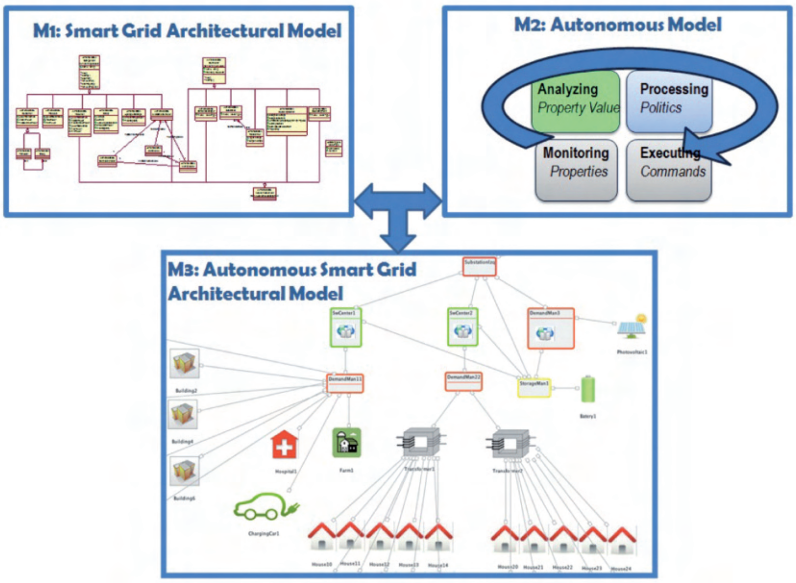

Figure 1: Autonomous Smart Grid Architectural Model

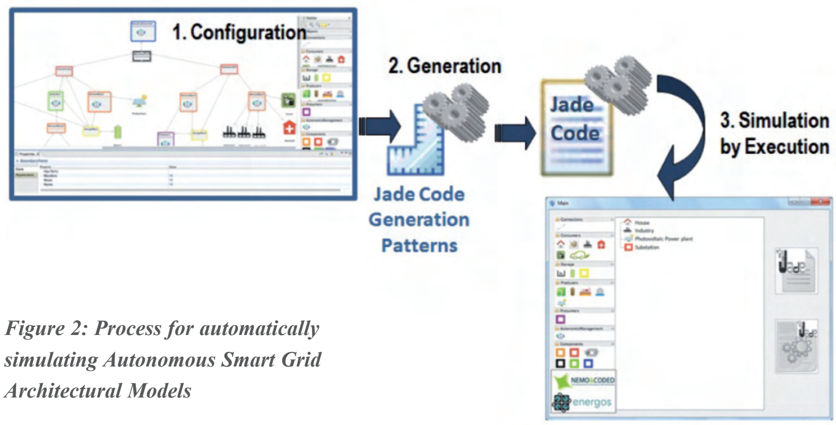

Figure 2: Process for automatically simulating Autonomous Smart Grid Architectural Models

The company Indra Software Labs (ISL) and the research group SYstems and Software Technology (SYST) of the Technical University of Madrid (UPM) are working in close collaboration on the CENIT Spanish project ENERGOS and the ITEA project NEMO & CODED to address these Smart Grid challenges. From the results of ENERGOS and NEMO & CODED, ISL and UPM are constructing a framework to support the design of Smart Grids by providing mechanisms for: (i) designing distributed software architectures in an intuitive way by using concepts of the power network domain [3], (ii) defining the autonomy capabilities of software components, (iii) generating code from these designs, and (iv) simulating the behaviour of the Smart Grid software architecture and its autonomous capabilities by executing the generated code.

This framework is based on an innovative approach which integrates a model for specifying autonomous behaviour, and an architectural model designed for specifying Smart Grids. The autonomous model establishes a loop for monitoring those properties that have to be controlled, analysing their values, processing the collected values through the use of a set of established policies, and executing the needed commands to update the properties (see M2, Figure 1). On the other hand, the smart grid architectural model extends software architectural models with the concepts of the power network domain to facilitate the design and comprehension of the architectural design (see M1, Figure 1). The resulting model of this integration allows autonomous smart grid architectures to be defined. As a result, any specialist of the energy area would be able to define the configuration of power network devices by inherently defining the software architecture and specifying the network devices in which the software components are to be deployed, and by defining which properties, acceptable values and policies are to be considered for its autonomous behaviour. This model is provided by the framework that has been constructed, which offers an intuitive and graphical power network language (see M3, Figure 1).

This framework follows a well defined process that consists of the configuration of autonomous smart grid architectures, the execution of model-to-code generation patterns and the execution of the generated code [3]. Specifically, the generated code is Jade, and we are now working on refining this generation and the platform to systematize the simulation by executing the generated code (see Figure 2).

Links:
http://kwz.me/4L
http://innovationenergy.org/energos/

References:
[1] S. Massoud and B.F. Wollenberg: "Toward a Smart Grid", IEEE P&E Magazine 3(5), 2005
[2] J.O. Kephart and D.M. Chess: "The Vision of Autonomic Computing", Computer, 36(1), IEEE, 2003
[3] S. Kelly and J.-P.Tolvanen: "Domain-Specific Modeling: Enabling Full Code Generation", John Wiley & Sons, 2008.

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Smart Management of Renewable Energy for Green Transport

by Raffaele Bruno, Luca Valcarenghi, Molka Gharbaoui and Barbara Martini

Concerns about the impact of climate change mandate the drastic reduction of green house gas (GHG) emissions through the increased utilization of renewable energy sources (eg wind or solar energy), as well as hybrid and electric vehicles (EVs). To achieve this goal we outline a smart management system for community-wide public charging infrastructures, which can foster the market penetration of EVs by effectively complementing home-based charging while coping with the power fluctuations of renewable energy sources.

One of the main targets for smart cities is a "new environmentally conscious form of urban living", which entails a more intelligent use of locally generated renewable energy and the integration of sustainable and greener sources into the large-scale car fuelling system [1]. Liberalization and deregulation of electricity markets mean that citizens are no longer passive consumers of electricity provided by large-scale distribution systems, but active market players and micro-producers at individual and community levels. Moreover, electric cars have gained popularity over the last two years thanks to increasing concern about the environment, public health, the unsustainable nature of fossil fuel use, and the release of a handful of affordable electric vehicles (EVs).

Several infrastructure problems stand in the way of widespread use of EVs. While EVs could be charged using conventional household electrical outlets (albeit with significant charge delays), we are not yet close to developing a large-scale public charging infrastructure, and such an infrastructure will be costly to build. Moreover, while the EV technology enables the shift from fossil fuel dependent combustion engines to electrical engines, much of the electricity used to recharge the batteries will still be produced via unsustainable methods. Finally, with increased use of EVs, the demand for electricity will soar, and, if charging is unregulated, will be accompanied by the risk of grid overload.

We argue that to address the above technical challenges there is a need for smart management systems for electric vehicle recharge (SMS-EV), which could jointly and autonomously control EV charging and distributed energy resources (ie, renewable sources) at a community/city-wide level. Specifically, we envision urban areas in which public charging infrastructures are built upon an interconnected mesh of residential/commercial charging docks, or charging stations (an illustrative example is provided in Figure 1). The SMS-EV will need to: (i) ensure a balanced usage of the electrical infrastructure minimizing the impact of EVs on grid reliability and peak demands; (ii) improve the sustainability of the EV charging infrastructure by optimizing the utilization of locally generated renewable energy; and (iii) maximize user satisfaction with the EV charging service (eg, minimizing EV charging times). This vision entails the use of emerging wireless networking paradigms (eg, VANETs) for information dissemination to achieve: good coverage without dense deployments, scalability, communication reliability, and fast and incremental deployability with

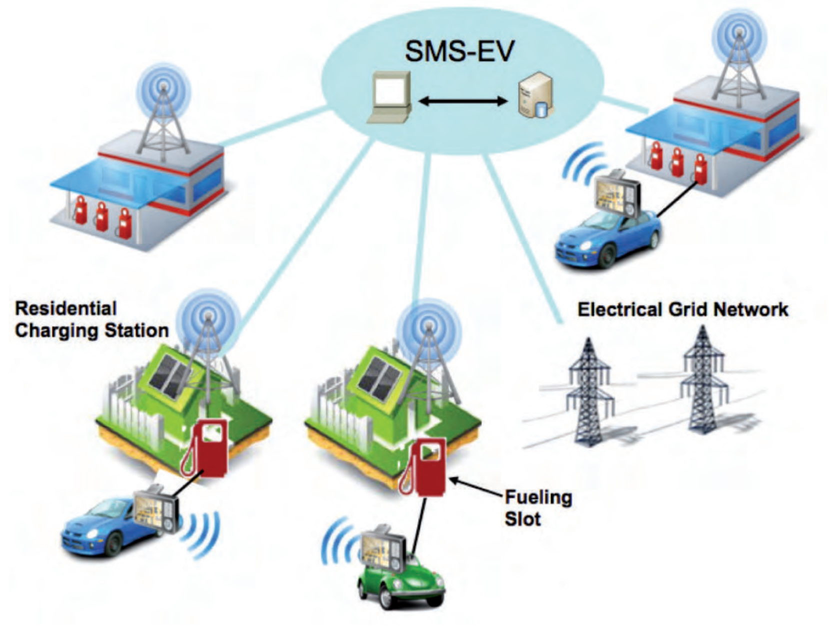

Figure 1: Example of a SME-EV architecture

a low initial investment. Most importantly, the SMS-EV must feature an intelligent service layer capable of providing customized information and services to drivers while ensuring an efficient use of energy resources at individual and community levels.

We are currently exploring the potential benefits offered by the SMS-EV [2], and preliminary results are reported in Figure 2. The considered scenario features an SMS-EV that applies two different policies for assigning an EV to charging stations when a new charging service request is used by an EV: (i) closest station policy (CS), which minimizes travelling times by assigning an EV to the closest charging station; and (ii) minimum waiting time policy (MWT), which assigns an EV to the station that minimizes the charging delay taking into account the time to complete the charging of other EVs currently present at each charging station. Intuitively, another essential factor that may affect the system performance is the type of power resources deployed in SMS-EV. Specifically, we consider two types of power sources: (i) standard grid-based power sources, which can be assumed to have a constant power production profile during the day; and (ii) solar panels, which are known to suffer from short-term variability of their output power due to changing atmospheric conditions even during high insolation daytime hours (in Figure 2 variability is assumed to be 50% of clear sky nominal power). Figure 2 reports the observed charging delays versus the arrival rate of charging requests for the case of a charging infrastructure deployed in 5x5 grid road network, in which each block size is 1km x 1km. The results show that the MWT policy is beneficial because it reduces the average waiting time with respect to the CS policy for both the types of power sources. It must also be noticed that for high request arrival rates the MWT policy combined with the utilization of solar power outperforms the CS policy even if utilizes traditional power sources. Furthermore, these results clearly indicate that there is a need for more sophisticated charging strategies that take into account vehicular mobility as well as the temporal variability of PV output power.

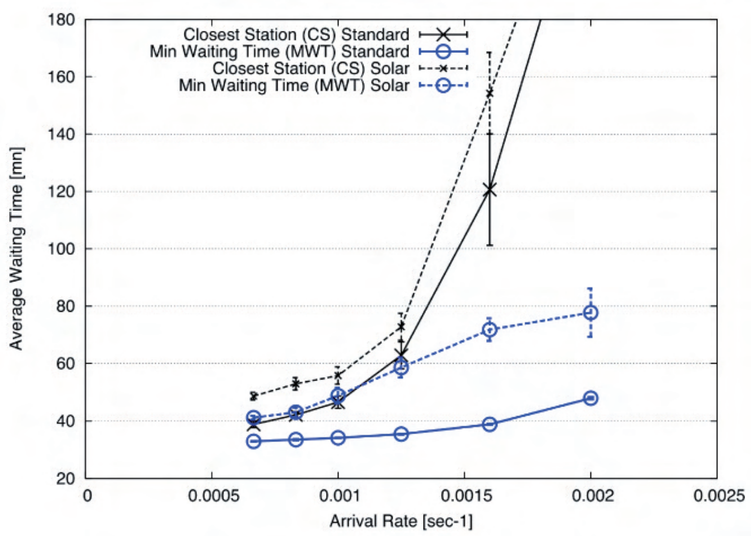

Figure 2: Comparison of charging times with different policies for charging station selection and different mixes of power sources

Link:
http://cnd.iit.cnr.it/index.html

References:

[1] C. Rissen et al: "Electric Vehicle Charging Solution for Smart Cities", Hitachi Review, vol. 61, no. 1, Feb. 2012

[2] M. Gharbaoui et al: "Effective Management of a Public Charging Infrastructure through a Smart Management System for Electric Vehicles", in proc. IEEE ENERGYCON-STS'12, Florence, Italy, 2012.

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Real-Time Visualization of MV/LV Energy Alarms on GIS Web Applications

by Christophe Joubert, Vicente Monrabal, Miguel Montesinos and Carlos Sánchez

In April 2006, in its Directive 2006/32/EC on energy end-use efficiency and energy services, the European Parliament and Council encouraged the installation of smart meters at every end-user in Europe with a complete coverage planned for 2018. This power network evolution implies new needs such as real-time management of energy flows to increase connectivity, automation and coordination of producers, providers and consumers in the distribution network. Our work contributes to the attainment of this goal by providing real-time visualization of energy alarms detected at the end-user end, ie medium voltage (MV) / low voltage (LV) energy alarms.

In the ITEA2 international project IMPONET (AVANZA TSI-020400-2010-103, ITEA2 Nº 09030), a comprehensive, flexible and configurable information system has been developed to support the most complex and advanced requirements in energy management, in particular power quality monitoring and the remote control and smart metering platform. To date, power companies have been using geographical information systems (GIS) with historical data to visualize energy alarms, faults, and other energy information on a map [1]. This project offers novel power quality monitoring solutions for power companies to visualize real-time information coming from the medium voltage (MV) / low voltage (LV) distribution network.

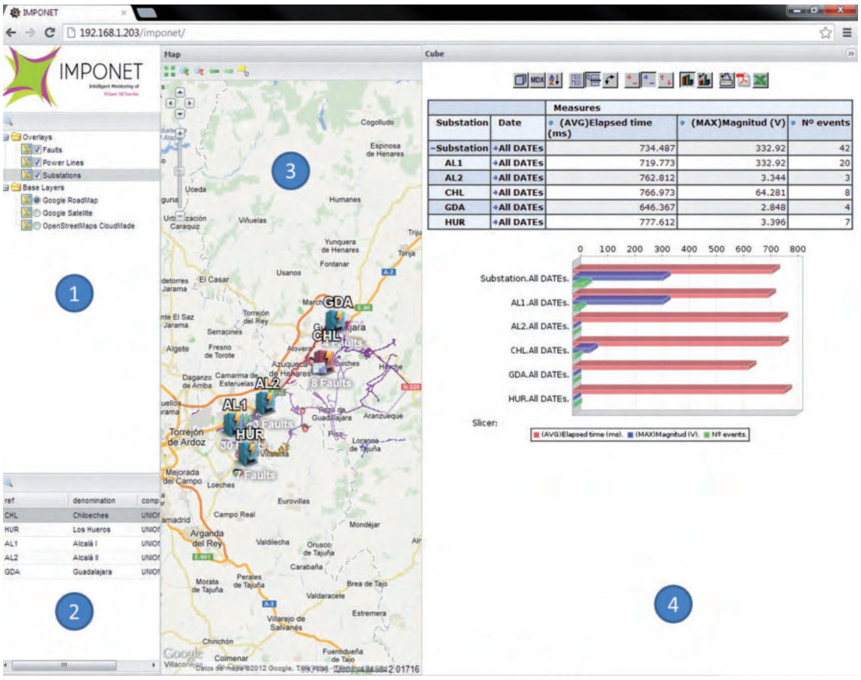

Figure 1: Geoportal for real-time and B.I. visualization of energy alarms

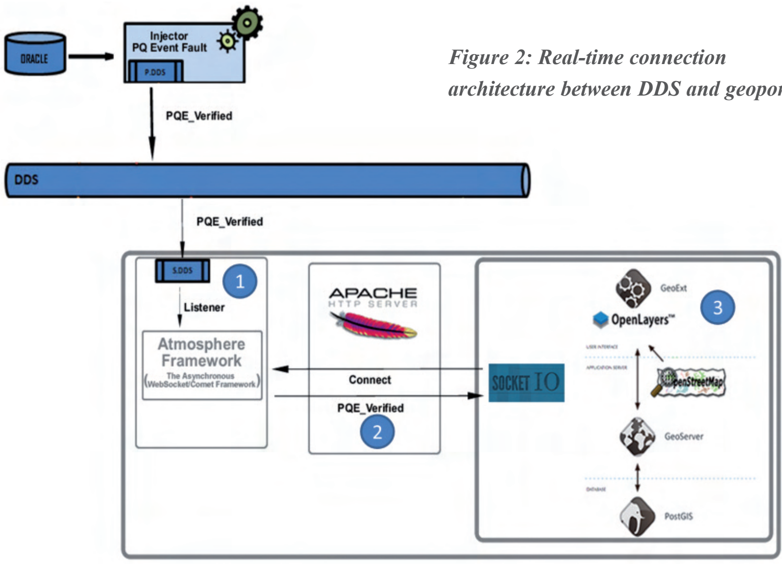

Figure 2: Real-time connection architecture between DDS and geoportal

In order to operate the network more efficiently, it is necessary to have a systematic and standardized method of exploiting data from a huge number of electronic devices involved in control and protection of power systems. One solution investigated in IMPONET is the use of the object management group (OMG) data distribution service (DDS) open standard for messaging that supports real-time systems [2]. Also, to achieve the ambitious goals that are envisioned for Smart Grids of the future, a new conception of network monitoring systems is required. Within the power quality monitoring force task, we developed a geoportal that allows the continuous monitoring of the network with real-time data processing capabilities. It includes features and services that enable providers to detect issues on the power network, to monitor their evolution and to make decisions based on this information.

The power quality monitoring geoportal is divided in four parts as described in Figure 1: layer tree, substation selector, map viewer, and business intelligence (B.I.) viewer. The layer tree contains a set of common and open base layers as well as several specific overlays: real-time faults, power network components, and B.I. layer for statistics. The map viewer allows a user to interact with any element of selected layers, and to show historical data or real-time events directly from the DDS. Finally, the map viewer interacts with the B.I. viewer, which allows a user to request any kind of statistics over the power quality OLAP cubes preprocessed from monitoring campaigns.

The novelty of our approach resides in the processing of real-time power fault events from DDS to GIS web clients in three stages, as illustrated in Figure 2:

1) When the fault overlay is selected, a DDS subscriber is internally launched and connected to the GIS client in order to capture fault events, ie voltage sags, swells and other power disturbances detected at the smart meters and substations.
2) Through a permanent link between the GIS application and the DDS subscriber, based on an atmosphere server for asynchronous web applications and Socket.IO for communication channels, fault events are transmitted in real-time to the GIS client. This technology allows any web client to interact with the service without needing to refresh the web client [3].
3) Fault events being geolocated, they are represented on the power network where faults occur (as indicated on Figure 3) as soon as they become available on the DDS. In the case of MV / LV faults, they appear close to the substations. Faults are depicted in different colours on a green to red scale in order to show the alarm severity based on duration and magnitude of the fault.

Figure 3: Real-time layer with geolocated fault events coming from DDS

The results are very encouraging: power companies have already shown an interest in such architecture, which provides features not yet covered by current power company solutions, in particular real-time geolocated information for the lower part of the power network, directly from the outputs of end-user smart meters.

Collaboration for this project spanned four countries (Korea, Republic of Slovenia, Spain and Turkey) and fifteen project partners: Answare, Deusto University, Tecnalia, INDRA, Innova, Kapion, Kema, LNL, UPM, Union Fenosa, Girona University, Ljubljana University, LDOS, Wooam. Our work is partially supported by the Spanish MEC INNCORPORA-PTQ 2011 program.

Link:
http://www.innovationenergy.org/imponet

References:

[1] G. Aydin: "Service oriented architecture for geographic information systems supporting real time data grids", Ph.D. Thesis: Indiana University, 2007

[2] J. A. Dianes et al: "Using standards to integrate soft real-time components into dynamic distributed architectures", Comp. Stand. & Interfaces, vol. 34, no. 2, pp. 238-262, 2012

[3] E. Bozdag et al: "Performance testing of data delivery techniques for AJAX applications," J. of Web Eng., vol. 8, no. 4, pp. 287-315, 2009.

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Using Wireless Smart Meter Networks for Power Quality Monitoring

Joel Höglund and Stamatis Karnouskos

The future of Smart Grids lies in standardization and open protocols. By using the capabilities of modern smart meters, which communicate over wireless radio, grid power quality monitoring can be improved while keeping costs low.

In NOBEL we have been developing middleware and services for the future smart electricity grids. One of the key issues, in the context of lower level networking, is how best to make use of the more fine grained smart meter measurement data. We have studied how smart meter data can be used to complement and partially replace more expensive grid monitoring equipment without comprising on power quality monitoring [1]. This is achieved using smart meters that communicate over low power radio, with the smart meters forming a wireless sensor network (WSN).

The European Commission FP7 NOBEL (www.ict-nobel.eu) project's partners include: SICS from Sweden, University of Duisburg-Essen and SAP from Germany, ETRA and Alginet from Spain and CERTH from Greece.

Part of the work has been to explore and outline the business advantages that can be gained by improved power quality monitoring [1]. Improved monitoring gives electricity providers proof of power quality that can be delivered to residential users and be used to attract new customers. It would allow residential customers to monitor their own power quality. It offers greater potential for early problem identification and preventive maintenance. Finally, it could enable electricity providers to better optimize the voltage delivered, which may lead to a reduction of the energy consumed of up to 4% [1] (for Sweden that would correspond to 5.6 TWh in 2011).

The next generation WSN based tests have been performed at a distributed testbed at SICS, Stockholm, Sweden, with the receiving enterprise services running at UDE in Duisburg. Larger scale user trials using several energy services have been performed while tapping into the existing smart meter infrastructure in Alginet, a small town outside of Valencia, Spain. In the lab tests, the smart meters are modelled with relatively cheap, low power, hardware. As an important partial goal is to reduce the overall consumption, new infrastructure should not offset the savings by its own energy consumption.

By being based on the Contiki operating system [2], the smart meter middleware is using implementations of the wireless standards which have gone through interoperability testing across different platforms. Contiki is being supported by a growing number of hardware platforms, and has an active developer community. Using the latest routing standard for wireless networks, RPL, the smart meter network becomes self-configuring. A newly installed device will automatically connect with the rest of the network, and acquire the needed network configuration data. This lowers installation costs, and makes it easy to add new meters.

Based on local voltage deviation detections, smart meters can trigger events to alert the local grid operator. The events could either trigger a request to automatically increase the sampling rate in the affected area, or be forwarded to a grid operator for manual decision making.

As the radio packet sizes in WSNs are smaller than on the wired internet, fragmentation and address compression become important issues. This is handled by a 6LoWPAN layer which ensures the maximum packet proportions can be used for actual program data. Still, it is worth spending some design effort to keep messages – meter readings – short so as to limit the delays of fragmentation which would increase network delays.

In our evaluations we have shown that the testbed could handle meters reporting data every 60 seconds. On top of that we made extra subscriptions when the system detected a voltage deviation, where a subset of the meters started reporting every 10 seconds to aid the tracing of quality problem origins. These results were communicated to an enterprise system via the NOBEL energy services and show that the suggested architecture is feasible with acceptable overhead [1]. The power network will continue to need high cost network analysers to get instantaneous state information at critical points in the grid. Nevertheless, there are clear advantages to complementing the architecture with modern smart meters capable of delivering fine grained monitoring data.

The NOBEL project started in spring 2010, and finished in December 2012. Security in the wireless networks has not been addressed within the project, but for real life deployments the customer data needs to be further protected, as access to or tampering of energy data may raise security and privacy concerns. Since the design is standard based, it is well prepared to be extended with IPSec [3], something which we currently investigating.

References:

[1] J. Höglund, D. Ilic, S. Karnouskos, R. Sauter and P. Goncalves Da Silva: "Using a 6LoWPAN Smart Meter Mesh Network for Event-Driven Monitoring of Power Quality", in 3rd IEEE International Conference on Smart Grid Communications (SmartGridComm), Tainan City, Taiwan, 2012

[2] A. Dunkels, B. Grönvall, and T. Voigt: "Contiki - a lightweight and flexible operating system for tiny networked sensors", 1st IEEE Workshop on Networked Embedded Sensors (EmNetS-I), Tampa, Florida, USA, November 2004

[3] S. Raza, S. Duquennoy, T. Chung, D. Yazar, T. Voigt, and U. Roedig: "Securing Communication in 6LoWPAN with Compressed IPsec", IEEE International Conference on Distributed Computing in Sensor Systems (DCOSS '11), 27-29 June 2011, Barcelona, Spain.

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Smarter Energy: Opportunities and Challenges

by Olle Sundström, Fabian Müller, Carl Binding, Bernhard Jansen and Dieter Gantenbein

To increase the share of renewable energy in the electric power system, smarter solutions are needed in many areas. The way we consume electricity needs to change so that consumption is to a greater degree influenced by the availability of energy. In a system with high penetration of fluctuating production, such as wind and solar power, all kinds of flexible loads need to be identified and utilized to balance the supply and demand.

At IBM Research – Zurich, we are involved in various research projects that focus on enabling an increased penetration of renewable energy in the power system. Energy can be buffered directly by, for example, the thermal mass of a house or the energy storage in a battery. Energy can also be indirectly buffered by time-shifting the consumption, for example, by starting an appliance at a different point in time than intended.

A first area of investigation has been the use of a large fleet of electrical vehicles (EVs) in the context of the EDISON project, where energy buffering was to be provided by the EV batteries [1]. Currently, we focus on thermal storage, be it for industrial cooling and refrigeration purposes or for domestic heating applications in the context of the EcoGrid EU project [3].

Our general approach is structured as follows:
- Identify a mathematical model describing the underlying physical model. For that purpose, we use system identification techniques based on observed historical data.
- Using observed data, we derive forecasts of future use of these systems. For example, we formulate trip predictions for EVs or predictions on hot-water usage in the case of boilers.

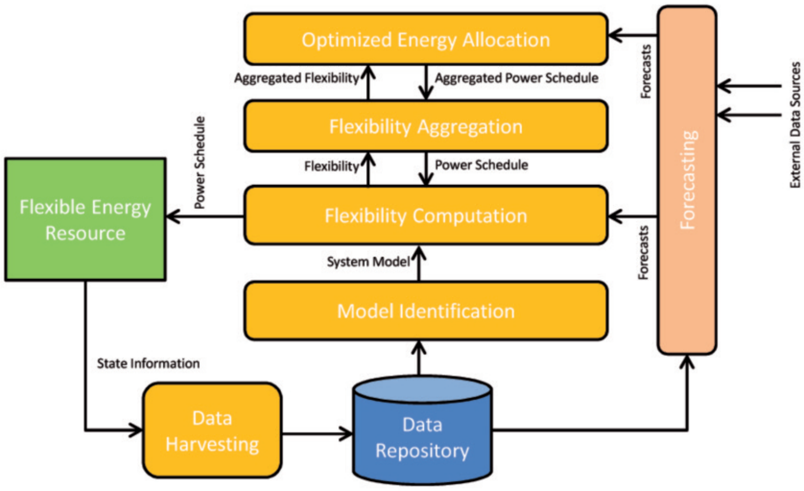

Figure 1: System architecture

- Based on the predictions and the system model, we compute the flexibility in terms of the electricity needed from the power system.
- This flexibility allows us to allocate power over time in such a way that the demand requirements are fulfilled while, for example, following stochastic renewable generation.
- The optimal power schedule is computed and communicated to the flexible energy resource as a control signal.

A schematic architecture of our approach is shown in Figure 1. We distinguish several layers. First, there is the data-collection layer, in which we use a large-scale communication and sensing infrastructure to harvest usage and generation information. A second functional layer performs the system identification.

A third layer computes the flexibility of the energy systems. We indicate minimum and maximum usage boundaries and, based on these, derive a minimum and a maximum inflow of energy needed to satisfy demand. Figure 2 illustrates this flexibility. The energy and power taken from the power system over time are constrained to remain within the energy and power flexibilities. All trajectories within the flexibility bounds would satisfy user demand, but differ in the timing of replenishment.

A fourth layer aggregates the flexibility, and the fifth optimizes the use of the flexibility. Here, optimization techniques are used to achieve the best usage of energy generation versus demand in general.

Our current focus is on applying the above energy-buffering paradigm and the system architecture in the framework of the EU project EcoGrid, where the main energy buffering is represented by home-heating systems driven by heat pumps. The system's flexibility is bound by the comfort zone set by the user, who may tolerate a temperature band around a set point.

We have achieved initial results in system identification based on the data collected in the pilot setup. Figure 3 illustrates the quality of the system modeling using the indoor and the outdoor temperature as well as the influence of solar radiance.

References:

[1] O. Sundström and C. Binding: "Flexible charging optimization for electric vehicles considering distribution grid constraints", IEEE Transactions on Smart Grid, Volume 3, Issue 1, pp. 26-37, 2012
[2] O. Sundström, C. Binding, D. Gantenbein, D. Berner, and W. Rumsch: "Aggregating the flexibility of domestic hot-water boilers to offer tertiary regulation power in Switzerland", in proc. IEEE Intelligent Smart Grid Technology Conference, Berlin, 2012
[3] D. Gantenbein, C. Binding, B. Jansen, A. Mishra, and O. Sundström: "EcoGrid EU: An efficient ICT approach for a sustainable power system", in proc. Second IFIP Conference on Sustainable Internet and ICT for Sustainability, Pisa, Italy, 2012.

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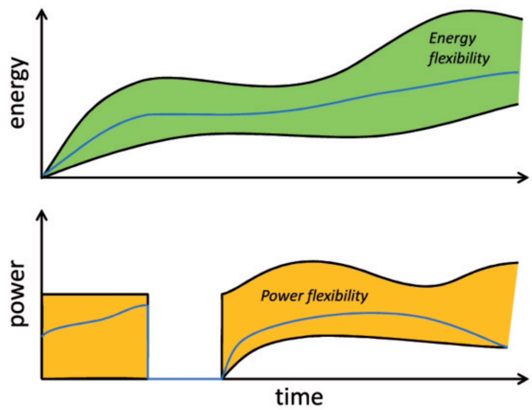

Figure 2: Schematic flexibility, with minimum and maximum energy needs and minimum and maximum power flexibility, together with a realization of the flexibility (blue curves)

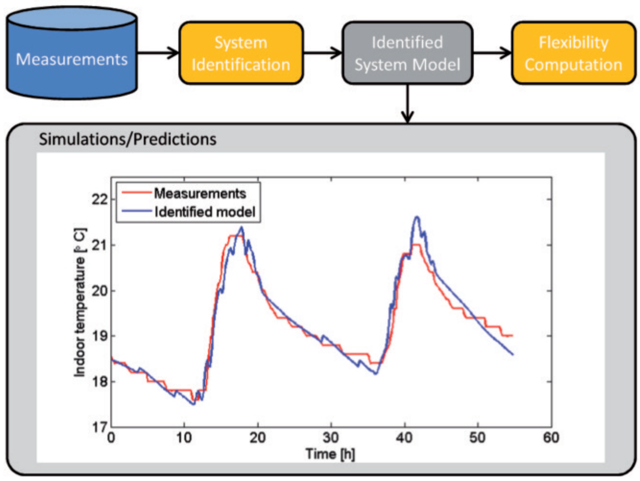

Figure 3: Modelling a home-heating system

Smart Demand-Side Response at Home

by Armin Wolf, Thomas Luckenbach and Mario Schuster

The threat of global climate change and the challenge of reducing carbon emissions necessitate new ways to collaboratively manage and optimize energy production and load. Home and living areas can be part of such an approach thanks to secured and standardized smart metering environments.

The availability of renewable energy fluctuates heavily. Because of the stochastic nature of energy production, energy consumption should follow its production. The introduction of time-variable energy tariffs is an approach to attract consumers to shift their energy loads into low demand periods. We have developed a smart energy management system that reacts to flexible electricity prices. The system optimally schedules electricity consumers, minimizing the overall energy cost while respecting device-specific load profiles and individual constraints defined by the user. According to a recent study on demand side integration, there is the potential to load shift more than 10 GW in private households in Germany [1].

The core of the realized energy optimization system comprises a constraint-based scheduler that schedules the load profiles of the considered electricity consumers on a common cost aware cumulative resource [2], respecting temporal constraints (eg washing before laundry drying) and capacity restrictions (eg determined by the main fuse). Therefore, the system receives the energy tariff for the considered scheduling horizon – typically 24 hours with fixed prices for a time resolution of 15 minutes – as well as the load profiles to be scheduled, the overall capacity level which must not be exceeded, and the temporal constraints on the load profile. The load profiles are represented by discrete pricewise constant functions showing the average power demand of an electricity consumer per time unit during its usage which has to be scheduled. The chosen time resolution depends on the application domain – typical resolutions are five or 15 minutes according to the tariff information. For instance, a typical dish washer has a low power demand while pre-/post-rinsing (eg 200 W) but has a high power demand during the washing/drying phase (eg 1 kW) such that a naive management approach, which starts dish-washing when the energy price is low, may not be the most economical option since the energy intensive part of the cycle might occur within the high-price period. The temporal constraints allow the formulation of:

- time slots, ie earliest start and latest completion times of the energy loads,
- mutual exclusions of several loads, eg caused by the same device or requiring an additional but exclusively available resource, eg an operator,
- temporal relationships between the start and end times of different loads, eg “before”, “while”, “after”, “earliest”, or “latest” conditions.

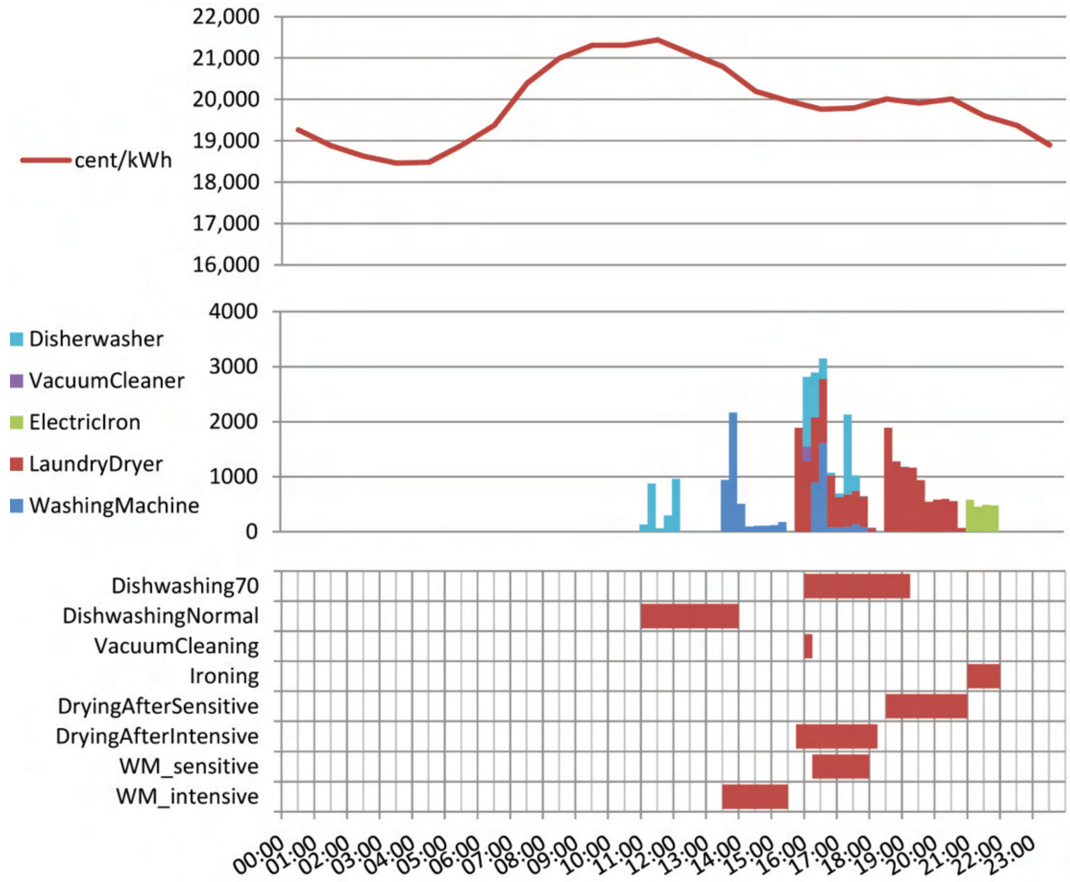

Figure 1: Example of a dynamic load management based on individual preferences and load profiles of typical devices

The system transforms this kind of input data and constraint definitions (defined in XML) into a mathematical, constraint optimization problem using a Constraint Programming (CP) approach. Our constraint-solving library "firstCS" [3] offers the necessary primitives and Operations Research (OR) functionality to define and solve the necessary equalities and inequalities resulting from variable tariffs as well as the temporal and capacitive restrictions. The achieved solution consists of two parts: a cost-minimal schedule of the loads and the according load distribution. Again, the output is in XML format. In particular, for the load distribution the interface standard for meter reading and control, IEC 61968-9, is used. We have chosen this format for easy comparison of the scheduled load with the real energy consumption measured by smart meters. These data in the same format show the difference between target and reality as well as the financial loss compared to the cost-optimal schedule. In order to perform the necessary analysis and perform a comfortable automatic control of the involved devices (causing the loads), the energy management system can run on our own energy management and control gateway.

This gateway is a programmable communication device that can take over the role of a gateway for Controllable Local Systems (CLS) to allow electrical devices to be switched based on the current load management. The CLS approach is also specified in the German guidelines for smart metering systems and gateways and the respective protection profile [4]. Additional software modules of our gateway enable demand side integration (eg our smart energy management) and load control. For comfortable use, the gateway offers a unified web-based user-interface on PC, appliances, and smartphones (using HTML5). The solution is an open interoperable gateway having a standardized interface to access certified smart meter gateways (SMGW), smart meters, and other machine-to-machine (M2M) devices. It also supports state-of-the-art home automation and facility control technologies such as digitalSTROM, KNX, ZigBee and 868MHz RF.

References:

[1] Demand Side Integration – Lastverschiebungspotenziale in Deutschland, VDE-ETG-Studie, June 2012

[2] H. Simonis and T. Hadzic: "A resource cost aware cumulative", in proc. ModRef 2010 workshop at CP 2010

[3] A. Wolf: "firstCS – New Aspects on Combining Constraint Programming with Object-Orientation in Java". KI – Künstliche Intelligenz, vol. 26, no. 1, 2012

[4] Federal Office for Information Security, Protection Profile for the Gateway of a Smart Metering System, Gateway PP, v01.01.01(final draft), 25.08.2011.

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Market Garden: A Scalable Research Environment for Heterogeneous Electricity Markets

by Felix Claessen, Nicolas Höning, Bart Liefers, Han La Poutré and Peter Bosman

How will we trade energy in the future? We can expect vast technological changes in our energy systems, leading to high heterogeneity in both supply and demand. Knowing the true value of energy at a given time and location will be crucial. Market mechanisms are methods of determining prices in complex, multi-actor settings. In the Intelligent Systems group at CWI, we have developed a research environment in which different market mechanisms for electricity can be studied and evaluated - in interaction, remotely and in a scalable manner.

In order to allocate energy efficiently in future energy systems, it will be vital to take an economic perspective. This is due to three major trends: the rise of intermittent renewable generation, new steerable demand appliances (eg electric vehicles and heat pumps) and market deregulation. The Intelligent Systems group at CWI has developed a software research environment to study market mechanisms for various economic future scenarios.

It is important to design and study a range of possible market mechanisms and their properties, since it is unlikely that a single market mechanism, for example one spot market [1], can be used in all local settings. Consider flattening the loads of the heating devices in a large office building: This can, in principle, be accomplished by continuously collecting price bids from the devices for the next 10 minute interval and updating allocations accordingly (see [2], for example). However, a different mechanism is needed if it is crucial for a substantial number of devices or participants to plan ahead, eg because electric vehicles in a residential area need to charge their batteries in time before their owners go to work [3]. A market mechanism for this situation should allow bidders to announce preferences for future time slots (eg when they need to leave) and incorporate that into the computation of an efficient out-

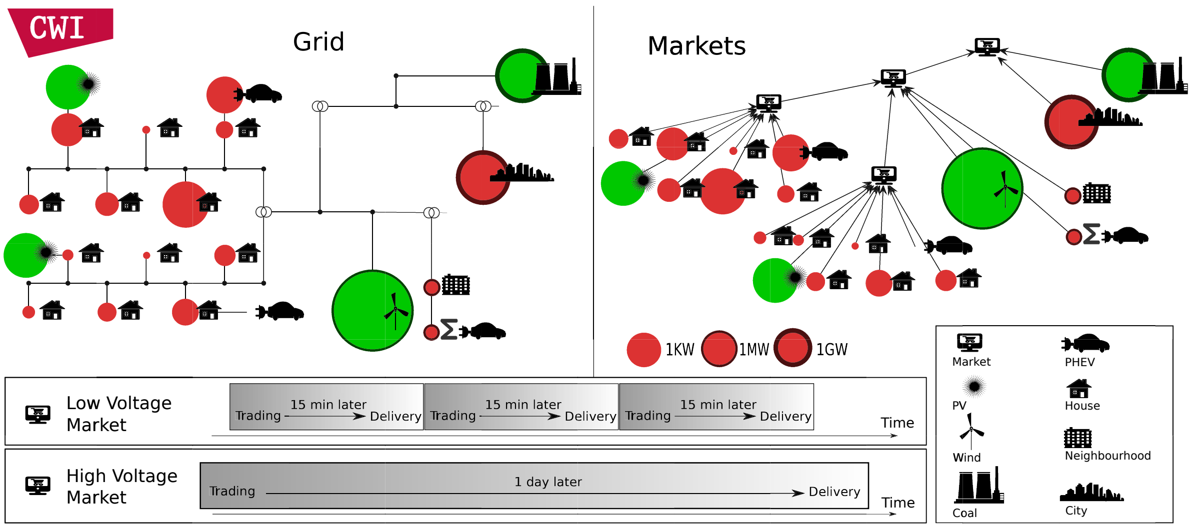

Figure 1: Simulation of a future scenario in Market Garden. A scenario consists of a network topology, a market hierarchy and a market timeline.

come. Other goals of market mechanisms can be to reward flexibility and to provide a minimum level of fairness. Not all such goals are compatible with each other and even if they are, including them can make a market mechanism too complex to be usable.

This has two major consequences for research. First, it becomes important to study which market mechanism works best in a given setting. Second, market mechanisms will differ in important aspects such as timing and expressive power of bids, so how can we expect the results of various local markets (on the low voltage level) to be aggregated and be used in national markets (on the middle and high voltage levels)?

To help answer that question, we have developed Market Garden, a scalable research environment for market mechanisms, written in Java. In Market Garden, users can model a physical grid and then associate the agents which are controlling devices on the grid in markets. Market Garden can host different market mechanisms, which define the formats of bids, the protocol of bidding and how an outcome is computed. For instance, one general market mechanism that is currently included in Market Garden is a clearing market with various possible bid formats (linear, piecewise linear, quadratic). Given a grid model, one or more market mechanisms and bidding strategies for agents, Market Garden runs agent-based simulations to compute the results.

The first advantage of Market Garden is that simulations can be hosted and remotely accessed on powerful servers. In 2011, a collaboration funded by the European Institute of Innovation & Technology (EIT), with participants from science and business, such as Siemens, Imperial College London, Ericsson and also our group at CWI, has developed four Future Scenarios for energy systems, forming a basis for further research into valuable business models. Partly funded by the EIT, the development and use of Market Garden aims to act as a catalyst for innovation in this scenario research by benefiting partners. Market Garden is therefore planned to be made available as an online simulation tool as part of the European Virtual Lab. This initiative enables distributed co-simulation by connecting existing hardware labs and simulators which model wind farms, coal plants, smart offices or houses, etc.

The second advantage is accelerated development through cooperation. Market mechanisms are set up in a modular fashion, allowing users to create different scenarios by coupling and interchanging mechanisms. Furthermore, scenarios, mechanisms and strategies can easily be reused.

In addition to accelerating research, Market Garden will be useful to end users, who can gain experience with their possible future roles and policy makers, who can be assisted in designing laws and regulation that hinder strategic market exploits and ensure societal benefits.

The Intelligent Systems group at CWI uses Market Garden to research trade strategies, novel market mechanisms and their interaction, thereby combining various research areas in computer science, including auction design theory, optimization and agent technology. The group also studies the use of sensor networks in smart buildings and electricity network planning.

It is planned that Market Garden will be available in 2013. If you are interested in writing and testing a scenario or joining a simulation, please contact us.

Link:
http://virtualsmartgrid.project.cwi.nl/wiki/Market_Garden

References:
[1] Schweppe, Fred C., et al: "Spot pricing of electricity." (1988)
[2] J. K. Kok, C. J. Warmer, and I. G. Kamphuis: "PowerMatcher: multiagent control in the electricity infrastructure", in proc. 4th international joint conference on autonomous agents and multiagent systems, ACM, 2005
[3] V. Robu et al: "An online mechanism for multi-speed electric vehicle charging", in proc. Second International Conference on Auctions, Market Mechanisms and their Applications (AMMA'11).

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The Power Trading Agent Competition

by Wolfgang Ketter and John Collins

Energy is at the foundation of modern society, and almost everything about the way we produce, use, and manage energy needs to change over the next few decades. Our work is focused on understanding this transition, particularly in the electric power sector.

We have developed Power TAC, a simulation environment that models a "liberalized" retail electrical energy market that includes a significant fraction of retail-level production (eg solar, wind) and storage (eg electric vehicles) capacities [1], and allows us to experiment with market structures in a variety of potential scenarios for the future energy landscape. Figure 1 shows a schematic view of the simulation environment, which models a wholesale market, a regulated distribution utility, and a population of retail energy customers and producers, situated in a real location on Earth during a specific period for the weather data that is available.

In this market, competing business entities or "brokers" offer energy services to customers through tariff contracts, and must then serve those customers by trading in the wholesale market. Brokers are challenged to maximize their profits by buying and selling energy in the wholesale and retail markets, subject to fixed costs and constraints. Costs include fees for publication and withdrawal of tariffs, and distribution fees for transporting energy to their contracted customers. Costs are also incurred whenever there is an imbalance between a broker's total contracted energy supply and demand within a given time slot. The competition revolves around brokers who play against each other to maximize their profits.

The distribution utility models the regulated natural monopoly that owns the regional distribution network, and is responsible for maintenance of its infrastructure and for real-time balancing of supply and demand. The balancing process is a market-based mechanism that uses economic incentives to encourage brokers to achieve balance within their portfolios of tariff subscribers and wholesale market positions, in the face of stochastic customer behaviours and weather-dependent renewable energy sources. The broker with the highest profit at the end of the simulation wins.

The Power TAC wholesale market is a relatively simple call market, similar to many existing wholesale electric power markets, such as Nord Pool in Scandinavia or FERC markets in North America, but unlike the FERC markets we model a single region, and therefore we do not model locational-marginal pricing.

Broker developers face a number of interesting challenges. Broker agents operate in a fast-paced information-rich environment. Customer behaviour is stochastic, and depends partially on weather and the actions of brokers. Brokers are challenged to predict customer power usage and wholesale market prices up to 24 hours in advance, and have multiple available actions to interact with the markets and influence customer behaviour. The competitive environment is oligopolistic, which means that broker actions have observable impacts on the competitive environment, and so accurate predictions may need to account for the effects of a broker's own actions in order to model the effects of other brokers' actions. Successful broker agent designs will typically integrate a variety of techniques from artificial intelligence, machine learning, and game theory [2].

There are many important open questions and research challenges posed by a power grid with large numbers of active participants. Examples include the role of retail brokers and their customers in grid balancing; demand-side management using dynamic pricing; forecasting supply, demand, and prices in the future grid; tariff terms and customer preferences; and impact of electric vehicle penetration on the grid. A number of these questions concern the structure of markets and the behaviours of market participants. Some of these can be addressed by game-theoretic analysis, but many are sufficiently complex that they cannot be effectively addressed by formal methods. To address these more complex issues, simulation-based techniques are required. Unlike more traditional simulation methods, Power TAC is a competitive simulation [2] that invites research teams to write their own autonomous software agents that compete with each other in rich economic simulation environments through annual competitions. Competitions produce large quantities of data, as well as the competing agent software, which will be publically available for analysis

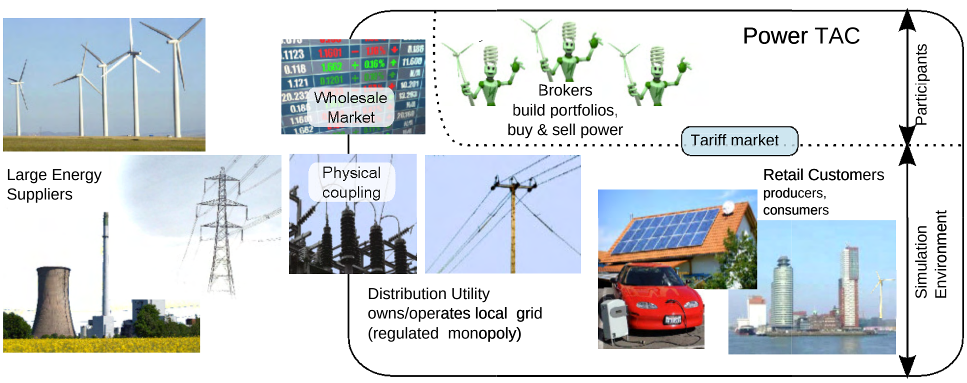

Figure 1: Power TAC scenario overview

by any interested parties. The ongoing discussion of Smart Markets [3] recommends rich market simulations such as Power TAC to validate market structures and to minimize real-world risks.

The 2013 competition is scheduled in conjunction with Association for the Advanced of Artificial Intelligence (AAAI) conference for July 2013 in Bellevue, WA, USA. Interested individuals and groups are invited to participate.

Link: http://www.powertac.org

References:
[1] W. Ketter, et al: "The 2012 Power Trading Agent Competition", Tech. Rep. ERS-2012-010-LIS, RSM Erasmus University, Rotterdam, The Netherlands (2012) http://ssrn.com/paper=2144644
[2] W. Ketter, A. Symeonidis: "Competitive benchmarking: Lessons learned from the Trading Agent Competition"; AI Magazine 33 (1), 2012
[3] M. Bichler, A. Gupta, A., W. Ketter: "Designing smart markets"; Information Systems Research 21 (4), 688–699, 2010.

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A Model-Free Flexibility Management System at KU Leuven and VITO

by Stijn Vandael, Bert Claessens, Tom Holvoet and Geert Deconinck

In the future smart energy system, millions of domestic appliances will be managed in order to support the electricity grid. Is it realistic to build exact mathematical models and controllers for each individual appliance? In Belgium, at KU Leuven, the University of Leuven, and VITO, the Flemish Institute for Technological Research, we take a different approach.

Recent years have seen an explosive growth in renewable energy. The European target is to achieve 60% electricity generation from renewable sources by 2050. Owing to the low controllability of renewable electricity generation, engineers are looking for flexibility in household power consumption patterns. For instance, heat pumps can store warm water in a buffer at flexible times. Similarly, electric vehicles (EV) can be charged at flexible times during the night.

In smart energy systems, millions of flexible household devices, which can intelligently manage their flexibility, will become available. However, building an exact mathematical model and controller for each individual device would be impractical and complex, because each has different characteristics, and its usage is difficult to predict. For example, different types of EV batteries will have different charging characteristics, and EV owners may depart at different times than expected. Furthermore, algorithms for optimally controlling a large number of devices quickly become computationally intractable, while consumers require a fast response. For example, is it realistic to keep an EV owner waiting for 15 minutes before charging, because calculations have to be done?

In a joint effort between the Belgian university KU Leuven and the research institute VITO, we have developed a flexibility management system for a large number of household devices, without the need for complex mathematical models at each individual household [1]. Essentially, this management system consists of two layers: an energy controller and a power controller (Figure 1). The energy controller trades on electricity markets, and steers the collective flexibility of a cluster of household devices accordingly. Based on this steering behaviour, the power controller decides on the power consumption of the cluster's individual household devices, and strictly respects each device's comfort settings.

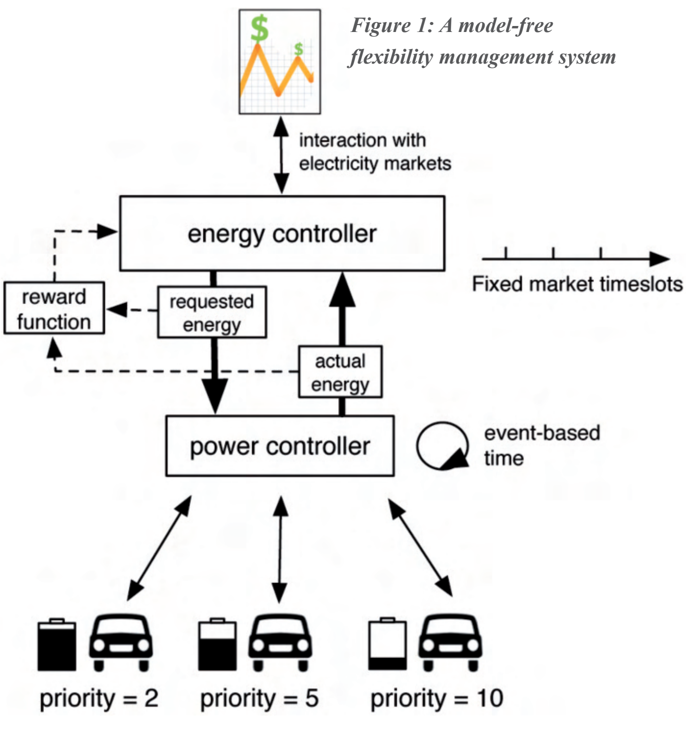

Figure 1: A model-free flexibility management system

The energy controller trades on electricity markets to acquire the best deal for the flexibility of its devices. In electricity markets, electricity is traded in energy amounts per timeslot. For example, at Belpex, the Belgian day-ahead market, electricity is traded in MWh (megawatt hour) on an hourly basis. Depending on the composition of the cluster, different short- and long-term contracts can be negotiated. At KU Leuven and VITO, a team of economists is studying these complex market interactions.

Based upon the agreed contract, the energy controller steers the flexible energy demand of its cluster. Before the beginning of each market timeslot, the energy controller sends a request to the power controller for the consumption of an amount of energy by the whole cluster. At the end of each market timeslot, the energy controller receives feedback on the actual amount of energy consumed by the cluster. This simple feedback mechanism hides any information about individual devices, and allows us to learn the appropriate energy requests, which are evaluated by a reward function (Figure 1). This reward function depends on the negotiated contracts. The key advantage of our approach is its independence of any underlying model, which means the energy controller can learn the behaviour of the cluster simply by observing the reaction to its energy requests [2]. The ability to learn these reactions arises from the repetitive collective behaviour of consumers.

The power controller translates energy amounts per timeslot to power control values for individual devices. In contrast to the once-per-timeslot control of the energy controller, the power controller continuously reacts to events (for example, a heat pump which is switched on) to control devices in its cluster, and respects comfort settings of consumers. The power control values are determined by a priority scheme, which assigns higher power values to devices with a higher priority. A device's priority is based on the "imminence" of its energy consumption. For example, an EV with an SOC (state of charge) of 20% will have a higher priority than an EV with an SOC of 80%. In general, the priority can easily be determined by a few key parameters of the device.

In a simulation framework developed at KU Leuven and VITO, the two-layer flexibility management concept has been extensively tested with heterogeneous clusters of devices (eg electric vehicles, heat pumps and boilers). These simulations show that it is possible to continuously improve control actions over a two weeks period, until an appropriate set of control actions is found. Furthermore, at VITO, the first real-world experiments are being set up using the two-layer flexibility management approach. Examples of devices, which are currently being managed, are electric scooters and washing machines. Both simulations and real-world experiments show that our approach is able to find close to optimal solutions, without the need for exact mathematical models.

References:

[1] S. Vandael et al: "A scalable three-step approach for demand side management of plug-in hybrid vehicles", IEEE Transactions on Smart Grid

[2] B. Claessens et al: "Self-learning Demand Side Management for a Heterogeneous Cluster of Devices with Binary Control Actions", ISGT-2012.

Links:

http://distrinet.cs.kuleuven.be/

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Demand Side Management for Multiple Devices

by Albert Molderink, Vincent Bakker and Gerard J.M. Smit

Steering a heterogeneous set of devices in a Smart Grid using cost functions: Demand Side Management (DSM) is an important element in smart grids. DSM is already in operation for large consumers, but thorough research is required into DSM on a building level within the distribution grid.

Decreasing flexibility on the production side of the supply chain, caused by a growing share of (uncontrollable) renewable generation, and an increasing load on the grid, due to consumer side developments as distributed generation and electrical cars, require flexibility on the consumer side of the supply chain to maintain a stable and affordable energy supply: Demand Side Management (DSM). A range of DSM methodologies have been proposed [1], based around strategies to optimize consumers' consumption patterns and to exploit the potential of buffers and distributed generation. Most proposed methodologies optimize at a device level. The problem with this approach is that it introduces device-level constraints, resulting in a very complex optimization problem that is subject to many constraints. The complexity can be overcome by using generic functions expressing the device constraints and ranking, in order of preference, different options relating to the device.

Cost functions, which reduce the complexity of the optimization problem to a cost optimization problem with a limited number of constraints [2], express the relationship between energy price and level of consumption (X_d). We use partial linear non-continuous functions (see Figure 1). The outcome of such an optimization problem is an energy price (A_{imp}), which in combination with the cost function of the devices specifies the resulting dispatch for each device.

In all control methodologies, a decision for every device is taken, often in a hierarchical way to maintain scalability. Therefore, the cost functions of multiple devices need to be aggregated. Adding the cost functions of two devices means adding two partial linear non-continuous functions. The sum of the two functions consists of all possible combinations of the individual parts of the two individual functions (see Figure 2), where some combinations may not be applicable.

We use a freezer and a fan to demonstrate how the cost functions of two consuming devices are combined. The energy price determines which option (eg switching on/off) will be chosen for each device; costs can be calculated based on the energy price, where the cheapest option will be chosen. Figure 3(a) shows the total costs for the possible scenarios as a function of energy price: when the energy price is lower than 1000, both devices will be switched on (the line with the lowest cost will be chosen); when the energy price lies between 1000 and 1100 only the freezer will be switched on; and when the price is higher than 1100 both devices will be switched off. So, in the combined cost function with one steering signal for both devices, the fan cannot be switched on while the freezer is switched off. The cost function of the freezer depends on the temperature of the freezer. Figure 3(b) shows multiple values of the energy price and multiple temperatures for the freezer when both the fan and the freezer are switched on, when only the freezer is switched on, when only the fan is switched on and when both devices are switched off.

As a second example, Figure 4(a) shows the cost functions of three electricity supply sources (production): electricity import, a generator and a battery. The battery is the cheapest source (when it is full), but has a limited capacity. The combined function (Figure 4(b)), shows which (mix of) source(s) is used for a given level of electricity consumption. When the above mentioned consumers (fan and freezer) and sources (import, generator and battery) are combined, the amount of consumption depends on the price, but the price (per unit) depends on the amount of consumption. For example, matching the above mentioned costs for demand and supply, both the fan and the battery would be supplied since the battery can deliver enough cheap electricity for both. However, when the capacity of the buffer would have been limited on 100W, only the freezer would have been supplied.

In conclusion, the cost functions for devices in combination with the options per device are a very flexible way to express the status of the device and desirability of different options. The control methodologies act on a homogeneous set of cost functions that keeps the algorithms much easier and less computationally intensive. Cost functions of multiple devices can be combined into one cost function to aggregate them for scalability, even when consumption and production are combined. A single energy price for a group of devices (combined cost functions) is a trade-off between complexity and flexibility: it disables certain combination of options and may consequently limit the application of a single price for steering. For more information, an example of steering a group of 400 houses with multiple devices and different control methodologies can be found in [3].

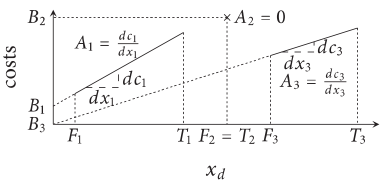
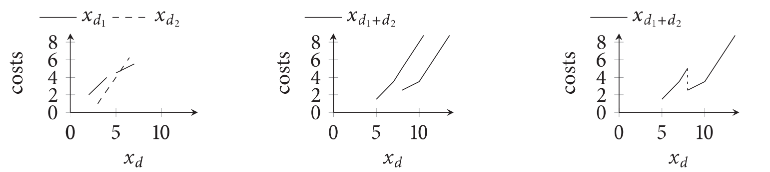
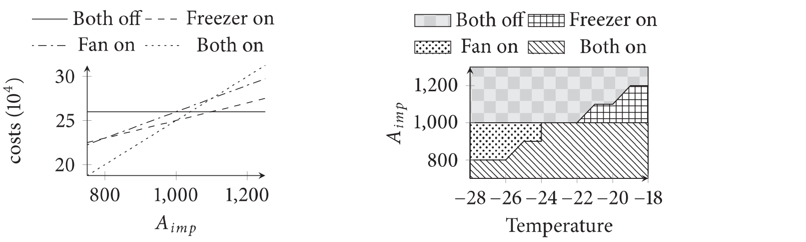


Figure 1: Example cost function



(a) Two separate functions (b) All parts of the combined function (c) The resulting combined function

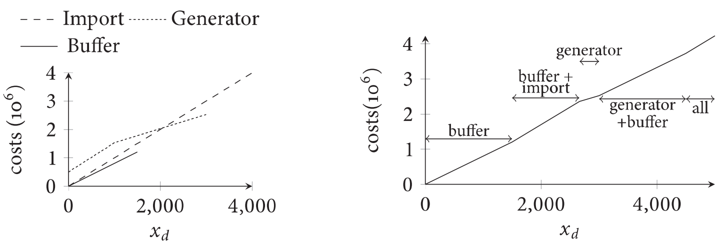
Figure 2: Combining two non-continuous, partial linear functions



(a) Combined costs of a freezer and a fan as a function of electricity price

(b) Deciding which devices are switched on as a function of the freezer temperature and the import price

Figure 3: Combined behaviour of a freezer and a fan



(a) Cost functions of three electricity sources

(b) Combined function for the three sources

Figure 4: Combination of multiple electricity supply sources

References:

[1] A. Molderink, et al: "Comparing Demand Side Management approaches", international conference on Innovative Smart Grid Technologies Europe, October 2012

[2] A. Molderink, et al: "Management and control of domestic smart grid technology", IEEE transactions on Smart Grid, vol. 1, no. 2, pp. 109–119, September 2010

[3] F. Claessen: "Smart grid control," master thesis, TU Delft, the Netherlands, 2012.

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The Gamification of Agent-Based Smart Grids

by Radu-Casian Mihailescu, Matteo Vasirani and Sascha Ossowski

Envisioning a smart grid scenario pervaded with controllable loads, we are working on the use of game mechanics to drive consumer behaviour towards efficient grid-wise use of energy. In order to cope with the challenges faced by current electricity networks, we aim to build a game layer on top of the electricity grid infrastructure and to use gamification as a catalyst for change, encouraging participation of customers in the energy field towards lower carbon generation and increased grid resilience.

Whilst the worldwide energy demand is expected to be 30 percent higher in 2040 compared to 2010, more of the same will not be sufficient to meet the challenges in this sector. In our work we advocate a consumer-centric approach, by encouraging a collaborative participation of customers for a more efficient use of energy. Presently, in the traditional model of electricity networks, users are not active participants, but merely represent sinks for electricity. Much like the internet, the electricity grid will be interactive, in the sense that power flow will become bidirectional and energy management will become distributed in the grid due to the many actors involved in the operation of the system (eg microgeneration, plug-in vehicles, controllable loads) [1].

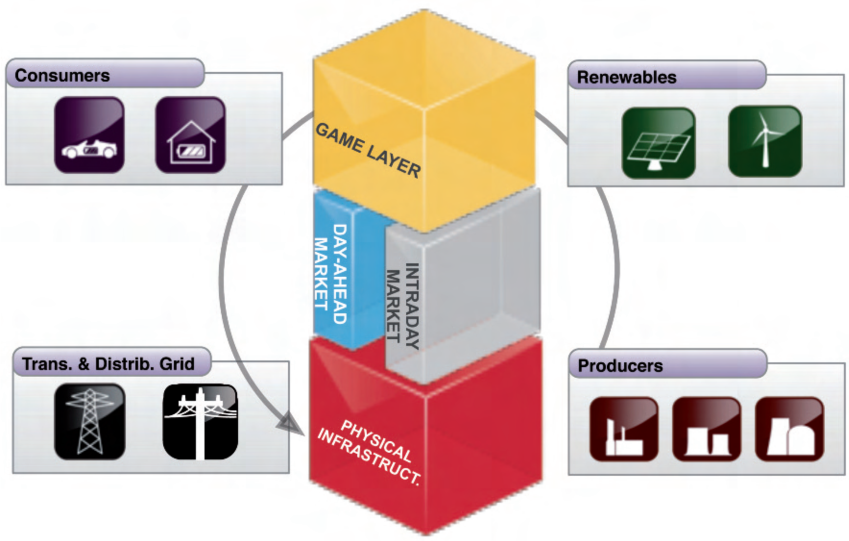

Figure 1: Consumer-centric smart grid configuration

Instead of varying supply in order to match demand, in a consumer-centric model users can adapt their energy consumption to balance excesses or shortages in the grid. This is particularly important during peakload intervals, when expensive, carbon-intensive generators need to be activated to cope with the high demand. Moreover, the increased penetration of renewable generators (photovoltaics, wind turbines) is expected to significantly increase the volatility in generation.

With these considerations in mind, we have developed a mechanism for coordination of the various actors in the grid, which operates on two levels (Figure 1). The distinction is correlated with the general organization of electricity markets. On one hand, the baseload energy requirements are traded in the day-ahead market, which settles the amount and price of electricity for each time-slot for the following day. On the other hand, the intraday market is responsible for mitigating the trading of short-term energy delivery. The difference in terms of time-horizon, means that different approaches are required to determine a viable scheduling solution for these two markets.

Firstly, to address the day-ahead market requirements we introduced a game-theoretic framework for analysing our setting given that consumers can be modelled as individual and independent decision makers whose behaviour impacts all other consumers and the grid as a whole. The key issue for enabling the network to work more efficiently is developing solutions that enable consumers to benefit from operating under a set of given constraints, provided by the network operator for flattening demand. To this end, a non-cooperative game is proposed in which agents representing consumers determine optimal strategies that can be translated into adaptations of their demand in order to maximize user satisfaction, represented as a utility function that aggregates energy and comfort costs. We then analytically derive the Nash equilibrium of the game - a strategy profile at which no user may gain by unilateral deviations - proving the existence and uniqueness of such an operating point for our given setting. Under this framework we introduced decentralized algorithms for non-cooperative environments where agents selfishly aim to maximize their utility, which we prove to converge to the Nash solution.

Secondly, the intraday market poses additional challenges, given that the system needs to react in real-time to sudden changes of the aggregated generation profile, in order to balance supply from intermittent renewable resources. Of course, agents as consumers in the network need to cooperate in order to attain the critical mass for significantly influencing the total demand curve and thus be enabled to participate in this market. This can be made possible assuming that consumers can engage in an online, self-interested negotiation for shifting loads and thus adapting their demand. However, considering the real-time constraints we reorient towards protocols that minimize computational and communication costs, unlike the classical stability concepts in coalitional game theory (eg the Core), where the computational complexity of the problem makes it intractable for all but the simplest of problems at hand. Here, we formulate the problem in terms of a cooperative game where agents learn prediction models regarding potential coalition partners and thus, can respond in an agile manner to situations that are occurring in the grid, by means of negotiating and formulating a priori solutions, with respect to the estimated behaviour of the system.

To sum up, we are providing a novel framework for managing the grid efficiently by envisioning a game layer on top of the electricity grid infrastructure that allows us to implement a consumer-centric approach as one key driving factor for a new vision of the grid via increasing participation of customers in the energy field.

Acknowledgements: This work is supported by the projects AT (CONSOLIDER CSD2007-0022, INGENIO 2010) and OVAMAH (TIN2009-13839-C03-02).

Link:
http://www.agreement-technologies.org

References:
[1] R-C. Mihailescu, M. Vasirani, and S. Ossowski: "An investigation of emergent collaboration under uncertainty and minimal information in energy domains", in proc.PRIMA'11, D. Kinny, J. Yung-jen Hsu, G. Governatori, and A. K. Ghose (Eds.). Springer-Verlag, Berlin, Heidelberg, 472-483.

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A Marketplace-Based Approach to Demand-Side Management in the Smart Grid

by Luigi Briguglio, Massimiliano Nigrelli, Frank Eichinger, Javier Lucio Ruiz-Andino and Valter Bella

Market mechanisms facilitated by Future Internet technologies will help manage energy demand in the smart grid. New scenarios, stakeholders and services will need to be considered in the development of strategies to manage energy generation, distribution and consumption.

Power grids are facing new challenges as a consequence of an increase in the use of renewable energy sources (RES). The fluctuation in power supply from these energy sources results in insecure and unstable operating points. Furthermore, the integration of distributed energy resources (DER), as well as distributed information systems, poses serious stability and security challenges in power network operation and management, necessitating reinforcement of the distribution grid. In the scientific literature, a wide range of applications of control theory have been suggested for balancing renewable energy generation and consumption. Above all, to overcome these problems we need to start considering new scenarios, stakeholders and services.

In this article, we present a proposal for the adoption of market mechanisms in order to allow grid users and grid operators to implement, for instance, contractual peak shaving policies, thus avoiding issues associated with the stability of electricity distribution networks.

The proposed solution is based on the engagement of all stakeholders (such as energy retailers, grid operators, customers) in the "controlled eco-system" [1]. We make the assumption that more detailed information on energy consumption and the introduction of energy contracts with (dis)incentives will raise awareness of how the behaviour of groups of consumers could impact on energy production/distribution and consequently encourage more efficient energy use.

In this context, the role of marketplaces is fundamental for the management of energy prices, contracts and incentives based on the energy available/used in the grid (as shown in the Figure 1). The following scenario demonstrates how the eco-system could work.

When energy retailers experience energy shortages, they buy energy at intra-day exchanges. When renewable production is low, this can be very expensive and a better option might be to ask their customers to consume less energy within a certain time frame. Similarly, grid operators monitor the electricity grid and may want to ask consumers to temporarily reduce their consumption in order to achieve grid stability. In a nutshell, such actions contribute to peak shaving in order to improve grid performance and reduce the need for auxiliary non-environmentally friendly peak production.

To this end, our team is defining and describing the architecture for a marketplace-based approach to demand-side management. In particular, the architecture is based on the idea of having two marketplaces (see Figure 2):
1. A B2C marketplace where consumers can subscribe to different demand-side-management programmes;
2. A B2B marketplace where "demand-side managers" can trade their bids for shifting energy demand.

The marketplaces are enabled by Future Internet technologies (identified by the yellow boxes in Figure 2) coming from the FI-WARE Generic Enablers (GE) infrastructure [2].

The role of the demand-side manager might be taken on by the local distribution system operator, by energy retailers or by dedicated demand-side-manager companies.

The architecture assumes an infrastructure where consumers have installed at their premises an energy-efficiency control system (EECS) that monitors and controls energy consumption by changing their programming parameters, and allows DSM signals to be received from the demand-side manager based on the subscribed conditions and user preferences. This is only possible with an entity (normally software) that can ensure security and effective programming of the appliances to avoid any inconvenience.

In the architecture, customers have access to the B2C marketplace where they can see different offers for demand-side management programs from demand-side managers. These offers could be based on real-time tariff schemes and users can then choose to enter into a contract with one of these services with the aim of reducing the monthly bills. The offers might be coupled with energy contracts and the incentives may vary in terms of how much money is paid (or deducted from the bill) when a customer actually reacts to load-shifting requests. By using such a service, customers allow the grid operator to send demand-response signals to their energy-efficiency control system. The signals are used to initiate actions in the appliances connected to the energy-efficiency control system, in order to schedule operations (e.g. electric-vehicle charging, starting a machine or appliance, reducing or increasing the temperature of building by a given amount). It is important that contracts allow the customer to override DSM signals at any time in order to make manual decisions about how and when to use the contracted energy.

The results, partially presented in this article, will be further refined in the European project FINSENY (Future INternet for Smart ENergY) [3] and in particular in the work package 6 "Electronic Marketplace for Energy". Modelling and specification activity is based on surveys (among different stakeholders) and a selection process which allowed identification of relevant use-case scenarios both from a business and a technical perspective. The specification of the architecture and its components will be completed by February 2013.

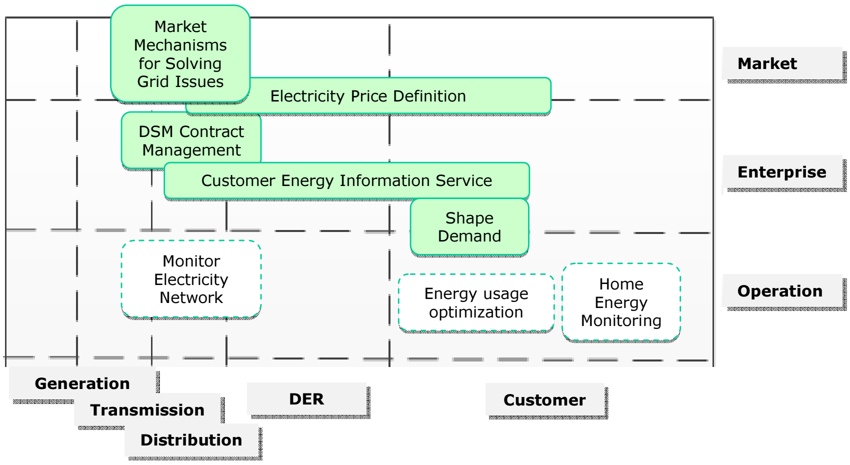

Figure 1: Marketplaces for DSM: key functions

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References:

[1] EU Commission Task Force for Smart Grids Expert Group 3: Roles and Responsibilities of Actors involved in the Smart Grids Deployment, http://ec.europa.eu/energy/gas_electricity/smartgrids/doc/expert_group3.pdf
[2] FI-WARE Security Generic Enablers: https://forge.fi-ware.eu/plugins/mediawiki/wiki/fiware/index.php
[3] FINSENY - "Future Internet for Smart Energy": http://www.fi-ppp-finseny.eu/

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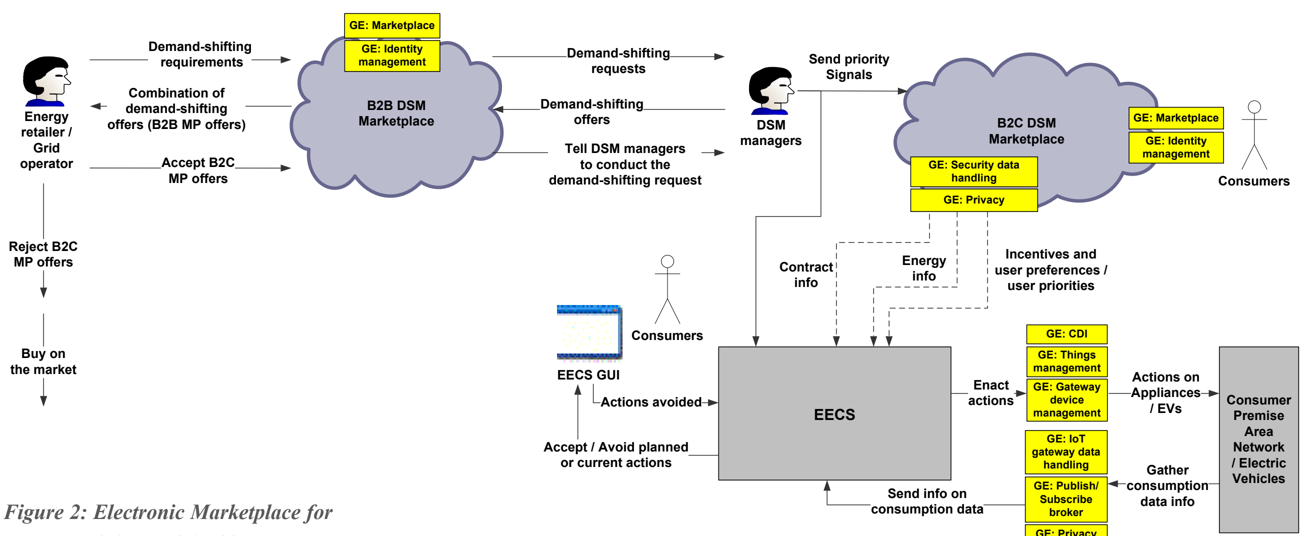

Figure 2: Electronic Marketplace for Energy: High-Level Architecture

Using an Intelligent Management System for Smart Residential Storage Systems

by Vicente Botón, Máximo Pérez, Adolfo Lozano-Tello and Enrique Romero

In order to transition the present day electrical grids into the smart grids of the future, it is essential that we develop effective energy storage systems. Intelligent software systems can be employed to manage stored energy and smart domestic devices in order to optimize local energy consumption whilst taking into account user behaviour and environmental conditions. An effective energy storage system will provide economic benefits and enable us to optimize use of the distribution grid.

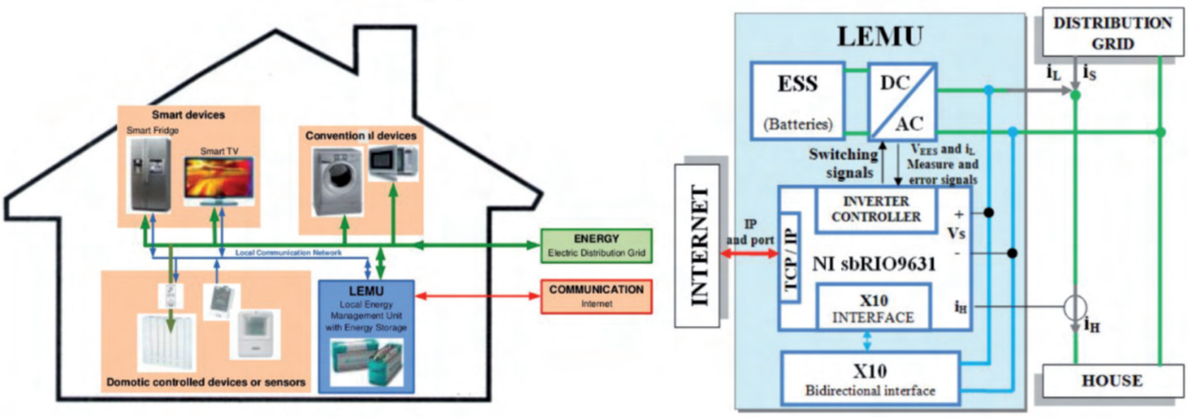

Figure 1: Schematic diagram of the interconnection of home appliances, and the local energy management unit (with energy storage system).

Energy storage systems (ESS) [1,2] are necessary to facilitate integration of both distributed generation systems, based on renewable energy sources, and smart devices, located in houses, residential and commercial buildings, into the power grid. Such systems can thereby help to manage the load profile, optimizing the performance of the distribution grid. This kind of system is typically associated with distributed generation plants - mainly with photovoltaic installations - but an ESS could also be used in the absence of an energy generation system, with the aim of smoothing the load curve or even controlling energy consumption depending on its price-by-hour.

These environments require both the ability to adapt themselves to the residents' consumption habits and the versatility to make decisions in a variety of situations. In this sense, identifying consumption patterns within a sequence of events in order to predict future peaks on the load curve can help us achieve energy optimization. This information could enable the system to recognize power consumption patterns and determine the best way to smooth future peaks. Identification of these patterns obviously requires a previous task of learning. In a smart grid environment, learning means that the system has to acquire knowledge about the use of energy and common behaviour of the electric distribution grids in an unobtrusive and transparent way.

An appropriate way to control smart houses is to use ontologies [3] to classify the types of appliances and sensors and their functionality to gain an understanding of the load profile of a house or residential building. Ontologies and SWRL (Semantic Web Rule Language) rules provide a precise definition of smart grid taxonomy and are reusable, so other systems can use them to classify their own components and to build rules that will allow new information to be inferred. One proposed system to integrate smart home devices and energy storage systems is IntelliDomo [3]. This system (see Figure 1) comprises Local Energy Management units (LEMU), which are located in houses or residential buildings with the aim of controlling the load curve, and a central system that receives data from a group of LEMUs via a conventional connection, eg ADSL, operated by telephone companies, that is typically found in houses and residential buildings. The data conveyed by the LEMUs are analysed by the central system using behavioural algorithms in order to decide on an action and this information is also communicated to the distribution grid operator to enable it to optimize the load curves. In this way, the system becomes a Central Energy Management and Intelligent System (CEMIS).

Using this system, each event captured by sensors and actuators is recorded. With these data, there is a learning module which incorporates algorithms in order to acquire users' habits and

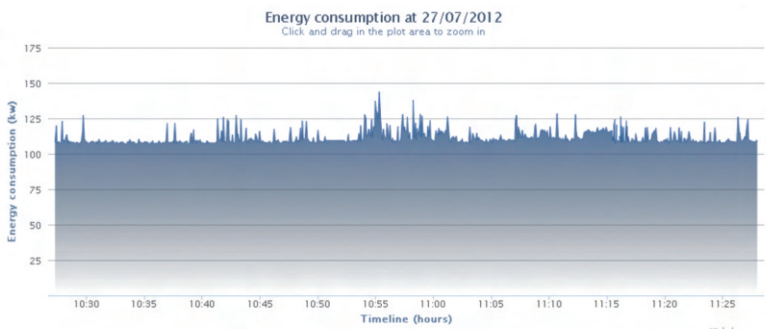

Figure 2: Example of the power consumed over time in the IntelliDomo system used to analyse the behaviour of the installation.

automatically generate production rules for behaviour patterns to anticipate the user's periodic actions. As a result, the system can adapt to changes in the identified patterns based on the user implicit and explicit feedback. The algorithms will analyse this dataset and look for frequent peaks in the load curves (see Figure 2). Once they recognize the patterns, they will design a strategy to coordinate the behaviour of the LEMU and optimize the use of the resources. This strategy is carried out by generating SWRL rules that automate the corresponding actions. Therefore, the Energy Optimization Module (EOM) will send the results of the data mining process to the IntelliDomoRules tool, which can build the rules and save them into the ontology. Thus, IntelliDomo can control several LEMUS to optimize energy consumption and manage smart home devices remotely.

Link:
http://www.intellidomo.es

References:
[1] C. Pieper, H. Rubel: "Revisiting Energy Storage: There Is a Business Case", the Boston Consulting Group, (2011)
[2] M. Guerrero, et al: "Supercapacitors: Alternative Energy Storage Systems", PRZEGLĄD ELEKTROTECHNICZNY, 2009
[3] A. Lozano-Tello, V. Boton: "Analysis of Sequential Events for the Recognition of Human Behaviour Patterns in Home Automation Systems" in proc. DCAI 2012, AISC 151, Springer-Verlag. pp 511-518, 2012.

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The Last One out Turns off the Light - Optimizing the Energy Efficiency of Buildings

by Lutz Ehrig and Danilo Hollosi

The project "S4EeB" (Sounds for Energy Efficient Buildings), which has been running since October 2011, aims to optimize the performance of existing building management systems by taking into account a building's occupancy rate using audio sensor networks as a new source of information. The overall goal of this demand driven approach is to reduce unnecessary consumption of energy for heating, ventilation, air conditioning, and lighting. In the course of the project the Fraunhofer Institute for Digital Media Technology IDMT, located in Ilmenau and Oldenburg in Germany, has been developing procedures and methods for analysing audio data in order to gain information about the occupancy rate of buildings, on the basis of which the energy consumption of a building can be optimized automatically.

A major proportion (35%) of electricity consumed in commercial and public office buildings is attributed to heating, ventilation, and air conditioning (HVAC). Together with street and commercial lighting this accounts for more than 60% of the electricity consumed in office buildings across the European Union [1]. With 50 million public buildings existing across Europe, this sector has a huge potential for improving energy efficiency.

While modern buildings and public spaces use sensing technologies on a broad scale, for instance motion detection, video surveillance, temperature measurements and gas detection, the potential of sound and noise has not yet been utilized for the purpose of building automation. Given the importance that humans attribute to sound and noise in their indoor and outdoor environments, sound based sensing seems an obvious choice to provide valuable information, such as estimates of the occupancy rate in buildings. Furthermore, audio sensors are unobtrusive and have a higher user acceptance compared to video surveillance systems, for example. Unlike cameras, acoustic monitoring does not require a free line of sight. Also, sound based systems require less computing power, which is appropriate given our goal of increased energy efficiency in buildings.

The S4EeB system consists of three main components that have already been, or will be, developed, as depicted in Figure 1: the audio system for sound and noise recording, the acoustic processing system for detecting acoustic events using a machine learning approach, and the management system for monitoring occupancy rates and controlling the building automation system.

The audio system consists of microphones to be installed inside the respective building. Ideally, the acoustic sensors should be distributed evenly across the space. However, due to architectural or infrastructure conditions and limitations, this may not always be possible. Hence, microphone arrays will be used, allowing analysis of the spatial acoustics of the respective areas in order to localize sound sources.

All acoustic sensors are connected to an acoustic processing unit (APU). The APU combines the microphone signals of one area or a particular part of it. Based on suitable signal parameters extracted from the audio signals in the APU, sound source localization and sound source separation are performed and the occupancy rate of a building is determined. Initial experiments have shown that the occupancy rate can be estimated with high accuracy by using approaches for machine learning based acoustic event detection. Furthermore, the modular layout of the APU allows users to easily modify the system so that it is capable of detecting security related acoustic events, such as cries for help or breaking glass. Hence, using the S4EeB system will not be limited to the project's objectives.

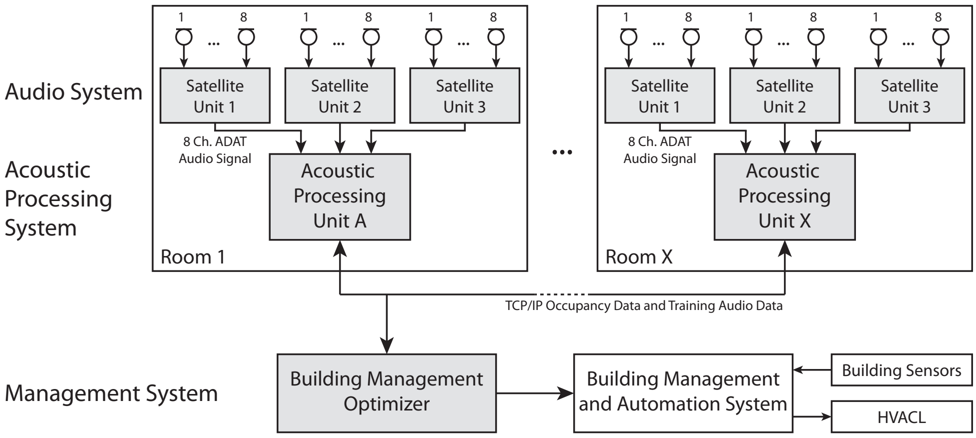

Figure 1 system components for the S4EeB project

All the data and semantic information from the APU are collected and analyzed by the building management system optimizer, which is the interface to the "classic" building management system. Based on the building's occupancy rate, its thermal characteristics, outside weather conditions, and other parameters, the optimal settings with respect to energy efficiency and user comfort will be determined. Thermal modelling of the building is done beforehand, providing the basis for the best strategy considering the building's energy consumption rate and the interaction of the building management and automation system with the HVAC system.

The main contributions of Fraunhofer IDMT to the project are: sound recording, audio signal processing, and acoustic event detection. In particular, audio data captured is analysed by algorithms developed by Fraunhofer IDMT, allowing the building's occupancy rate to be determined for the purpose of integrating this data into the building energy management system.

This three-year project is funded by the European Union, and its consortium comprises research institutes and industry partners from four European countries, who have long-standing experience in building control strategies, audiovisual applications, microelectronics and mechanical components as well as in consulting and dissemination of results. The project recently finished its first year of collaborative development of a prototype system and the corresponding components. In the first quarter of 2013, field tests will start at the S4EeB demo sites, namely Milano-Linate airport and two shopping malls in Spain, Principe Pio in Madrid and Maremagnum in Barcelona.

Links:
http://www.s4eeb.org
http://www.idmt.fraunhofer.de

Reference:
[1] P. Bertoldi and B. Atanasiu: "Electricity Consumption and Efficiency Trends in the Enlarged European Union", European Commission, Institute for Environment and Sustainability, 2007.

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Ambient Intelligence for Energy Efficiency in a Building Complex

by Giuseppe Lo Re, Marco Ortolani and Giuseppe Anastasi

The quest for energy efficiency currently represents one of the most stimulating challenges both for academic and industrial organizations. We address the issue of ensuring timely and ubiquitous monitoring of a potentially large building complex in order to optimize their energy consumption.

Over 50% of energy produced worldwide is consumed by the industrial sector, whilst residential and commercial buildings account for about 20%, mainly due to inappropriate use of appliances, such as heating, ventilation and air conditioning (HVAC) systems and artificial lighting [1]. Hence, the International Energy Agency's (IEA) roadmap has set the goal of reducing energy consumption by HVAC systems by 30% and 17% in residential and commercial buildings respectively by the year 2030. Similarly, the goal is to reduce energy consumption by artificial lighting by 3% and 14% for residential and commercial buildings respectively [2]. Consequently, recent years have seen a growth in research on energy efficiency in residential/commercial buildings.

Studies show that providing appropriate feedback to building occupants can help reduce overall energy consumption, but in the long term this is not an effective approach [3]. Using an automated Building Management System (BMS), in addition to user cooperation, is a more viable solution, especially in the context of ambient intelligence (AmI). AmI is a new paradigm in Artificial Intelligence that relies on the assumption that the environment is permeated by a set of sensors and actuators, remotely controllable according to some policy, in order to bring the environmental conditions closer to the user's ideal conditions while taking into account particular global constraints.

Within the "SmartBuildings" project, we are currently designing and prototyping an AmI-based BMS targeted to a building complex (eg, a campus or a residential complex), rather than just a single building. In our approach, the remote sensor infrastructure acts as the termination of a centralized reasoner, where sensed data are processed to extract higher-level information and perceive high-level features such as who is in a specific area or what this person is doing there (eg reading, talking, standing). Finally, a set of actuators modifies the environmental conditions.

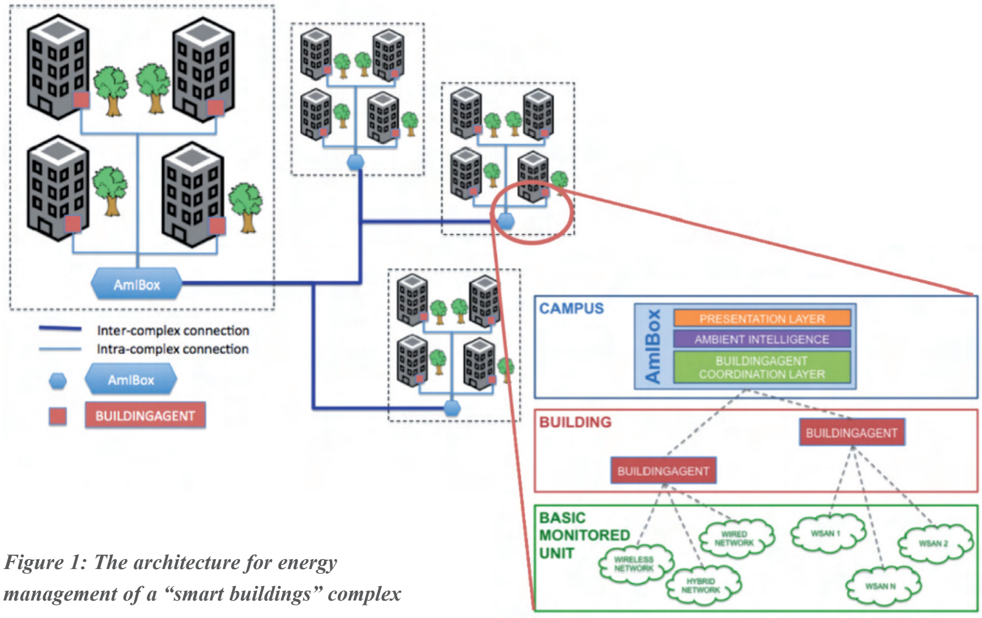

Figure 1: The architecture for energy management of a "smart buildings" complex

Our system architecture has been conceived to guarantee the scalability of the proposed solution with respect to the number of buildings to be monitored and the number of different devices to be used. In order to efficiently organize the system modules, each corresponding to a different logical task, we chose a three-tier architecture as a model. The physical layer consists of sensors and actuators; the middleware layer defines a set of AmI components that can be composed to implement intelligent AmI functionalities; the application layer allows for applying the monitoring and controlling rules in compliance with energy constraints.

From the viewpoint of deployment, the building premises constitute the basic monitored units of our system, where the sensor and actuator networks are installed. These networks are heterogeneous both in terms of the adopted technology and of the performed monitoring/actuating tasks. Several basic monitored units are coordinated by a BuildingAgent, responsible for performing reactive control and further data aggregation. Small buildings will have a single BuildingAgent per building, while medium or large buildings could have more. In our vision, an individual building is part of a community coordinated by a central orchestra leader, the AmIBox (see Figure 1). The latter ensures coherence of the adopted energy saving strategy, besides providing high-level AmI functionalities, performing intelligent reasoning and choosing the adopted energy saving strategy. The AmiBox could also take into account externally imposed constraints, such as those arising from the connection with an energy provider's Smart Grid infrastructure.

The project is currently in progress. We have already deployed a minimal prototypal setup, by equipping one floor of our department with commonly available sensor nodes for monitoring the typical environmental quantities (temperature, humidity, light) and with the corresponding actuators. Moreover, we are able to monitor the globally consumed energy through a remotely controllable power meter. The research group operating at the Lab of Networking and Distributed Systems (Univ. of Palermo) is currently focusing on the design of core intelligent functionalities, such as user profiling, predicting the occupancy status of the monitored premises, or detecting the activity patterns of users, that will form the basis for subsequent intelligent reasoning. For instance, we have developed a Bayesian inference system for multi-sensor data fusion in order to reliably infer the presence of users from the available sensory information. Probabilistic reasoning accounts for the partial correlation between sensory signals and states, and allows the system to cope with noisy data, while the possibility of integrating data coming from multiple sensors exploits the redundancy of such devices deployed throughout the environment. In order to reduce the costs of the overall system and limit its intrusiveness, the number of sensors should be kept as low as possible. To this end, the research group operating at the Pervasive Computing and Networking Lab (Univ. of Pisa) is investigating the use of advanced methods for extracting individual consumption estimates from aggregated measurements.

This research is part of the "SmartBuildings" Projects funded by the Sicilian regional Government with European funds.

Link: http://www.dicgim.unipa.it/~networks/ndslab/

References:

[1] U.S. Energy Information Administration: "International Energy Outlook 2010 – Highlights", report DOE/EIA-0484(2010), http://www.eia.doe.gov/oiaf/ieo/highlights.html

[2] International Energy Agency, 2011: "Technology Roadmap, Energy-efficient Buildings: Heating and Cooling Equipment", http://www.iea.org/papers/2011/buildings_roadmap.pdf

[3] X. Jiang, et al: "Experiences with A High-Fidelity Wireless Building Energy Auditing Network", in proc. ACM SenSys 2009.

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Secure Smart Grids or Say 'Goodnight Vienna!'

by Florian Skopik, Paul Smith and Thomas Bleier

With the increasing use of novel smart grid technologies, a comprehensive Information and Communication Technology (ICT) network will be established in parallel to an electricity grid that, owing to its large size and number of participants and access points, will be exposed to similar threats to those experienced on the current Internet. Whilst there have been a number of guidelines and best practices for securing future smart grids, further work is required in this area to make them readily applicable. In this article, we introduce the (SG)² project, which aims to address these issues and provide practical advice to smart grid stakeholders in Austria.

The smart grid will revolutionize electricity networks, allowing increased use of decentralized clean energy sources. It will make use of Information and Communication Technology (ICT) in a number of ways, for example, to manage decentralized energy sources, such as from photovoltaic and the associated markets. In general, the smart grid will be more open than current electricity grids, and will incorporate a greater degree of measurement-based control deeper within the network, eg, in distribution systems, based on data acquired from smart meters. This openness together with new automatic control loops make smart grids more vulnerable than current power grids to potentially serious attacks [1]. Personal privacy concerns abound, for example, issues relating to unauthorized access to metering data: it will be possible to determine detailed usage patterns of electrical appliances, including the television channel house occupants are watching, based on metering data [2]. Therefore, it is vital that security and privacy issues are a primary concern for the future smart grid.

Various international organizations, such as NIST in the USA and ETSI in Europe [3], have developed guidelines and frameworks that can be used to improve the security of Smart Grids. However, because they do not consider factors such as local market conditions, requirements and deployments, and legal constraints, these guidelines cannot be directly applied. Furthermore, they have seen limited real-world application, making it unclear how suitable they are for their intended purpose. Our research aims to build on these existing guidelines and frameworks, in order to make them functional.

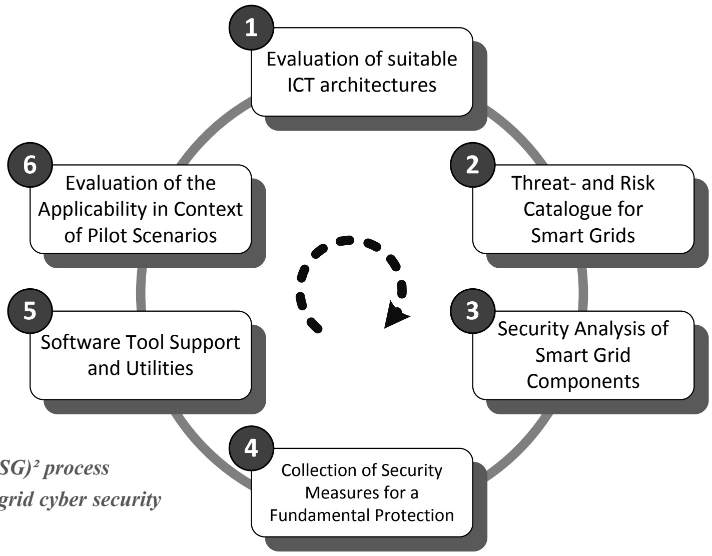

Figure 1: The (SG)² process model to smart grid cyber security

An Austrian perspective: the (SG)² project

The goal of the Smart Grid Security Guidance (SG)² project is to study effective countermeasures to smart grid security threats. The project investigates and develops methods, concepts and process models, and accompanying software tools to minimize the risk posed by cyber threats and to ensure the security of smart grids in Austria (see Figure 1). Novel approaches to the modelling of complex ICT-supported smart grid architectures will be defined in the project, which will form the basis for an analysis and evaluation of primary forms of attack and attack surfaces. This information can be used to estimate the potential impact of attacks.

Architectural models are examined with respect to threats and vulnerabilities, in order to determine the most effective protective measures against possible attacks. Electricity providers have traditionally focused on ensuring the safety and reliability of their infrastructure. However, in the future, malicious attacks that hinder the increasingly networked ICT components within their systems need to be accounted for. An important outcome of the (SG)² project will thus be a taxonomy and catalogue of countermeasures that can be applied to ensure the security of smart grids for a given threat. For a realistic risk assessment, the project also deals with penetration tests and security analysis of smart grid components. Because of the complexity of securing a smart grid, software tools are being developed to support the use of the guidelines and methodologies produced in the project.

A strong collaboration between industry, research and government

In order to attain the ambitious goals of the (SG)² project and to ensure the wide applicability of developed tools, major stakeholders in important sectors related to smart grids in Austria need to be involved. These stakeholders create a well-balanced consortium including security research institutions, companies from the security industry sector, energy utilities, and governmental organizations. The project is led by the AIT Austrian Institute of Technology. Other large research partners are the University of Technology Vienna, and the Siemens AG – Corporate Technology Austria. Practical security expertise in penetration testing is contributed by SECConsult Unternehmensberatung GmbH. The Energieinstitut an der JKU

Linz GmbH investigates societal impact of (SG)² research results; additionally the participation of the Ministry of the Interior (BM.I) and the Ministry of Defence and Sports (BMLVS) ensures the development of applicable solutions from a governmental perspective. Finally, the developed guidelines will be evaluated within the context of three energy utilities in Austria, which, owing to their different sizes, require different solutions: LINZ STROM GmbH, Energie AG Oberösterreich Data GmbH, and Innsbrucker Kommunalbetriebe AG.

This two year project runs from 2012 to 2014 and is financially supported by the Austrian security-research program KIRAS and by the Austrian Ministry for Transport, Innovation and Technology (BMVIT).

Links:
http://kwz.me/4l
http://kwz.me/4p

References:

[1] F. Skopik, et al: "A Survey on Threats and Vulnerabilities in Smart Metering Infrastructures", International Journal of Smart Grid and Clean Energy, vol 1, issue 1, September 2012, pp 22-28

[2] U. Greveler, B. Justus and D. Loehr: "Multimedia Content Identification through Smart Meter Power Usage Profiles", 2012 International Conference on Information and Knowledge Engineering, Las Vegas

[3] European Telecommunications Standards Institute (ETSI): Smart Grid Technologies; http://www.etsi.org/website/Technologies/SmartGrids.aspx (2012)

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Preparing for the Smart Grids: Improving Information Security Management in the Power Industry

by Maria Bartnes Line

The power industry faces the implementation of smart grids, which will introduce new information security threats to the power automation systems. The ability to appropriately prepare for, and respond to, information security incidents is of utmost importance, as it is unrealistic to assume that one can prevent all possible incidents from occurring. Current trends show that the power industry is an attractive target for hackers. A major challenge for the power industry to overcome are the differences regarding culture and traditions, knowledge and communication, between ICT staff and power automation staff.

Two major technological changes make smart grids interesting from an information security point of view. One is that new technologies are introduced into the power automation systems; commercial off-the-shelf products replace proprietary hardware and software. The other is integration; ICT systems and power automation systems will be much more tightly connected than before. Smart grids consist of complex power grids that interact with equally complex ICT systems. This implies that well-known information security threats like computer break-ins, industrial espionage, malware attacks and denial-of-service attacks will be highly relevant for the power industry in the near future, if not already. ICT security incidents targeting power automation systems, or other types of SCADA systems, are not science fiction - they are already happening. We have had Stuxnet, Duqu and Flame, and we should expect to see more of the kind in the near future.

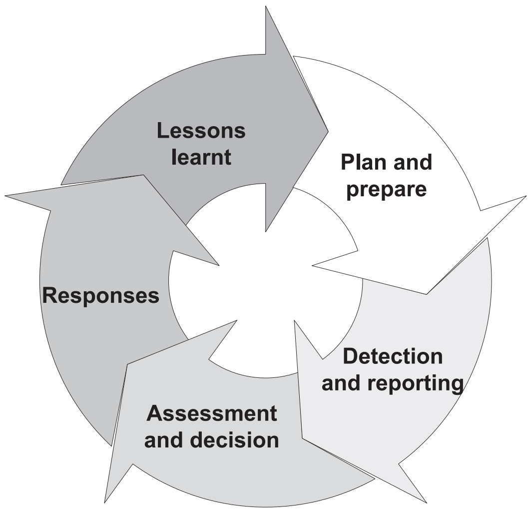

Figure 1: The complete incident management process (ISO 27035)

Power automation systems and general communication oriented ICT systems have traditionally been operated separately. There have been limited, if not zero, logical connections between them, and they have served quite different purposes. The staff operating the two systems tend to have different backgrounds; electric power engineering and computer science. The technology bases are different, and so are management routines. Facilitating and achieving understanding and well-functioning collaboration in this intersection between ICT staff and power automation staff will be the most important task on the way to successful information security incident management for smart grids.

Incident management is the process of detecting and responding to incidents, including supplementary work such as learning from the incidents, using lessons learnt as input in the overall risk assessments, and identifying improvements to the implemented incident management scheme. ISO/IEC 27035:2011 Information Security Incident Management [1] describes the complete incident management process as consisting of five phases; 1) Plan and prepare, 2) Detection and reporting, 3) Assessment and decision, 4) Responses, and 5) Lessons learnt.

Current practice in the power industry

In order to study current practice on how information security incidents are being detected and responded to, and to identify needs for improvements in order to be prepared for the introduction of smart grids, we are now performing qualitative interviews. Our interviewees represent three different roles in a set of large distribution system operators (DSO):

- Chief Information Officer (CIO) /Head of ICT
- Chief of Information Security Officer(CISO)/Head of ICT Security
- Head of control room/power automation systems

We chose these particular interviewees with the intention of identifying current cooperation and possible synergy effects from future cooperation, and viewing the overall management system in general. Both technical measures and human actions are being identified, including how the post-incident analysis is performed. Such an aftermath typically includes information sharing, lessons learnt, and how experiences are transferred into the overall information security routines in the organization.

Future activities

Qualitative interviews give us a large amount of information. There is, however, a risk of getting the "perfect picture", how things should be done according to the book, and not just actual practice. We would therefore like to follow-up the interviews by running retrospective group interviews at selected DSOs. If, or when, they experience a high-impact incident, we would like to go through the complete course of events in order to understand how the organization responded to that specific incident. Questions we are interested in exploring include how the incident was detected, reported and resolved, in which ways they followed their plans, and if not, how, and in particular why, they deviated from their plans.

We would also like to study smaller DSOs to see whether there are differences regarding their current practices compared to those of the larger DSOs.

There are usually quite a few differences between theory and practice. Observation is therefore also included in our plans for the near future. While the interviews give much insight in how incident management is planned and performed, observing the work in practice will give invaluable additional knowledge. Having knowledge of both theory and practice will enable us to compare the routines actually implemented, suggest realistic improvements, and hence make a valuable contribution to the industry.

The longterm goal is to contribute to an efficient incident management process in smart grid environments.

The project is being carried out at NTNU, in close cooperation with SINTEF and the Norwegian Smart Grid Centre. The project period is 2011-2015.

Reference:

[1] ISO/IEC 27035:2011 Information Security Incident Management

Link:

http://www.item.ntnu.no/people/personalpages/phd/maria.b.line/start

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Cybersecurity in the Smart Grid

by Magnus Almgren, Davide Balzarotti, Marina Papatriantafilou and Valentin Tudor

In the past, the easiest way to attack the electrical grid would have been to physically access and destroy components. However, with the introduction of the smart grid and its increased dependence on information and communication technologies (ICT), the future grid may be vulnerable to pernicious cyber attacks performed remotely. In CRISALIS and SysSec, we are studying the properties of the envisioned smart grid to enable us to anticipate and mitigate future attacks against this critical infrastructure.

In Europe and elsewhere, the electrical grid is being transitioned into the "smart grid" in order to increase flexibility and accommodate large scale energy production from renewable sources. This transition involves, among other steps, the installation of new, advanced equipment – for example, the replacement of traditional domestic electrical meters with smart meters - and remote communication with devices – for example, allowing remote access to an unsupervised energy production site. Together with the new functionalities, this transition introduces concerns about how the technology can be misused by adversaries [1].

Many of the new security issues in the smart grid are well-known problems in the information and communication technology (ICT) domain, such as buffer overflows in devices and sloppy implementations of cryptographic protocols. However, the solutions from the more mature ICT domain may not be directly applicable to the smart grid due to resource-constrained devices (smart meters), the life cycle of components (there will always be legacy systems) or the impossibility of immediately shutting down and patching a machine that needs to run 24/7. Other issues originate from the electrical and power engineering domain (device tampering).

There are also challenging new problems originating from the intersection between the electrical engineering and ICT domains, for example where a cyberattack (buffer overflow) in turn affects properties of the electrical grid (power quality), which in turn may propagate back to the ICT domain (vulnerability of control loop) [2]. An interdisciplinary approach is required to identify possible solutions to these problems.

In SysSec, a network of excellence in Europe, and CRISALIS, a European research project, we are working on improving the security in critical systems, in particular the smart grid, through two orthogonal approaches. One major problem is the lack of cross-domain expertise in both ICT security and power engineering. Being a network of excellence, SysSec organizes several activities to bring together researchers and practitioners from different domains. For example, we organized a summer school for students across Europe for a hands-on approach to learn more about reverse engineering of malware targeting critical infrastructures. To our surprise, we hit the ceiling on the number of students we could accept within less than a week of the announcement, forcing us to create a waiting list. This points to the need for better education in this area and we will also include modules for hardware security and critical infrastructure protection as part of the effort in SysSec to provide a common curriculum on cyber security.

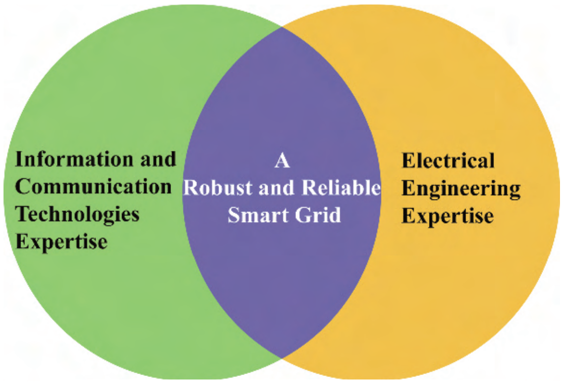

Figure 1: In SysSec, we organize events so that people from different domains can meet and discuss interdisciplinary problems related to the smart grid.

Another major problem hampering the analysis of security properties of the smart grid is the proprietary nature of the technologies and protocols involved: there are few open source tools available to perform an in-depth analysis of a system. For this reason, we are developing a toolset in CRISALIS that can be used by researchers to validate security claims made by vendors and increase the overall security of the deployed components. One of the first deliverables will be open-source fuzzers for protocols used in this domain. By working closely with industrial partners, the goal is to provide new tools to detect intrusions and effective techniques to analyse infected systems.

Even though the smart grid is a necessity, it is important to understand the security risks before complete systems are deployed and interconnected across Europe. Learning from and avoiding simple problems that have already been encountered in the ICT domain, we may focus on the new types of threats that arise as a consequence of the interdisciplinary nature of this complex environment. For this reason, projects such as SysSec and CRISALIS, which bring together experts from different domains, are crucial at this stage.

CRISALIS may be contacted at contact@crisalis-project.eu. SysSec may be contacted at the corresponding contact@syssec-project.eu, followed in twitter (twitter:syssecproject) and Facebook (http://www.facebook.com/SysSec).

References:
[1] National Institute of Standards and Technology Interagency: "Guidelines for Smart Grid Cyber Security (NISTIR 7628)," vol. 1-3, http://csrc.nist.gov/publications/PubsNISTIRs.html#NIST-IR-7628, 2010
[2] Costache et al: "Remote control of smart meters: friend or foe?", EC2ND-2011, Gothenburg, Sweden.

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CoppEnd – A Security System for Power Equipment

by Dimitrios Serpanos, Athanasios Safacas and Dimitrios Stachoulis

Copper theft is emerging as a significant problem in the evolution and operation of critical infrastructures, such as power grids, transportation networks and water facilities. The problem has become acute due to inadequate security measures for infrastructure as well as a lack of a strict legal framework for transportation and trading of metals. CoppEnd (Copper - defEnd) is a security system designed to protect systems that use copper, focusing on power systems and their components, such as transformers.

Electricity networks constitute critical infrastructures worldwide, since they support almost all economic and social activities. Importantly, electricity networks are scaling to accommodate the increasing use of renewable energy sources and the ever-increasing power demand. Efficient interconnection of new electrical power plants with the distribution networks leads stakeholders to introduce extensions, modifications, and new routings, while installing advanced software systems in control centres. Electricity providers are incorporating new tools and processes in order to offer electricity to consumers in an optimal way, based on both demand and production levels at any given point in time. The evolution of conventional power grids to smart grids requires correct and unhindered cooperation of all installed equipment. However, the evolution is limited by external factors that can severely damage, causing them to malfunction. One of the main problems, especially in Greece, is the unreliable operation of electrical equipment owing to the theft of copper in their components.

A significant problem in the power distribution network is the destruction of

Medium Voltage (MV) transformers, because of their copper content (approximately 150-200 kg in each). Their damage has disastrous effects on social and economic activities due to the loss of millions of euros during long power-outs (hours or even days at a time). These incidents have a very negative impact on operators, who need to replace the transformers and to compensate their customers. Importantly, theft incidents sometimes result in serious injuries or even loss of life.

CoppEnd is a security system for the protection of MV transformers in the network. CoppEnd enables early detection of human intervention to the system as well as tracking of the transportation of components, thus enabling timely intervention by authorities. Thus, transformers are protected, even in isolated areas.

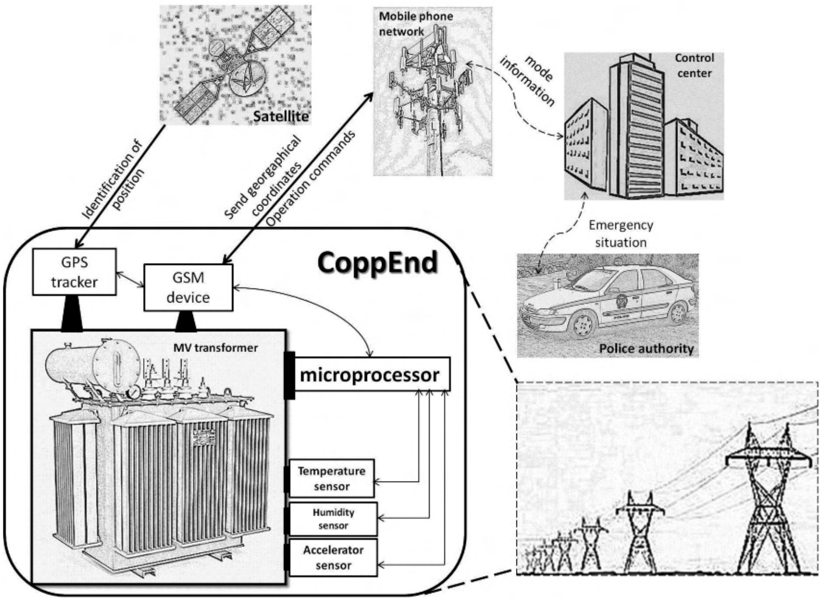

Figure 1: CoppEnd overview

The Greek power distribution network, operated by the Hellenic Electricity Distribution Network Operator S.A., spans more than 230,000 km, mostly in agricultural and isolated areas. The network size prohibits its continuous and uninterrupted physical monitoring, thus enabling the illegal detachment of transformers and removal of their copper. The increasing incidents, targeting more than 155,000 medium-to-low voltage units, need to be addressed not only by a stricter legal framework, but also through adoption of sophisticated protection systems [1-2]. Protection systems that use high-tech security components, such as CoppEnd, discourage individuals from attacking the network and enable their tracking when equipment is stolen. This approach differs from the conventional approaches that use mechanical means, with little success.

CoppEnd continuously records the location of the equipment to which it is attached. It contains a GPS tracker equipped with a GSM transmission subsystem. The GPS tracker detects its exact geographical coordinates, while the GSM subsystem transmits the coordinates to the control centre, which positions it on the map. Thus, an administrator at a control centre is able to identify whether the initial, correct location remains stable. System control occurs through text messages to CoppEnd, which enable operation modes (on/off/standby) or change the coordinate reporting intervals (default is 30 seconds). Additionally, CoppEnd includes a microphone, controlled by the control centre, for the transmission of real-time voice data that may be useful, depending on the event or emergency. CoppEnd is attached on a transformer so that the existent electromagnetic field does cause interference and so that it cannot be extracted without causing damage to the transformer; this ensures its appropriate activation.

Any deviation from the original location constitutes an event that is reported to the control centre. Events are evaluated by the operator, since a movement may not be a malicious attack but another incident, eg an intense lightning strike. When a transformer is removed from its original location, CoppEnd alters its operation, enabling a self-powered mode via a battery system that is effectively kept charged through the power network itself; the trigger is enabled when normal power interruption is detected or when the included acceleration or pressure sensors give a command. When on battery, CoppEnd transmits at longer intervals, in order to avoid detection and lengthen its battery lifetime.

Overall, CoppEnd is a smart grid component and not just a security system. Its sophisticated architecture and operation, employing sensors and specialized middleware, discourages copper thieves and enables their tracking, while providing additional information to the operator, such as the exact location of the transformers in the area, evaluation of the quality of the transformer's oil and emergency detection, including cases of natural disasters.

We envision extending the use of CoppEnd in the future to protect smart grid components for water supply, sewerage, and railway companies that face similar problems.

Link:
http://www.isi.gr/en/projects/coppend

References:
[1] T.M. Overman, R.W. Sackman, T.L. Davis, B.S Cohen: "High-Assurance Smart Grid: A Three-Part Model for Smart Grid Control Systems", in proc. of the IEEE, 99(6), pp. 1046 - 1062, June 2011
[2] A.R. Metke, R.L. Ekl: "Smart Grid security technology", Innovative Smart Grid Technologies (ISGT), 2010 , vol., no., pp.1-7, 19-21 Jan. 2010

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PowerAPI: A Software Library to Monitor the Energy Consumed at the Process-Level

by Aurélien Bourdon, Adel Noureddine, Romain Rouvoy and Lionel Seinturier

Energy consumption by information and communication technologies (ICT) has been growing rapidly over recent years. Comparable to the civil aviation domain, the research community now considers ICT energy consumption as a major concern. Several studies report that energy consumption is an issue during all steps of a computer's life, from hardware assemblage, to usage, and dismantling. Research in the area of Green IT has proposed various approaches to save energy at the hardware and software levels. In the context of software, this challenge requires identification of new development methodologies that can help reduce the energy footprint. To tackle this challenge, we propose PowerAPI, a tool to quantify this energy consumption, by providing an application programming interface (API) that monitors, in real-time, the energy consumed at the granularity of a system process.

"Two per cent of the global energy consumption", "equivalent to the annual production of eight nuclear plants", a number of studies agree that Information and Communication Technologies (ICT) energy consumption has become a major issue. Several studies aim at reducing this energy footprint at each step of the computer's Life Cycle Assessment (LCA). At the usage stage, this involves not only building new kinds of energy-efficient hardware but also acquiring an understanding of the energy impact of software and how we can influence it. In order to provide a basis for this knowledge, the Inria ADAM project team has developed a library, named PowerAPI, providing an application programming interface (API) to monitor in real-time the energy consumed at the granularity of a system process.

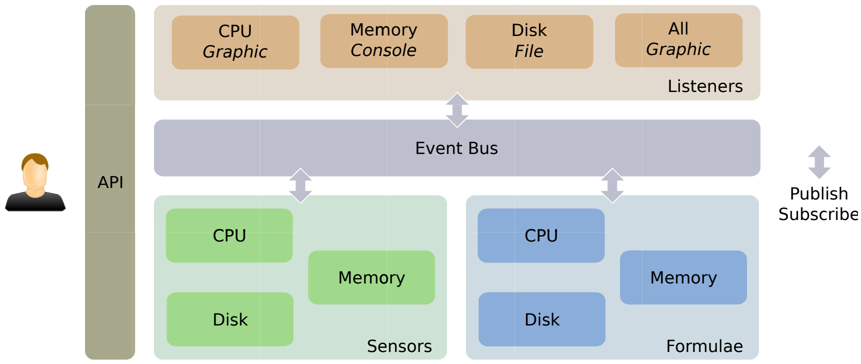

Figure 1: PowerAPI architecture

Monitor energy spent at the process level

Unlike current state-of-the-art technology, PowerAPI does not require any external device to measure energy consumption. This is a purely software approach where the estimation is based on energy analytical models that characterize the consumption of various hardware components (eg CPU, memory, disk). PowerAPI is based on a highly modular architecture where each module represents a measurement unit for a specific hardware component (see Figure 1).

One objective of PowerAPI is to provide a simple and efficient way to estimate the energy consumption of a given process. (1) Simple, because API is close to the user requirements. For instance, the question: "What is the CPU energy consumption of my process #123. Please give me fresh results, every 500 milliseconds, displayed on my console.", can be transcribed into PowerAPI as illustrated by the instruction displayed in Figure 2, where Process(123) is the process #123, 500 milliseconds the real-time refresh period and CpuListener a listener responsible for reporting energy consumption on the user console. (2) Efficient, because the library is an actor-based framework in which the user builds the library by choosing modules to consider for the user's particular requirements. PowerAPI is thus limited to the user's needs, avoiding any extra computational cost.

```
PowerAPI.startMonitoring(
  Process(123),
  500 milliseconds,
  classOf[CpuListener]
)
```

Figure 2: Example of PowerAPI requirement

Use cases

The following two research contributions, which have been developed on top of PowerAPI, demonstrate the benefits of this software library.

What is the energy consumption of the programming languages?

First, we want to compare the implementations of a given algorithm, using several programming languages. The results highlight that the choice of a programming language has an impact on the energy footprint of the application itself. Interpreted languages consume more energy than compiled ones. This result can be intuitive as a first insight, but raises the question of the rise of interpreted languages, especially with their recent increase in use on the server-side by the Web community. Details about this experiment are available in [1].

Where are energy hotpots located within an application?

Second, we want to delve deeper into the previous result, by monitoring not only the process, but also the process' source code itself. The aim of this experiment is to develop a tool that can provide developers a real-time cartography of energy hotspots in their application code. This study reports that, when using a Web container like Jetty, around 80 % of the global energy consumption under stress conditions is attributable to a mere seven classes (out of 146). This information is useful for developers who want to know what changes could be made to reduce the energy footprint of the application. Details about this experiment are available in [2].

On-going work

On-going work includes the development of additional use cases for PowerAPI. In particular, in collaboration with several Green IT actors, such as ADEME, Green Code Lab, and GreenIt.fr, we are currently working on a project called Web Energy Archive that aims at monitoring and comparing the energy consumption of Internet Web sites.

Links:
PowerAPI:
http://abourdon.github.com/powerapi-akka
ADAM project-team,
http://adam.lille.inria.fr

References:
[1] A. Noureddine et al: "A Preliminary Study of the Impact of Software Engineering on GreenIT", Greens@ICSE'12
[2] A. Noureddine et al: "Runtime Monitoring of Software Energy Hotspots", ASE'12,

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Smart Energy Management for Greener Supercomputing

by Mohammed el Mehdi Diouri, Olivier Glück and Laurent Lefèvre

A supercomputer is a system built from a collection of computers performing tasks in parallel in order to achieve very high performance. An exascale machine is a supercomputer capable of performing more than 1018 floating point operations per second (1 Eflop/s). Such extreme-scale systems are needed by 2018 in order to meet new scientific challenges, such as enabling highly sophisticated genome calculations and proposing individualized patient treatments. As they will gather hundreds of millions of cores, exascale supercomputers are expected to consume enormous amounts of energy (between 25 and 100 MW). In addition to being very large, their power consumption will be very irregular. Furthermore, the applications that will run on such extreme-scale systems will need energy consuming services such as fault tolerance, data collective operations. In order to manage the execution of extreme-scale applications on future supercomputers in a sustainable and energy-efficient way, we propose a framework called SESAMES: Smart and Energy-aware Service-oriented Application Manager at Extreme-Scale [1].

Since the power consumption of these large scale systems is enormous and dynamic, SESAMES establishes a permanent negotiation with the energy provider (Figure 1). Through this dialog, SESAMES gives the energy supplier an agenda of the estimated power consumption. It also gathers from the energy supplier the agenda for: energy price, energy sources used, and power capping. The price, energy source (coal, sun, wind etc) and threshold limit will vary at different times. Supercomputer users may prefer to consume energy at times when it is the cleanest and least expensive whilst energy providers may adapt the supply according to demand and may choose to disable some production of energy produced from a polluting source during times of low power use.

Furthermore, in order to reduce global energy consumption, SESAMES is able to act directly on the supercomputer nodes. An energy sensor is plugged to each node and measures the current power consumption. SESAMES collects these energy logs. In order to gather the execution context, SESAMES also establishes a dialog with users of supercomputers. This interaction with the user occurs at the moment of reserving computing nodes and just before running applications and services (see Figure 1).

In order to run their applications, users send to SESAMES a reservation request to book some of the supercomputer's nodes. A reservation request consists of the number of nodes required, the reservation duration, the earliest possible start time and the latest possible start time. In order to make a reservation, SESAMES solves a multi-criteria optimization problem by taking into account several constraints. It attempts to allocate the supercomputing nodes at the time desired by the user by consuming the least amount of energy, the cleanest energy, at the lowest financial cost and without exceeding the power capped by the energy provider. If no solution exists, SESAMES informs the user that the requested reservation is not possible. If there exists a unique solution that optimizes all the criteria, SESAMES makes the corresponding reservation and informs the user about it. Otherwise, SESAMES computes the solutions that optimize each criterion separately and asks the user to choose between the solution that minimizes the financial cost or the one that provides the cleanest energy.

Once the reservation is done, SESAMES gives the user the opportunity to estimate and reduce the energy consumption of the different services (like fault tolerance) that he would like to run while executing his applications. For each service, several versions are possible. The least energy consuming version depends on

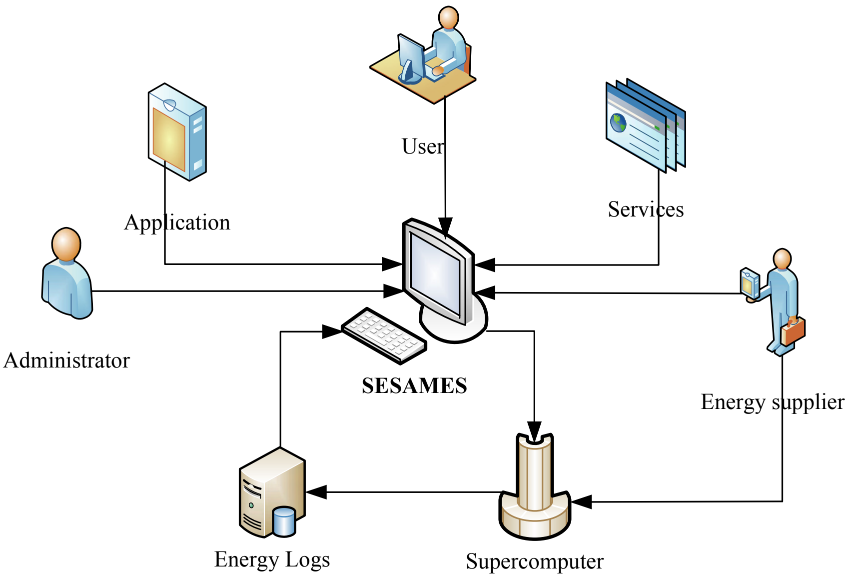

Figure 1: Global infrastructure: external interactions with SESAMES

the application's features. Hence, the first step to consuming "less" energy is to choose the least energy consuming version for each service. Thanks to the interaction with the user, SESAMES takes into account the application features and the user requirements in order to provide an energy estimation of the different versions of the services requested by the user.

To reduce the energy consumption of supercomputers, SESAMES proposes to apply some green leverages at the component level: shutting down or slowing down an idle resource component (processor, memory, disk, etc.). The shutdown approach involves dynamically turning off unused resources and turning them back only when they are needed. The slowdown approach involves dynamically adjusting the performance level of a resource according to the performance level the application and users really need. The green leverages proposed depend on the idle periods predicted and on the rights assigned by the supercomputer administrator to the user. The energy consumption of these green solutions is estimated by SESAMES in order to make the user aware of the energy savings generated by the green solutions suggested.

Reference:

[1] M. Diouri, O. Gluck, and L. Lefevre: "Towards a novel Smart and Energy-Aware Service-Oriented Manager for Extreme-Scale applications", First Workshop for Power Grid-Friendly Computing (PGFC'12), San Jose, USA, 2012.

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AI4B: Accountable IT Infrastructures for Optimizing Supply Chains in Bioenergy Symbiotic Networks

by Theodore Dalamagas and Antonis Kokossis

Project AI4B aims to develop a data-driven approach to establish bioenergy networks of biomass feedstock producers and collectors, aiming to remove bottlenecks in the biomass supply pipeline and develop accountable, economically and environmentally sustainable bioenergy practices.

Biomass - biological material from living or recently living organisms - represents the largest renewable energy source and is the only renewable energy source that is based on carbon. Raw materials, such as wood, agricultural residues, food waste, industrial waste and co-products have captured the interest of markets and industries worldwide following the uncertainties in fossil fuel supply and the need to reduce greenhouse gas emissions. Involvement in the biomass business in Greece has several advantages, since Greece reports an agricultural share of the GDP that is three times higher than the EU average, and thus there are plenty of sources for raw biomass materials.

The AI4B project, co-financed by EU's Regional Development Fund and by national resources, comes at a critical stage for the country, in line with a major effort to develop renewable energy sources, which is planned to be one of the driving forces to turn recession into growth. AI4B mobilizes academic partners, IT SMEs and regional development agencies to develop innovative IT infrastructures to remove existing bottlenecks in the biomass supply pipeline, and develop economically and environmentally sustainable bioenergy practices [1]. In AI4B, we focus on symbiotic bioenergy networks. "Symbiotic networks" [2] is an innovative environmental practice that brings together companies from all business sectors through material trading and sharing assets to add value, reduce costs and benefit the environment.

We focus on symbiotic networks with biomass supply chains involving biomass producers (BP) and biomass col-

Figure 1: Overview of the AI4B infrastructure

lectors (BC). BPs are regional players that provide storage points or production facilities. BCs are industrial players that collect biomass from BPs and employ valorization technologies for energy production. Our vision is twofold:
- To set up IT infrastructures to support "networking" between BPs and BCs by providing intelligent matchmaking and retrieval services.
- To leverage societal interaction and participation as an intrinsic part of the network by giving every citizen or public administration access to supply chain data.

A data-driven symbiotic network
We follow a data-driven approach to maintain biomass symbiotic networks. BPs register on the network and provide information about biomass feedstock, for example: type, quantity and location of production. BCs also register and provide information about available biomass processing options and supply requirements. We will adopt the Linked Open Data (LOD) paradigm to set up biomass data infrastructures (BDI) for BPs and BCs. The LOD paradigm involves practices to publish, share, and connect data on the Web. "Linked", means that data are interlinked under diachronic naming schemes, so that anyone can easily combine them and extract knowledge in multiple ways. "Open", means that data are fully disclosed under open formats, open licenses, and machine readable formats. AI4B will set up a LOD base providing matchmaking and retrieval services so that BCs are able to identify BPs (and vice versa) according to their supply/production requirements.

Regional development and planning
The dispersed geographical distribution of biomass raises difficulties for the estimation of biomass quantities, the evaluation of technological pathways for biomass energy and the determination of the final cost for BCs. BCs need to explore several alternative delivery models to determine cost-effective biomass supply chains, and to identify the geographic distribution of the economically exploited biomass potential. Spatial planning can assist biomass logistics, and provides a means for exploring and evaluating alternative scenarios of biomass supply chains (characteristics, transportation cost, selection/sizing/costing of biomass production site) to determine optimal configurations. Key components in such an infrastructure are: (a) processing technology models that predict the output of biomass-related process blocks (eg the entire biodiesel process that converts biomass and fossil into new products) given input information (eg material and energy streams), (b) performance models that evaluate the economical performance, energy consumption, and greenhouse gas emissions, and (c) logistic models that address logistics and supply chain considerations. AI4B will provide services to set up cost-effective biomass supply chains, and explore alternatives in biomass processing and supply chain configurations based on what-if analysis tools.

Accountability in biomass symbiotic networks
AI4B will adopt the LOD paradigm to expose: (a) currently available spatial data infrastructures (SDI) as geoLOD data, and (b) process, performance and logistic models as biomass LOD data. LOD is considered worldwide as a driving force to provide transparent and accountable processes. In AI4B, all stages of biomass supply chains will be transparent. Every citizen or public body will have access to supply chain data, and be able to query decisions and demand ramifications.

The AI4B project is just about to start, and involves the following partners: Athena Research Center, National Techn. University of Athens, Centre for Renewable Energy Sources, Eratosthenes SA, CLMS Ltd, Tero Ltd, Kenakap SA, Aenol SA.

Acknowledgements: The authors acknowledge Dr. Ioanna Papamichael, Nontas Tsakonas, Dr. Yannis Zorgios, Stratos Arampatzis, Panayiotis Patras, Sevasti Basdeki for their contribution in this work.

Links:
http://en.wikipedia.org/wiki/Industrial_symbiosis
http://linkeddata.org
http://www.esymbiosis.gr
http://www.cres.gr/kape/energeia_politis/energeia_politis_biomass_uk.htm

References:
[1] G. Grant et al: "Information and Communication Technologies for Industrial Symbiosis", Journal of Industrial Ecology, 10(5), 2010
[2] R. Isenmann, K. Chernykh: "The role of ICT in Industrial Symbiosis Projects. Environmental Informatics and Industrial Environmental Protection: Concepts, Methods and Tools", 2009.

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Hydrodynamics-Biology Coupling for Algae Culture and Biofuel Production

by Olivier Bernard, Jacques Sainte-Marie, Bruno Sialve and Jean-Philippe Steyer

Biofuel production from microalgae represents an acute optimization problem for industry. There is a wide range of parameters that must be taken into account in the development of this technology. Here, mathematical modelling has a vital role to play.

The potential of microalgae as a source of biofuel and as a technological solution for CO2 fixation is the subject of intense academic and industrial research. Large-scale production of microalgae has potential for biofuel applications owing to the high productivity that can be attained in high-rate raceway ponds [1].

Figure 1: A typical raceway for cultivating microalgae. Notice the paddlewheel which mixes the culture suspension. Photo: INRA

Based in France, "Green Stars" is a large research and development project involving scientists and industry whose aim is to explore the use of micro-algae, particularly in the form of "third generation biofuels". The program has enormous promise, with this resource potentially offering a tremendous solution for the major economic developments of the coming decade. Some microalgal species have far more efficient growth, by photosynthesis, than terrestrial plants. Moreover, they can accumulate oils or sugars, which can be turned into biodiesel or bioethanol. Twenty to 30 tons of oil per hectare per year are expected to be extracted from micro-algae, compared with six tons from the palm trees and a little more than one ton from rapeseed.

The objective of Green Stars is to lay the foundations for the entire sector, from energy generation to waste recycling and the production of compounds of interest. Green Stars also plans to play a long-term role in this field by training technicians, engineers and researchers.

The role of mathematical modelling and simulations

One of the key challenges in the production of microalgae is to maximize algae growth with respect to the used exogenous energy (paddlewheels, pumps, etc.).

There are a large number of parameters that need to be optimized, including: the characteristics of the biological species, the raceway shape and the stirring provided by the paddlewheel; consequently our strategy is to develop efficient models and numerical tools to reproduce the flow induced by the paddlewheel and the evolution of the biological species within this flow. Here, mathematical models can greatly help us to reduce experimental costs.

Owing to the high heterogeneity of raceways due to gradients of temperature, light intensity and nutrient availability through water height, we cannot use depth-averaged models (Shallow Water type models). We adopt instead more accurate models that have recently been proposed [2]. These models are particularly appropriate for representation of these free surface systems. For hydrodynamics, we use the incompressible hydrostatic Navier-Stokes equations, forced by a paddlewheel-like move. The biological dynamics are represented by an improved and distributed (in space) model that includes light effect on algae growth and carbon storage depending on nitrogen limitation.

We show, through 3D numerical simulations, that our approach is capable of discriminating between situations of rapidly moving water or slow agitation, choosing an optimal water height or proposing initial conditions for the biological variables. Moreover, the simulated velocity fields can provide lagrangian trajectories of the algae. The resulting light pattern to which each cell is submitted when travelling from light (surface) to dark (bottom) can then be derived. It will then be reproduced in lab experiments to study photosynthesis under realistic light patterns.

It is clear, however, that many complex physical phenomena have to be added to our model, such as the effect of sunlight on water temperature/density, evaporation and external forcing (wind). Moreover, some microalgae species do not only swim in the water (advection plus diffusion effects) but also deposit.

References:

[1] B. Sialve, N. Bernet and O. Bernard: "Anaerobic digestion of microalgae as a necessary step to make microalgal biodiesel sustainable", Biotechnology Advances, 27:4, p. 409-416, 2009

[2] E. Audusse, M.-O. Bristeau, M. Pelanti and J. Sainte-Marie: "Approximation of the hydrostatic Navier-Stokes system for density stratified flows by a multilayer model", Kinetic interpretation and numerical solution, J. Comp. Phys., 230, p. 3453-3478, 2011.

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A Projector as Mobile Visualization Device on an Assistive Robot

by Paul Panek, Christian Beck, Georg Edelmayer, Peter Mayer and Wolfgang L. Zagler

Even small robots have great potential to support the elderly. We have created a prototype of a LED projector module that enables a small humanoid robot to project text, graphics and video to a surface next to the user.

The research project KSERA (“Knowledgeable SErvice Robots for Aging”) develops a social assistive robot that supports older persons, especially those with Chronic Obstructive Pulmonary Disease (COPD), in their daily activities and care needs. Independence and overall quality of life can be enhanced when individuals are able to engage in self-management of their disease.

The small NAO humanoid, from French company Aldebaran, is used for the robotic platform. It serves as an interface between the user and the system, which is embedded in a smart home environment enabling ubiquitous monitoring of the user’s activities and health status and of the environmental conditions.

As the humanoid robot we used is comparatively small (57 cm tall) it is not able to carry HCI devices such as a tablet PC and to present it to a sitting or standing user. To overcome this restriction an innovative LED projector module mounted on the robot’s back was developed in the KSERA project.

The projector unit on the robot’s back (Figure 1) projects text, graphics and video information towards a wall next to the user. With video phone communication a camera in the robot’s head is used to transmit the user’s video stream towards the communication partner (Figure 2). This is intended for social communication (friends, family members), video communication to medical services and in the case of emergency (eg a fall).

The main innovation is considered to be the mobility of the solution, as the assistive robot with its projector equipment can come to the user anywhere in the apartment. The text and graphics to be projected are provided by the KSERA intelligent server; similarly, the timing of the beginning and end of projections is controlled by the KSERA state machine. The projector component is responsible for the visualization of the information to be shown to the user. For initial laboratory evaluation, a workshop with a small group of experts from the care domain was organized following a qualitative approach. The experts agreed that the quality of audio and video was good and would be adequate for video communication in the given context.

Added value was found to be in the persistence of projected text and graphic for somewhat more complex messages (eg daily agenda, air quality information) and in the video phone capability. The latter provides more comprehensive information regarding the actual state and emotional situation of the user than can be achieved with an audio only connection. The video connection is particularly useful in emergency scenarios, when the operator of the emergency centre needs to quickly assess the severity of the situation.

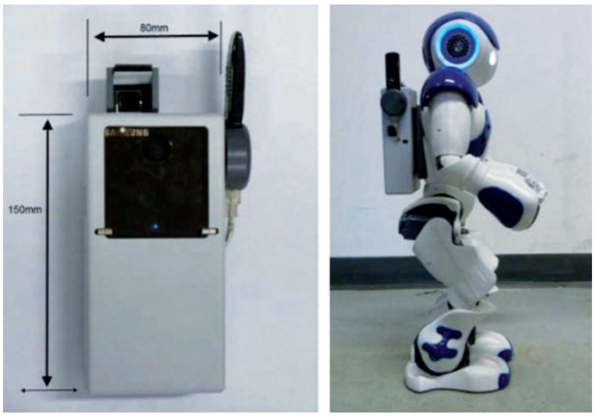

Figure 1: Prototype of LED projector unit (left) mounted on the humanoid NAO robot (right)

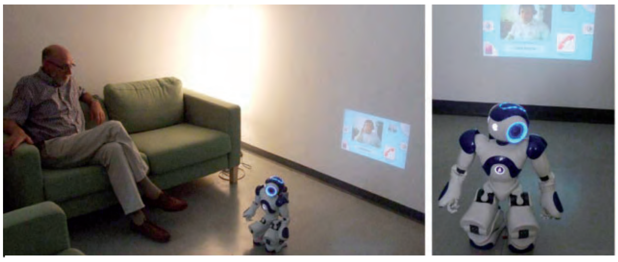

Figure 2: NAO robot with a LED projector unit on its back during video communication between KSERA user (sitting on a couch) and a call centre operator.

Discussion and conclusions

A mobile video solution is much appreciated by experts and potential end users. Despite the promising results, some limitations of the current prototype system exist, namely: The low brightness of the LED projector used (30 ANSI lumen). By using blinds on the windows and artificial light in the test room, a realistic environment could be set up but it was at the lower limit of ambient brightness recommended for living areas. It is expected that brighter projectors will be available in the near future overcoming this drawback.

Further work will involve validating the integrated KSERA prototype with older users in Austria and Israel in near to real life environments.

Acknowledgement

This work was partly funded by EC in the FP7 KSERA project.

Links:
http://www.ksera-project.eu
http://www.aldebaran-robotics.com/
http://www.aat.tuwien.ac.at/ksera/

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ATLAAS-P2P: A Two-Layer Architecture for Approximated Search in Peer to Peer

by Ranieri Baraglia, Patrizio Dazzi, Matteo Mordacchini and Laura Ricci

ATLAAS-P2P is a two-layered peer-to-peer (P2P) architecture for developing systems, providing resource aggregation and approximated discovery in P2P networks. It gives users a flexible and easy means of searching for resources and also benefits resource providers by assisting users to find them.

The process of identifying useful resources in a P2P network is highly dependent on query formulation. Users should be able to easily express their needs, and an efficient query resolution mechanism should efficiently find relevant resources and limit the number of messages exchanged. Common techniques for searching resources in P2P systems are based on range queries over a set of attributes. However, the volume of resources in a P2P network may be very large and heterogeneous, and users rarely have the appropriate knowledge about the available resources to allow them to properly formulate their queries. A user may, however, be able to define their "ideal" resource and ask the search system to find resources close to such an entity. Thus, instead of having to specify precise ranges on all attributes, the user simply has to provide an example of what is needed.

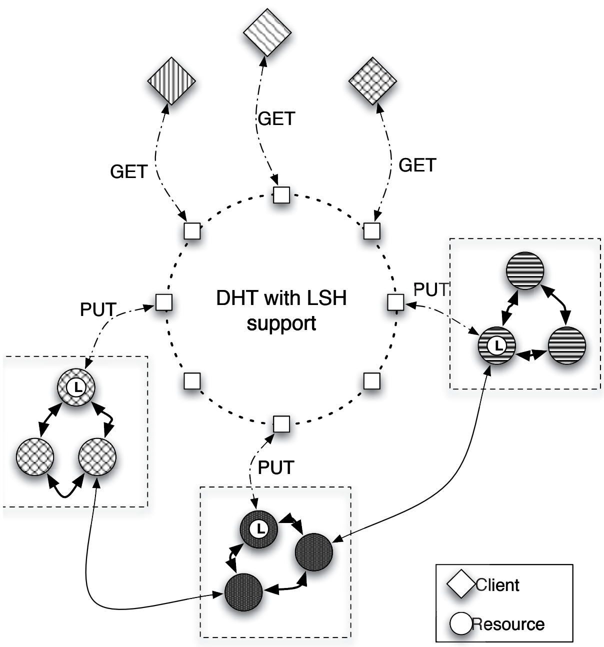

Figure 1: The overall architecture of ATLAAS-P2P

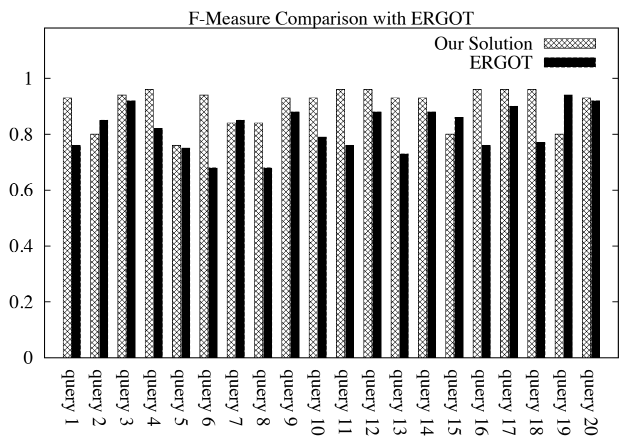

Figure 2: ATLAAS-P2P performances

This mechanism would simplify the work for users and lead to a more efficient exploitation of the search system. Moreover, it would provide an effective infrastructure for advertising for resource providers, facilitating their discovery by users.

ATLAAS-P2P consists of a P2P system that provides flexibility in the way that users express their requirements and an effective solution for enabling users' requests to reach resource providers. It is based on a two-layer architecture, where peers in the network represent the resources of providers. The lower layer is an unstructured, gossip-based, P2P network allowing peers to efficiently gather in logical groups of nodes representing similar resources. The role of this layer is to automatically capture the affinities existing between resources belonging to different providers and to group them in common communities. Those communities distributively elect their own representatives. The profiles of these representatives are used as the descriptors of such communities. Once elected, each representative registers itself on the higher layer, a structured, DHT-based network.

The structured network has been extended to support approximated searches over the community representatives. Users can submit the queries to this network by providing sample resources consisting of prototypes of the resources they are searching for. Gossip-based protocols are used to find and select similar representatives to forward the query within their community. This means that when none of the resources available in the system matches a user's request, the user is offered suitable alternatives.

The overall architecture of ATLAAS-P2P is sketched in Figure 1. Peers (circles) form distinct communities built on a similarity basis in the unstructured gossip-based layer. Each community elects a representative, denoted with an L in the figure. Each representative is in charge of registering itself on the higher structured layer. Users of the systems (rhombus) can query the structured network searching for the resources they need. Results will consist of the most significative community profiles and their representatives. The representatives will act as entry points to further forward queries to the peers of the represented community.

Instead of searching for peers whose profile is similar to that specified by the user this architecture searches for communities. This reduces both the number of comparisons to perform and the number of peers to contact. As a consequence, the amount of generated network traffic also decreases.

The ability of ATLASS-P2P to return significant resources has been tested using a dataset of 200 word domain labels organized in a hierarchical structure built by exploiting the WordNet domain [1]. The content of this dataset has been used to generate textual descriptions. Such descriptions have been assigned to 5000 peers according to a Zipf distribution for building the peer profiles.

ATLAAS-P2P performances are presented in Figure 2, in which they are compared with those provided by ERGOT [2], a solution for this task, which is based on semantic overlay networks.

References:

[1] B. Magnini, G. Cavaglia: "Integrating subject field codes into wordnet", in proc. of LREC 2000
[2] G.Pirrò, D.Talia, P.Trunfio: "A DHT-based semantic overlay network for service discovery", Future Generation Computer Systems 28 (4), 2012

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Epeerdemics: A Peer-to-Peer Simulator Targeting Epidemic-Based Protocols

by Patrizio Dazzi and Emanuele Carlini

Since the late 'nineties, peer-to-peer (P2P) protocols have become increasingly popular. Traditionally, these systems have been used to implement widely distributed applications, such as file-sharing services, as they provide efficient support for the discovery and distribution of information.

Several different structured P2P protocols have been proposed for distributed networks. "Structured", in this context, refers to the protocol's ability to organize network links and data to provide specific guarantees and bounds on performances. Recently, P2P protocols have also been exploited for information diffusion and aggregation, including resource discovery and system monitoring and community-based information dissemination. These applications introduce new requirements to P2P protocols, since information freshness, rather than information precision, is their main focus.

Epidemic-based (also known as gossip-based) P2P protocols are unstructured communication approaches that disseminate information in a manner similar to the spread of viruses in a biological community. They are often used to solve problems that might be difficult to tackle in other ways owing to the complex structure and dimension of the network and the fast rate of information change.

These developments have fostered an increasing interest within the research community in the conception and design of novel epidemic protocols. A typical issue is the need to consider classical non-functional requirements, such as scale and performance as foundational aspects of protocol design. Indeed, these protocols fit networks comprising hundreds of thousands of nodes characterized by frequent changes in shared data and affected by considerable churn rates.

Since it is unfeasible to obtain access to thousands of machines worldwide, the performances and limits of epidemic protocols are normally studied through simulations. In this sense, well-designed simulators facilitate the development of new protocols allowing for the simulation of many nodes within limited computational units. Properly designed simulators also ease the deployment of the protocols on a real infrastructure with minimal disruption to the code.

In the last decade, several P2P simulators have been proposed. Essentially, they differ in the level of abstraction provided, the programming language used and flexibility in developing protocols. To ease the evaluation and comparison of protocols, these simulators are often bundled with several well-known protocols. Unfortunately, only a few P2P simulators are specific to unstructured protocols and only a subset of them provide a bundle of epidemic-based protocols as baselines for testing.

We developed Epeerdemics with the aim of filling this void. Epeerdemics is an extension to Overlay Weaver [1], an overlay construction toolkit widely diffused in the P2P community, mainly used for developing structured protocols. Epeerdemics is specifically designed to ease the develop-

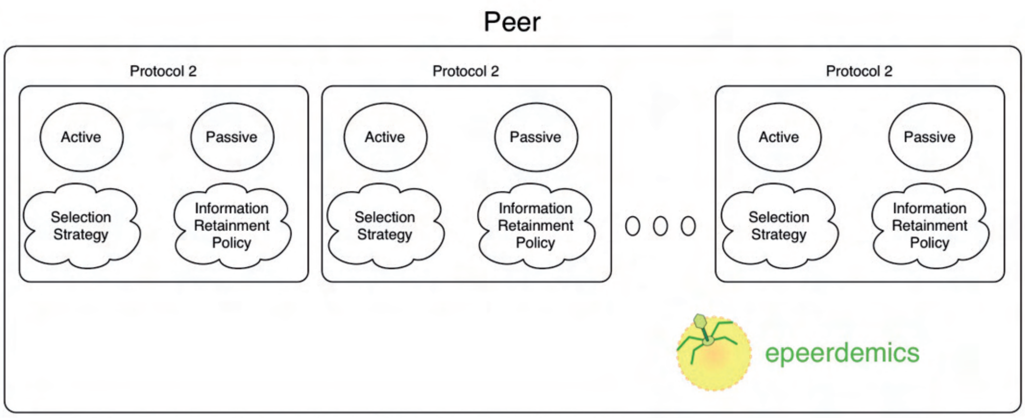

Figure 1: Epeerdemics protocol architecture.

ment and testing of epidemic-based protocols. Protocols can either be developed from scratch or by extending the protocols provided with Epeerdemics. To this end, Epeerdemics provides two of the most used epidemic-based peer sampling protocols: Cyclon and Vicinity. Cyclon realizes an inexpensive peer sampling to build an overlay characterized by a random-graph structure. Vicinity is a semantic peer-sampling based protocol built on top of Cyclon that realizes an overlay network in which the links express similarity between peers.

From an operative point of view, each epidemic protocol is based on two threads, one active and one passive. The active thread is activated by a timer. When activated it selects one or more peers to communicate with and sends them (a subset of) its own knowledge. These interactions awaken, in the selected peers, the respective passive threads. Each passive thread answers by sending back to the sender (a subset of) its knowledge.

The amount and kind of information exchanged as well as the information retention strategy is protocol dependent. Epeerdemics supports programmers in implementing these choices and strategies. To implement an epidemic protocol with Epeerdemics, a programmer has simply to extend two Java classes: One for implementing the selection strategy to decide which peers to communicate with and one to specify the information retainment strategy, ie which information to store or discard.

Here at ISTI-CNR, Epeerdemics has been used successfully for developing several different epidemic-based protocols. These range from simple enhancements to existing protocols to the definition of completely new protocols, including GoDel [2] a protocol for building Delaunay overlays and [3] a gossip-based overlay construction for large scale online games.

References:

[1] Kazuyuki Shudo, Yoshio Tanaka, and Satoshi Sekiguchi: “OverlayWeaver: An Overlay Construction Toolkit”, Computer Communications, 31(2):402–412, 2007

[2] R. Baraglia, P. Dazzi, B. Guidi, and L. Ricci, “GoDel: Delaunay Overlays in P2P Networks via Gossip”, IEEE International Conference on Peer-to-Peer Computing, 2012

[3] E. Carlini, L. Ricci, and M. Coppola: “Reducing Server Load in MMOG via P2P Gossip”, in proc. ACM Workshop on Network and System Support for Games, Venice, Italy.

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gRecs: Exploiting the Power of Data Mining Techniques for Efficient Computation of Group Recommendations

by Kostas Stefanidis and Kjetil Nørvåg

gRecs is a research prototype system designed for providing suggestions to groups of users about items of potential interest. In particular, gRecs proposes an extensive model for group recommendations based on recommendations for items liked by similar users to the group members. This is achieved with the use of data mining techniques. More specifically, since the main bottleneck is to identify the most similar users to a given one, we model the user-item interactions in terms of clustering and use the extracted clusters for predictions.

Recommendation systems provide suggestions to users about a variety of items, such as movies and restaurants. The large majority of these systems are designed to make recommendations for individual users. However, there are contexts in which the items to be suggested are intended for a group of people, rather than an individual; for instance, recommendations for restaurants, tourist attractions, movies, TV programs and holiday destinations. Recent approaches try to satisfy the preferences of all group members either by creating a joint profile for the group and suggesting items with respect to this profile or by aggregating the single user recommendations into group recommendations. gRecs opts for the second approach owing to its greater flexibility and potential for efficiency improvements.

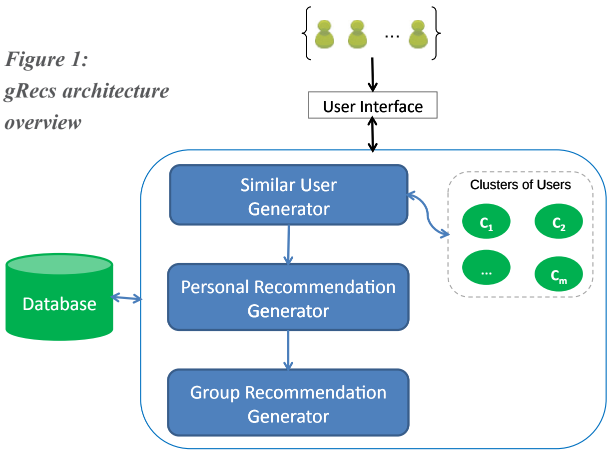
gRecs proposes a framework for group recommendations following the collaborative filtering approach. The most prominent items for each user of the group are identified based on items that similar users liked in the past. Users are considered similar if there is an overlap in the items consumed. In particular, the two types of entity that are dealt with in recommendation systems, ie, users and items, are represented as sets of ratings, preferences or features. Users initially rate a (typically small) subset of items and ratings are expressed in the form of preference scores. A recommendation engine estimates preference scores for the unrated items and offers appropriate recommendations. Once the unknown scores are computed, the k items with the highest scores are recommended to users.

To efficiently aggregate the single user recommendations into group recommendations, we leverage the power of a top-k algorithm. We employ three different aggregation designs: (i) the least misery design, capturing cases where strong user preferences act as a veto, (ii) the most optimistic design, capturing cases where the most satisfied member is the most influential one, and (iii) the fair design, capturing more democratic cases. To deal with reliability issues, we introduce the notion of support in recommendations to model how confident the recommendation of an item for a user is.

Group recommendations are presented to users along with explanations about the reasons that the particular items are being suggested. Explanations are given as text using a template mechanism.

A main problem of this approach is to identify the most similar users for each user in the group. A solution that involves no pre-computation requires computing the similarity measures between each user in the group and each user in the database. To avoid exhaustively searching for similar users, we perform some pre-processing steps offline. In particular, we propose building clusters of similar users, considering as similar those users that have similar preferences. To partition users into clusters we employ a bottom-up hierarchical agglomerative clustering algorithm. Initially, our algorithm places each user in a cluster of his own. Then, at each step, it merges the two most similar clusters. The similarity between two clusters is defined as the minimum similarity between any two users that belong to these clusters (max linkage). The algorithm terminates when the similarity of the closest pair of clusters violates a user similarity threshold δ. Ideally, the most similar users to a specific user are the members of the cluster that the user belongs to. Recommendations are computed based on the preferences of these cluster members. Figure 1 shows a high level representation of the architecture of our system.

Figure 1: gRecs architecture overview



Our results show that employing user clustering considerably improves the execution time, while preserving a satisfactory quality of recommendations [1]. To deal with the high dimensionality and sparsity of ratings, we envision subspace clustering to find clusters of similar users and subsets of items for which these users have similar ratings.

We designed and developed the gRecs system at the Norwegian University of Science and Technology in Trondheim, Norway, funded by the ERCIM "Alain Bensoussan" Fellowship Programme, in collaboration with Irini Ntoutsi and Hans-Peter Kriegel from the Ludwig Maximilian University of Munich, Germany.

Reference:

[1] I. Ntoutsi, K. Stefanidis, K. Nørvåg and H-P. Kriegel: "Fast Group Recommendations by Applying User Clustering", in proc. of ER 2012.

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Utility-Theoretic Ranking for Semi-Automated Text Classification

by Giacomo Berardi, Andrea Esuli and Fabrizio Sebastiani

Researchers from ISTI-CNR, Pisa, have addressed the problem of optimizing the work of human editors who proofcheck the results of an automatic text classifier with the goal of improving the accuracy of the automatically classified document set.

Suppose an organization needs to classify a set of texts under a given classification scheme, and suppose that this set is too large to be classified manually, so that resorting to some form of automated text classification (TC) is the only viable option. Suppose also that the organization has strict accuracy standards, so that the level of accuracy that can be obtained via state-of-the-art TC technology is not sufficient. In this case, the most plausible strategy to follow is to classify the texts by means of an automatic classifier (which we assume here to be generated via supervised learning), and then to have a human editor proofcheck the results of the automatic classification, correcting misclassifications where appropriate.

The human editor will obviously inspect only a subset of the automatically classified texts, since it would otherwise make no sense to have an initial automated classification phase. A software system could actively support the human editor by ranking, after the classification phase has ended and before the inspection begins, the automatically classified documents in a such a way that, if the human editor inspects the documents starting from the top of the ranking and working down the list, the expected increase in classification accuracy that derives from this inspection is maximized. We call this scenario "semi-automated text classification" (SATC).

A common-sense ranking method for SATC could consist in ranking the automatically classified texts in ascending order of the confidence scores generated by the classifier, so that the top-ranked documents are the ones that the classifier has classified with the lowest confidence [1]. The rationale is that an increase in accuracy can derive only by inspecting misclassified documents, and that a good ranking method is simply the one that top-ranks the documents with the highest probability of misclassification, which (in the absence of other information) we may take to be the texts which the classifier has classified with the lowest confidence.

We have recently shown [2] that this strategy is, in general, suboptimal. Simply stated, the reason is that, when we deal with imbalanced TC problems (as most TC problems indeed are [3]) and, as a consequence, choose an evaluation measure - such as F1 - that caters for this imbalance, the improvements in effectiveness that derive from correcting a false positive or a false negative may not be the same.

We have devised a ranking method for SATC that combines, via utility theory, (i) information on the probability that the document is misclassified, and (ii) information on the gain in overall accuracy that would derive by proofchecking it.

We have also proposed a new evaluation measure for SATC, called Expected Normalized Error Reduction (ENER). Since different users will inspect the ranked list down to a certain "inspection depth", ENER uses a probability distribution over inspection depths as a parameter. ENER measures then the expected value (over this probability distribution) of the reduction in error that inspecting a ranked list down to the specified depth would bring about.

We have used ENER as the evaluation measure for our experiments, which we have run on a standard text classification dataset. The results show that, with respect to the common-sense baseline method mentioned above, our utility-theoretic ranking method is substantially more effective, with computed improvements ranging from +16% to +138%.

The approach we present is extremely general, since it applies straightforwardly to cases in which evaluation measures different from F1 are used; multivariate and non-linear evaluation measures can be handled too, provided they can be computed from a standard contingency table. By using our method, it is also easy to dynamically provide the human editor with an estimate of how accurate the classified set has become as a result of the proofchecking activity.

References:
[1] A. Esuli and F. Sebastiani: "Active Learning Strategies for Multi-Label Text Classification", in proc. of ECIR 2009, Toulouse, FR, 2009, pp. 102-113

[2] G. Berardi, A. Esuli, and F. Sebastiani: "A Utility-Theoretic Ranking Method for Semi-Automated Text Classification", in proc. of ACM SIGIR 2012, Portland, US, pp. 961-970

[3] H. He and E. Garcia: "Learning from imbalanced data. IEEE Transactions on Knowledge and Data Engineering", 21(9), 1263-1284.

Link:
http://nmis.isti.cnr.it/sebastiani/Publications/SIGIR12.pdf

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A Radio Telescope of the Superlative

by Ton Engbersen

The worldwide community of Radio-Astronomy has envisioned building a very large, highly sensitive radio telescope partly in South Africa and partly in Australia by 2020. The total effective area of this radio telescope should approach one square kilometer and therefore it is called the Square Kilometre Array (SKA). The SKA instrument is expected to generate Exabytes of data per day which need to be processed and reduced, such that approximately 1 Petabyte per day is left to be stored for later use by Radio Astronomers.

Current expectations for the SKA are that the low frequency array (70 – 450 MHz) and the initial mid frequency (450 – 3000 MHz) will each comprise about 500,000 antenna elements while the high frequency array (3 – 10 GHz) will consist of approximately 3000 dishes. A quick calculation assuming no beamforming before Nyquist sampling results in 3.5 10^{15} samples/s or 300 ExaSamples per day (assuming 24 hour operation). Processing this is clearly beyond the capabilities of even the fastest supercomputers one can envision by 2020. The streaming and real-time nature of the SKA makes it unlikely that supercomputers are ideally suited for this application, like in LOFAR [1]. A significant research and development effort is therefore needed. For IBM, with our focus on future Big Data and Big Data analytics, this is a highly interesting field of research: it promises to make analytics low cost and energy efficient. We have named the project DOME after the protective astronomical telescope covering.

DOME

A five-year, 33 million Euro project has been defined between IBM Research – Zürich and ASTRON, funded by the Dutch Ministry of Economic Affairs, Agriculture and Innovation and the Province of Drenthe, The Netherlands. The objective is to investigate novel exascale computing technologies and concepts, with a focus on energy-efficient data processing, data storage, and nano-photonics at a fundamental level. In addition, the DOME project will collaborate with Small and Medium Enterprises and other academic partners in the Netherlands to stimulate economic activity through supporting the development and testing of new high-performance computing applications.

Research Projects

In DOME, seven research tracks are defined:

1. Algorithms and Machines: The goal is to design a whole-system bounds framework enabling system-design space exploration in the early phases of the SKA implementation and thus guide the design decisions for platforms which will hold future exascale systems. A methodology already in development in the IBM Laboratory in Zürich forms the basis: analytical models and equations tie application properties, device technology and compute architecture trends together to arrive at predictions of performance[2], power and hardware cost.

2. Access Patterns: The SKA will generate approximately one Petabyte per day, data which will need to be kept on storage media and made available for future analysis and distribution. New storage technologies as well as very low power storage technologies (magnetic tape) will be investigated and through the – hopefully – automatic learning of the system about typical usage patterns of this radio astronomy data, the system can autonomously decide on which storage tier the data will be stored, and moved when its access is anticipated.
3. Nano-photonics: Transport of data will remain a major cost factor in the SKA system. A particular focus will be put on the processing of signals in the optical domain.
4. Micro servers: Through carefully selecting the appropriate computing hardware and energy-efficient peripheral hardware, this work-stream tries to pack as much computing power in as small an area as possible – under severe energy limitations.
5. Accelerators: This work-stream will address questions around what makes an architecture energy-efficient, and easily programmable.
6. Compressive Sampling: capture and processing of analog signals is traditionally done in 2 steps: sampling and compression. Usually sampling is done at the Nyquist frequency, followed by often lossy compression. Why sample at this high frequency to then discard samples?
7. Real-Time Communications: The objective of this work-stream is to create a computing architecture able to real-time process high-bandwidth data motion and compute intensive workloads on an Exascale-class system.

These seven work-streams will be performed in close cooperation between ASTRON and IBM in the ASTRON & IBM Center for Exascale Technology, Dwingeloo, The Netherlands and the IBM Research Laboratory, Zürich, Switzerland. We expect to achieve exciting results in the area of exascale computing, applicable not only to SKA and radio astronomy but also to Big Data analytics. After all, isn't the SKA the ultimate Big Data analytics challenge?

References:

[1] M. de Vos, A.W. Gunst, R. Nijboer: "The LOFAR Telescope: System Architecture and Signal Processing", in proc. IEEE, vol. 97, Issue 8, pp 1431- 1437, DOI 10.1109/JPROC.2009.2020509, 2009, IEEE Journals & Magazines

[2] P. Stanley-Marbell, V. Caparrós Cabezas, R. P. Luijten: "Pinned to the walls - impact of packaging and application properties on the memory and power walls", in IEEE International Symposium on Low Power Electronics and Design (ISLPED'11), pp 51–56, Fukuoka, Japan, 2011

[3] J. W. Romein: "An Efficient Work-Distribution Strategy for Gridding Radio-Telescope Data on GPUs", in ACM International Conference on Supercomputing (ICS'12), Venice, Italy, 2012

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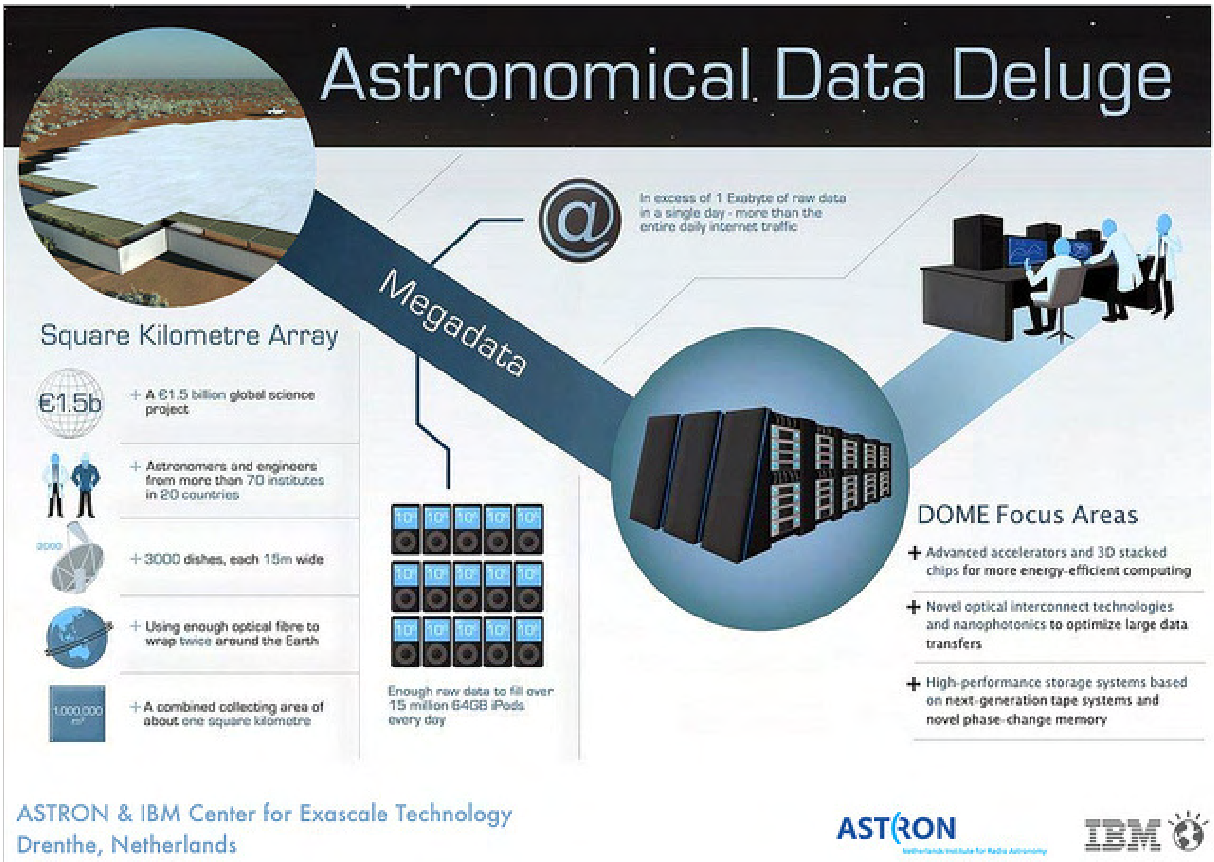

Figure 1: The Astronomical Data Deluge

The Green-Wake Project Targets both Air Traffic Security and Airport Throughput

by Sébastien Lugan and Benoit Michel

The Green-Wake project has developed a new LIDAR (Light Detection And Ranging) scanner able to detect vortices generated by airplanes taking off and landing, thereby increasing airport security while decreasing the time between two consecutive flights.

Wake vortices and wind shear are potential causes of accidents and injuries to passengers and crews on aircraft of all types. They cannot be detected by sight and result in sudden disruption to the aircraft's trajectory, potentially affecting safety. There are currently few options for protection from these phenomena, and the main way to ensure safety with regard to wake vortices is to impose mandatory separation between aircraft. The resulting delays can affect the airport's operating performance. Green-Wake has developed and tested a Doppler LIDAR system able to detect both wake vortices and wind shear in front of an aircraft that may soon be inserted into the noses of commercial aircrafts or on the side of the runways and will help avoid the related hazards.

LIDAR challenges

Wake vortex and wind shear detection has been the focus of a few research programmes funded by Europe and the US, and the LIDAR technique offers a technical solution to this problem. Since LIDAR requires the use of a laser, there is a considerable challenge to designing and building a system that has the performance required to detect hazards, is suitable for installation on aircraft, and also meets the safety and cost requirements of the aerospace industry.

The LIDAR system may be installed in the airplane's nose or on the ground on the side of an airport runway. Fixed locations offer several advantages, such as minimizing the weight and complexity of on-board equipment and providing measurements and warnings to all approaching and departing aircraft.

The Doppler LIDAR

The Doppler LIDAR system uses an ultraviolet laser that emits a beam into the air. The beam is slightly decolimated and diverted 10 times per second by a pair of orthogonal oscillating mirrors in order to scan a volume rather than a single line. When the beam encounters aerosols in the scanned volume, it is reflected back to its source, where a semi-transparent mirror lets the received photons pass through to a detector. Interference fringes between the original laser beam and reflected beam are used to measure the aerosol particles' radial velocities. The useful air volume scanned by the system covers distances from 50 to 200m in front of the LIDAR system and the scanning area is approximately 120m wide and 50m high. As the beam is invisible and decolimated to present a minimum 50 mm width, it poses no safety threat to any person in the measurement zone.

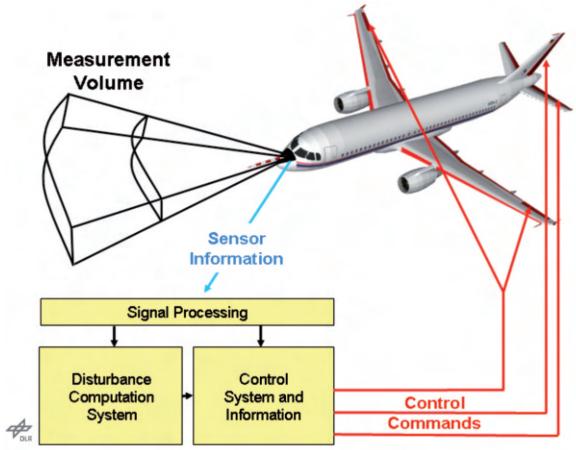

Figure1: Hazard detection and feedback loop

Scanning mirrors

Oscillating mirrors provide the required volume scanning in front of the laser. Moving mirrors back and forth ten times per second may seem a trivial task compared with setting up lasers, light amplifiers, and interferometers. However, in order to give useful results, the scanning system required the development of a new, stiff, lightweight composite mirror with a beryllium face skin mounted on a honeycomb core.

Airfield trials

Airfield trials were conducted over a two-week period at Charleroi-Brussels South (Belgium) airport in October 2012. With over 60 commercial airplanes taking off each day in front of the Green-Wake LIDAR prototype over the trial period, a lot of data were acquired to validate the concept and to give enough information to the team that is now facing the last step of this research effort: its implementation in a commercially deployable system.

A complementary European consortium

The Green-Wake project was funded by the European Commission from 2008 to the end of 2012. The project consortium included EADS Deutschland GmbH, Université catholique de Louvain (Belgium) and Technical University of Sofia (Bulgaria), the Aeronautical Research and Test Institute VZLU (Czech Republic), and the German Aerospace Center DLR, and a number of European high-tech SMEs.

Link: http://www.greenwake.org/

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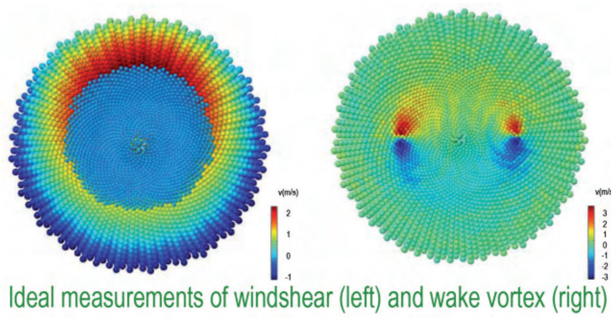
Figure 2: False colour representation of wind shear and wake vortex in front of a departing airplane.



International Workshop on Information Technology for Energy Applications

by Paulo Carreira and Vasco Amaral

The National Engineers Association in Lisbon, Portugal hosted the International Workshop on Information Technology for Energy Applications (IT4ENERGY 2012) organized in conjunction CITI and INESC-ID research laboratories held on September 6-7th, 2012 and sponsored by IEEE Portugal Section. This was the first event on the topic that counted more than 60 participants including senior researchers, PhD and Msc students as well as industry practitioners.

Information technology (IT) for energy applications is growing in relevance mostly due to the need of IT solutions to support the growing dynamics of energy markets as well as to an upsurge of interest in intelligent systems to optimize energy usage within homes, buildings as well as in commercial and industrial facilities. These IT tools will have the ability to (i) coordinate production with consumption in scenarios of demand variability, (ii) integrate and analyze data from multiple sources and (iii) assist users in the decision-making process as well as (iv) to intelligently manage equipment and devices on behalf of the user.

Developing IT for energy applications is a challenging multi-disciplinary effort that often requires bringing together distinct engineering disciplines (e.g., Civil, Mechanical, Electric and Computer Engineering) along with specialists from other fields such as Architecture and Management. We believe that Computer Science will play a critical role not only as a catalyst toward creating a homogeneous body of knowledge regarding information technology for Energy Management, but also as a vehicle for creating disruptive new solutions for energy problems. Therefore, this workshop aimed at bringing together specialists from academia with different backgrounds spanning Mechanical, Electrical Engineering as well as Computer Science; Industry experts active in the fields of Energy, IT, Building Automation and Facilities Management.

The event counted the attendance of the successful figure of 60 participants, nine high quality full papers (out of 20 submissions) and nine short papers. The first day of the event was dedicated to eight tutorial sessions, and the second day to research papers organized into four presentation sessions on the subjects of Smart Grids, Energy Consumption Profiling, Energy Data Management and Intelligent Load Control. In his keynote address entitled "Intelligent Scalable Monitoring and Control Technologies for Smart Micro-Grids and Grids", Professor G. Kumar Venayagamoorthy, a world renowned specialist in Smart Grids, highlighted the multi-disciplinary nature of his own research, which underscore the reason of this event.

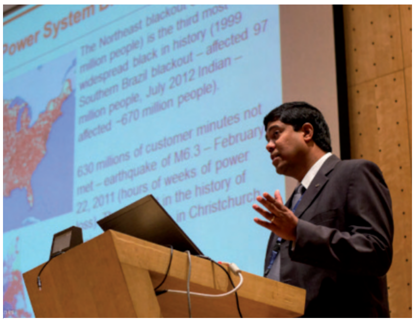


Figure 1: Professor Kumar Venayagamoorthy's keynote address

The papers presented covered a number of very important topics, namely: Software for energy applications; Data mining and decision support techniques for energy data; Models and techniques for energy consumption forecasting; Descriptions and characterizations of energy consumption patterns; Integration of energy data; Energy data visualization; Sensor networks, metering and energy data acquisition; Interoperability solutions including middleware and protocols for energy applications; Demand-side management; Home and building automation applications to energy; Energy-efficient control techniques; and Intelligent load control.

This workshop also aimed at establishing links between industry and academia. Therefore, researchers were invited to present and discuss the foreseeable impact of their work in ways that could be understood by industry participants. In turn, industry practitioners were invited to have demonstration stands displaying their solutions and to discuss relevant issues and collaboration opportunities with specialists. Moreover, student presenters had an opportunity to collect positive and constructive comments from a diversified panel.

The goal of this workshop was to establish itself as an impacting discussion forum on the topic of Information Technology for Energy Applications. An expanded and revised selection of the best papers is now being organized to be published as a post-proceedings volume.

Figure 2: One of the stands displaying ISA's Cloogy ®, a home energy management system

Links:
http://it4energy.com
http://www.inesc-id.pt
http://citi.di.fct.unl.pt
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ERCIM/EWICS/ Embedded (Cyber-Physical) Systems Workshop 2012

by Erwin Schoitsch

Following a tradition since 2006, the ERCIM Working Group on Dependable Embedded Systems and EWICS organized again a full day workshop during the annual SAFECOM conference.

SAFECOMP is nowadays an established international conference in the field of Computer Safety, Reliability and Security. The 31st International SAFECOMP Conference took place in Magdeburg, Germany, on 25-28 September, 2012. About 150 participants attended this year's conference. SAFECOMP has contributed to the progress of the state-of-the-art in dependable application of computers in safety-related and safety-critical systems since it was established in 1979 by EWICS TC7, the European Workshop on Industrial Computer Systems, TC7, Reliability, Safety and Security.

Partners from ERCIM, EWICS (European Workshop on Industrial Computer Systems Reliability, Safety and Security), from several EU-Framework and ARTEMIS (European Embedded Computing Systems Initiative) projects atttended the conference and the associated workshops, and reported on related subjects.

TheERCIM / EWICS / Embedded (Cyber-Physical) Systems Workshop workshop was jointly co-organised by the ARTEMIS projects MBAT (Combined Model-based Analysis and Testing of Embedded System), SafeCer (Safety Certification of Software-Intensive Systems with Reusable Components) and R3-COP (Resilient Reasoning Robotic Co-operating Systems). To be distinct from the SAFECOMP conference mainstream, the workshop accepted reports on "work in progress" aiming at fruitful discussions and experience exchange. Reports on European or national research projects (as part of the required dissemination) as well as industrial experience reports were welcome.

Workshop participants

Although there were five workshops and one tutorial in parallel, 18 registered and two partially attending participants listened to the Cyber-physical Systems Workshop and took part in the intensive discussions.

The workshp was composed of six sessions:
- Introduction: ERCIM, EWICS, ARTEMIS: Embedded Systems Safety, Security and European Strategy (providing an overview over ERCIM, EWICS, MBAT, SafeCer and R3-COP)
- Dependable Embedded Systems Applications
- Secure Systems – Systems Security
- Validation, Verification and Qualification
- Systems Safety and Trust
- Ambient Assisted Living.

Three embedded systems applications were presented in the first session of the workshop: one paper discussed the elaboration of safety requirements in the avionic domain (by EADS, an industrial paper), the second paper presented the ARTEMIS robotics/ autonomous systems research project R3-COP, focussing on the knowledge-based approach to compose robotic applications and tool chains for V&V from a collection of building blocks in ontology-driven data bases, which is considered as basis for a reference technology platform for robotics and autonomous systems, as developed by AIT Austrian Institute of Technology, DTI Danish Technology Institute, tecnalia Spain, TU Brno, Czech Republic and other R3-COP partners.

The session on system security included three presentations looking at different aspects of secure systems. "On the Design of Secure Time-Triggered Systems" focussed on a novel joint safety and security architecture for dependable time-triggered systems, adding the security aspects to the already well-studied and proven time-triggered system architecture (by AIT, TU Vienna, Austrian Academy of Sciences and TTTech).

Todays' and evolving cyber-physical systems (CPS) have as typical feature wide-spread distribution of nodes. In the presentation of the work of pSHIELD, another ARTEMIS project, by SESM (Italy) and the Polytechnic Institute of Coimbra (Portugal), an architecture framework was demonstrated supporting security, privacy and dependability as a built-in feature in a network of embedded nodes, improving also re-use of already verified embedded components and systems. The "Cyber-Physical Attacker", developed by Technical University of Denmark (DTU), models attacker scenarios addressing the peculiarities of a cyber-physical adversary, which allows the security properties of a CPS to be studied.

Validation, verification and qualification are issues of great importance when trying to prove trust in CPS. The NuSMV model checker is well known in the formal methods community. The first paper in this session presented an interesting extension to NuSMV, Parallel NuSMV, which was presented by ALES S.r.l. from Italy as part of the FormalSpecs Verifier Framework for the formal verification of complex embedded systems, using Simulink/ Stateflow models.

One of the ideas to considerably improve and speed up development of safety-critical embedded systems is the use of tool chains, which implies seamless integration of different tools to cover significant parts of the development life cycle. Safety standards require qualification of tools, but are not looking in-depth into the issue of integration of pre-qualified tools into tool-chains. The paper on "Automated Qualification of Tool Chain Design" from KTH (Sweden) presented a promising approach to reduce effort in qualifying tool chains by automatically analysing a tool chain model for safety issues acknowledging the MBAT project. The last paper of this session was on a model-based development approach for the design and validation of electronic control systems by simulation, using a Data Time Flow Simulator, developed by AIT in the context of the ARTEMIS project POLLUX which tackles problems on the design of the next generation of electric cars.

A topic always crucial in the context of safety-critical systems is how to achieve and prove trust in such systems. One issue in these systems is predictability, essentially in the time domain. Compiling for time predictability is one approach to generate code which has a predictable timing behaviour even in the case of complex processors. Within the T-CREST project, the University of Technology of Vienna and the University of Hertfordshire (and others) worked on HW/SW architectures and code-generation strategies to achieve time-predictability, explaining the single-path code generation process in their paper. In the NOR-STA project, the University of Gdansk addressed development, maintenance and assessment of structured, evidence-based arguments to support trust assurance in CPS, using the TRUST-IT methodology and presenting the adequate tool support in the NOR-STA platform of software services available on internet.

In the last session NTNU (Norwegian University of Technology) presented a third application and implementation: an experience with a low-cost AAL monitoring system to enable elderly people a longer and safer stay at home.

The SAFECOMP proceedings are published by SPRINGER in the LNCS series no. 7612.

Link: http://www-e.uni-magdeburg.de/safecomp/about-sc-2012/workshops/103-ercim-cps

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17th International Conference on Theory and Practice of Digital Libraries

Valletta, Malta, 22-26 September 2013

The International Conference on Theory and Practice of Digital Libraries (TPDL) constitutes a leading scientific forum on digital libraries that brings together researchers, developers, content providers and practitioners in the field of digital libraries. Started as "ECDL" in 1997, in conjunction with the activities of the ERCIM-coordinated DELOS Network of Excellence on Digital Libraries, TPDL has progressed and is now acknowledged as one of the state-of-art research conference not only in the field of digital libraries, but also in the fields of computer and information sciences.

Under the general theme "Sharing meaningful information", TPDL invites submissions for the proliferation of scientific and research osmosis in the categories "Full Papers", "Short Papers", "Posters" and "Demonstrations".

More information:
http://www.tpdl2013.info

Call For Papers

The International Conference on Network and Service Management (CNSM) is the premier annual conference of novel results and experience reports in all aspects of management of networks, pervasive systems, enterprise and cloud computing environments. It provides an excellent venue for presenting and discussing the latest innovations and developments. CNSM 2013 will take place in Zürich, Switzerland. The conference is organized around a single track of paper presentations where fundamental research results are discussed.
This core track is accompanied by series of workshops, tutorials and poster sessions where more focus discussions and progress reports are presented. CNSM invites academic, government, and industry researchers to submit papers to be presented in the core track of the conference. All areas of Network and Service management are welcome.

Topics of interest include but are not limited to:

General Management Issues
- Monitoring, correlation and diagnosis
- Performance management, fault management and reconfiguration
- Resource allocation and optimization
- IT services, business impact analysis and business process management
- Configuration and accounting
- Security, trust and privacy
- Energy management and optimization
- QoS management

Management Techniques and New Paradigms
- Self-Management and adaptation
- Economic models for management
- Policy-based and declarative models of management
- Virtualization
- Control theory and optimization
- Content centric networking
- Stochastic models and machine learning in management

Management and adaptation in
- Cyber-Physical Systems and Smart Cities
- Sensor networks, opportunistic and mobile ad-hoc networks
- Pervasive systems including Body Area Networks, Vehicular and Home Networks
- Cloud computing and Grid Environments
- Enterprise Systems and Federations
- SOA and Web services
- Multimedia and data services
- Data centers
- Social networks, cloud based applications

Network Management
- IP operations and management
- Broadband access networks
- Overlay and virtual networks
- Wireless and mobile networks
- Hybrid and next-generation networks
- Data Center Networks

Authors are invited to submit original contributions (written in English) in PDF format. Only original papers, not published or submitted for publication elsewhere can be submitted. Papers can be of two types: full or short papers. Submissions will be limited to 8 pages for full papers and 4 pages for short papers, in IEEE 2-column style. Papers exceeding these limits, multiple submissions, and self-plagiarized papers will be rejected without further review.

The workshops of CNSM 2013 invite researchers and practitioners to share and discuss their ongoing work, research and practical development experiences, and original results on specific new challenges and emerging trends in relation to the management of networks and services.

We welcome your contributions and look forward to your participation at CNSM 2013.

General Chair
Burkhard Stiller, University of Zürich, Switzerland

TPC Co-Chairs
Gabi Dreo Rodosek, Universität der Bundeswehr München, Germany
Metin Feridun, IBM Research - Zurich, Switzerland

Workshop Chair
Rui L. Aguiar, Universidade de Aveiro, Portugal

Important Dates

Paper Registration	**April 23, 2013**
Paper Submission	**April 30, 2013**
Acceptance Notification	July 15, 2013
Camera Ready Papers	August 15, 2013
Conference Dates	October 14-18, 2013

Latest ISTAG report identifies Software Technologies as the missing key enabling technology

The IST Advisory Group (ISTAG) - the advisory body to the European Commission in the field of Information and Communication Technology (ICT or IST) stresses in its latest report that “missing the strategic importance of software technology as a key enabling technology will lead to a significant drawback for global competitiveness.” The report mainly recommends: “A Strategic Agenda for Software Technologies in Europe should be created in cooperation with Industry, Academia and Public sector. The agenda should outline the strength from a European perspective and how we can renew and strengthen it. Common goals and needs in the short, medium and long term should be described. It should also describe what actions should be implemented to achieve these goals and needs and how we can, in a smarter way, make use of existing efforts, resources and facilities. The agenda should also draw up proposals on how the strategic work should be organized, run and quality assured”. The first version of this Agenda should be delivered before mid-2013.
The full report is available at: http://kwz.me/SD

“The Web We Live In”

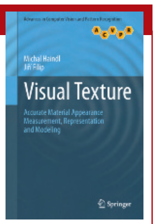
The last-of-the-year issue of the journal Computer Networks, entitled “The Web We Live In”, has just been published. The issue reprints the first two papers published on Google (written by Google’s founders in 1998), and has additional papers on the evolution of the Web and Web Science, a paper on economic aspects of the Web, comprehensive surveys on information privacy and social networks, a description of how the Web combines the virtual with the real, and what the Web has done for education. A paper on security raises the question: Do we already have more security technology than we are willing to live with?
http://www.sciencedirect.com/science/journal/13891286/56/18

Book

Michal Haindl, Jiří Filip

Visual Texture

Accurate Material Appearance Measurement, Representation and Modeling



This comprehensive book presents a survey of the state of the art in multidimensional, physically-correct visual texture modeling. It is the first book to provide a detailed treatment of texture synthesis covering all known aspects of the most advanced visual surface representation – the Bidirectional Texture Function. From basic principles and building upon the fundamentals to the latest advanced methods, the book brings together research from computer vision, pattern recognition, computer graphics, virtual and augmented reality. This book is intended for researchers, lecturers, students and practitioners.

Springer, Series: Advances in Computer Vision and Pattern Recognition, Hardcover 300 pages, ISBN 978-1-4471-4901-9

Marco Conti nominated Head of DIITET, a new department of CNR

Following a restructuring and streamlining of the Italian National Research Council (CNR), seven departments have been created to represent the main thematic areas of research. The departments are responsible for coordinating and promoting the scientific and technology transfer activities of CNR. DIITET will focus on the domains of manufacturing, ICT, energy and transportation and will supervise the activities of 22 institutes. The main objective of DIITET will be to promote interdisciplinary research in key sectors of the European digital agenda and Horizon 2020 with particular attention to the development of those technologies that will ensure secure cities and communities, smart energy and intelligent mobility and transportation systems. Areas of importance will include ICT, energy, advanced materials, sustainable mobility and advanced manufacturing and processing. Dr Conti is currently Head of the Ubiquitous Internet Lab of the CNR Institute for Informatics and Telematics (IIT). He has published widely in the fields of design modelling and performance evaluation of computer networks pervasive systems and social networks. He is Editor-in-Chief of Elsevier Computer Communications and Associate Editor-in-Chief of Elsevier Pervasive and Mobile Computing. He is the founder of successful conference and workshop series such as ACM RealMAN, IEEE AOC, ACM MobiOpp, and IFIP/IEEE SustainIT.

Informatics Europe offers Department Evaluation

Informatics Europe through the Department Evaluation initiative introduces a new service aimed at the assessment of research quality in the fields of Informatics, Computer Science and IT. The service is offered to Informatics Europe members and to all other Departments, Faculties, Schools and Research Institutes in Informatics, Computing, etc in Europe and beyond. It is characterized by an exclusive, peer-review driven evaluation process based on the standards and experiences of Informatics Europe.

On 20 November at the 2012 European Computer Science Summit, held in Barcelona, the first Research Evaluation Certificate was awarded to the Department of Informatics of the University of Zurich. The evaluation at the University of Zurich was performed in July by a committee of highly respected experts in the field, chaired by Prof. John Mylopoulos. The evaluation report and results were already presented and the outcomes and advices thoroughly discussed between the Department of Informatics of the University of Zurich and the Department Evaluation Committee of Informatics Europe.
http://www.informatics-europe.org/services/department-evaluation.html

ERCIM – the European Research Consortium for Informatics and Mathematics is an organisation dedicated to the advancement of European research and development, in information technology and applied mathematics. Its member institutions aim to foster collaborative work within the European research community and to increase co-operation with European industry.

ERCIM is the European Host of the World Wide Web Consortium.

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28 February 2013

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