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News Analysis

Consortium to develop smart local grid management SoC/SiP and infrastructure concept

By Bill Murray

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The energy saving benefits of the smart power supply grid are well documented. But what about the savings potential of smart *local* energy grids? How much energy can you save by managing and balancing local energy generation with local consumption? And how do you do it? The SmartCoDe project aims to use electronic system level (ESL) design and verification techniques to devise a system-on-chip (SoC) or system-in-package (SiP) design together with an operating infrastructure concept, which enables energy monitoring and control at the home appliance level – and at a price that consumers can afford. We ask the experts how. They are Professor Christoph Grimm (upper photo), chair of embedded systems at the Vienna University of Technology, and co-chair of the Open SystemC Initiative's analog/mixed-signal working group, and Peter Neumann, project manager at edacentrum.

SCDsource: First of all, what is a local energy grid?

Grimm: It is a grid of renewable energy supplies, energy storage systems, and consumers, both in a building and its environment. On the supply side, a building can obtain its power from both the main power grid and local wind turbines or photovoltaics. The energy is consumed by a very wide variety of appliances, such as lighting; heating, ventilation, air conditioning (HVAC); as well as kitchen, bathroom, and entertainment appliances. It can also be consumed by energy storage units such as electric car batteries.

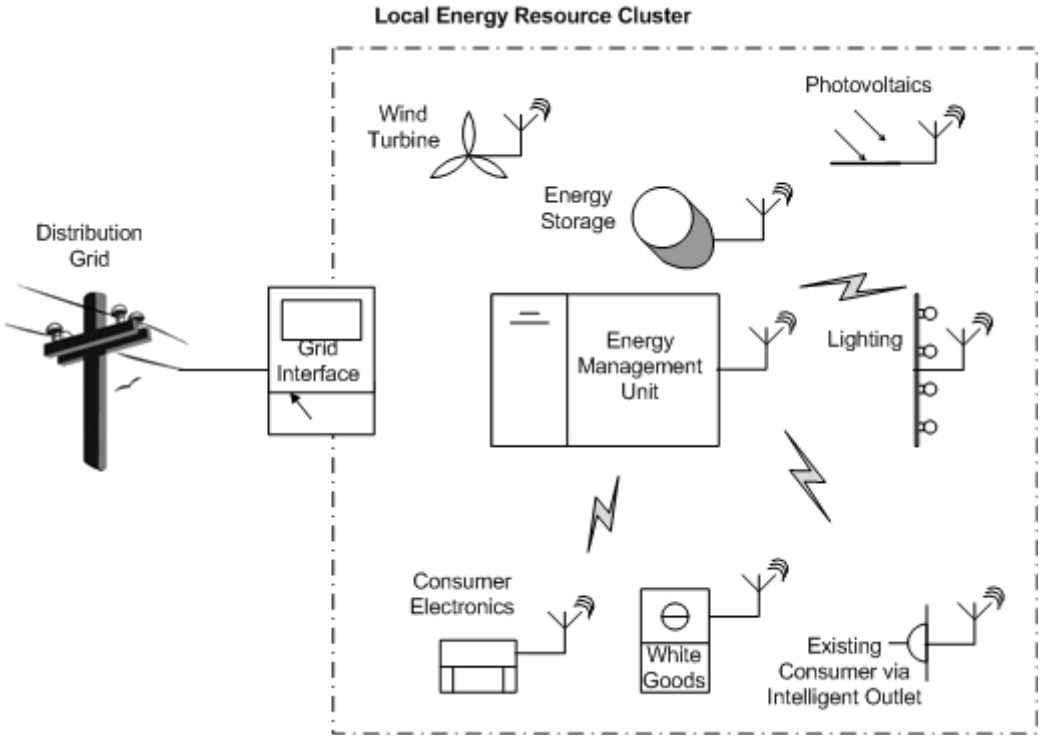

Figure 1: A smart building grid consists of renewable energy sources, storage systems, and consuming appliances

SCDsource: What's the problem that you want to solve?

Grimm: A major issue is that renewable energy supplies are unpredictable. With renewable energy contributing an increasing percentage of the total energy supply, it will become a challenge to keep the power grid both stable and cost-efficient. Smart energy management in buildings and their environments can mitigate this problem. However, using existing technology, the requisite infrastructure is expensive – existing "big iron" systems can achieve these savings cost-effectively only in single, high-consumption commercial sites.

SCDsource: So, how does SmartCoDe intend to solve this problem?

Neumann: It requires highly granular monitoring and control of both energy sources and consumer appliances to enable consumers to schedule energy use in a conservative and cost-effective manner. Cost is the key. Existing management systems run into hundreds of dollars per managed device, so only big energy producers and consumers can cost-justify them. Surveys show that home and office consumers would be willing to adopt the technology if the cost per managed devices falls below about $4.50. So, that's our goal.

SCDsource: And what are the potential energy savings?

Neumann: Smart management of this "neighborhood" grid could cut standby energy consumption by up to 10 percent, while residential demand side management could reduce it by up to 16 percent.

SCDsource: What will a SmartCoDe system look like and what will it do?

Grimm: SmartCoDe will be a small, inexpensive, integrated device that will be embedded in all kinds of appliances. It will have all of the features needed for energy management: power measurement, wireless communication, autonomous power supply for ultra-low standby, and the ability to control the

appliance via, for example, a simple serial interface.

Energy management itself will be performed by a central energy management unit that monitors the power grid, local renewable energy sources and storage systems. The unit will be able to monitor the power grid via the power frequency, or over the internet. This would enable grid operators to apply dynamic pricing policies based upon the availability of grid power. So, the energy management unit would use the SmartCoDe infrastructure to help consumers to schedule their power consumption, enabling them to reap the rewards of conservative energy use.

For the public grid, SmartCoDe could at least partially solve the problem of renewable sources' unpredictability of supply. Right now, we still need the public grid to guarantee supply. But if we could increase renewables' predictability – especially around the usual peak periods – it would allow local energy grids to participate in the energy market as both predictable energy consumers and reliable energy suppliers. We might even end up with energy-positive grids – a long-time dream of conservationists. Indeed, a region-wide array of local energy grids might even – one day – be a credible back up in the event of main power grid failure.

SCDsource: Could someone hack this network and turn my heater off?

Neumann: The system will have robust defenses against malicious attacks and intrusion. Data and command integrity and authenticity are top priority, followed by confidentiality and sophisticated access control. Consumers will accept nothing less.

SCDsource: So, what is the team going to deliver?

Grimm: We want to enable the development of both commercial products and an effective infrastructure. So, we will investigate and evaluate different architectures, and assess their relative technical and economic feasibility. The planned deliverables include:

- A toolkit for modeling and analyzing smart energy grids at various levels of abstraction, written in SystemC, a C++ class library. This includes functional models of a local energy grid consisting of energy-consuming units and a decentralized wind turbine.
- An executable specification and high-level architectural models of an integrated circuit. These will be open source to ensure device interoperability. Implementation is a matter for the device suppliers – it could be a system-on-chip or a system-in-package (SoC/SiP).
- A wind energy forecasting methodology

For validation and verification, we will integrate prototypes in a "living lab."

SCDsource: That's a wide range of expertise. Who's supplying it?

Neumann: There are eight partners in five countries. Ardaco works on secure data transmission and secure communication; ennovatis works on energy management systems; Infineon works on system integration and SoC/SiP; Quiet Revolution works on small-scale energy generation (wind turbines) energy forecasting; Tridonic works on lighting and building automation; the University of Novi Sad develops the energy management software; and Vienna Technical University is modeling and designing the wireless sensor network.

SCDsource: Could you expand on the kind of wireless technologies that are under consideration?

Grimm: We first studied power-line communication. However, wireless communication is much more dependable and less expensive. We will build upon the Zigbee physical and MAC layers as a foundation. However, we'll probably define our own profiles to meet the design goals, especially those concerning costs and information security / privacy.

SCDsource: Could you expand on the kind of sensors that will be used?

Grimm: That has yet to be determined. We are investigating and discussing different means, most notably to measure power consumption.

SCDsource: Who owns the resulting deliverables?

Neumann: The executable spec and high-level architecture of a SmartCoDe node will be public. The project's architectural implementation will remain confidential, but anyone in the public domain can verify their own architectural implementation against the executable spec. The project partner company that generates any particular IP owns it, but will supply it to other project partners under agreed conditions.

SCDsource: When will we see some tangible results?

Neumann: We will build the demonstrator - the Living Lab - at the ennovatis Vienna location in 2011/2012. The demonstrator will include prototype SmartCoDe nodes - probably as a PCB implementation - integrated in household appliances. In the second half of 2012, feedback from the demonstrator will be incorporated into the models, specs, and prototype to establish a stable architecture by the end of the project in 2013.

SCDsource: Many existing home appliances still have a long life expectancy. Can they be retrofitted?

Neumann: Yes. The consumer simply buys a new outlet equipped with the SmartCoDe device. The consumer can set the "identity" of the new outlet – for example, as a fridge – allowing the central management unit to recognize and manage it.

SCDsource: How do you expect deployment to occur: Market forces? Government subsidy? Government edict?

Neumann: It has to be market forces. At this stage, we cannot bet on government action. Maybe, as climate change policies become more solid, energy management systems might well become obligatory at some point. We're promoting market forces from the supply side by involving "associated partners" – partners not directly involved in the project – who will leverage our work to supply the infrastructure and the SmartCoDe device.

SCDsource: Who is funding this development?

Neumann: The European Union. It's an integral part of the EU's "20 by 2020" objective – 20 percent renewable energy by the year 2020.

Further Reading

Virtual platforms – a reality check, part 1

Virtual platforms – a reality check, part 2