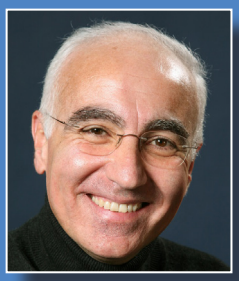

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SmartGrid

SMART GRIDS, SMART BUILDINGS AND SMART SENSORS FOR OPTIMIZED AND SECURE MANAGEMENT OF ELECTRICITY DISTRIBUTION USING DEDICATED MICROELECTRONIC ICS AND REAL TIME ICT

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What it's about…

Developing of new technologies dedicated to the real time monitoring and management of smart grids with validation in the EPFL campus

Context and project goals

The emerging concept of Smart grid is to be realized by renovating the existing power systems in a way that introduces intelligence in different levels of it. Part of this intelligence has to deal with a large demand for real-time and best decision-making. In order to keep the reliability of the power system and to improve its efficiency, the decision-making is essentially tied to the optimization of such system at different levels. Additionally, a solution to the optimization problem is of interest only if it meets stringent time frame demands dictated by the need of real-time operation of the smart-grid. A distributed intelligence system can cope with all these requirements: It is able to compute at each level of the hierarchy of the smart grid, from the large-scale bulk grid down to each individual building.

Nowadays, smart sensing is well integrated into power grids. However, the mass of data that need to be exchanged and managed is impressive. The amount of information to be processed grows due to the increasing number of controlled devices inserted into the grid. A large amount of data needs to be collected, analyzed simultaneously and results must be provided with strict time constraints.

These considerations lead to the idea that some of the major operation problems of distribution networks, such as voltage and power flow controls, can be solved in a distributed manner that helps to relieve the information-processing burden and enhance the system security while preventing critical events. In particular, new electronic integrated circuits can be used to run an emulation of a power system faster than real-time in a distributed configuration. The capability of evaluating different scenarios instantaneously enables a modification of the paradigm of the power system control and optimization. The additional analysis speed gained allows dealing with the growing needs for flexibility in greenenergy oriented grids.

In the frame of this project, it is proposed to create a new environment for an optimized and secure management of electricity distribution using dedicated mixed-mode microelectronic Integrated Circuits (ICs) and a real-time layer of Information and Communication Technology (ICT).

This new concept will make uses of the power systems (both medium- and low-voltage levels) of the EPFL campus as a test platform where the different research groups integrate their competences, cross-interact and deploy the technologies they developed. Indeed, the EPFL power system, characterized by a total number of 40 medium-to-low voltage substations, a maximum absorbed power of 30 MW, the presence of active power injections composed by 2MW photovoltaic panels installation integrated with a 6 MW combined heat and power generation units, represents a realistic 1:1 scale infrastructure with the strategic advantages of being framed within a research environment.

How it differentiates from similar projects in the field

This project is addressing the real time monitoring with dedicated electronics of the smart grid starting from the human needs using environmental sensors going through the optimization of buildings power consumption including the monitoring of the stability and the security of all the system at high level.

The human behavior observation is adding regulation parameters and can provide a new paradigm in the optimization in real time of power grid.

Quick summary of the project status

- Development of a phase measurement unit (PMU) prototype with a Phasor Data Concentrator (PDC). This functionality has been integrated within the PMU calibrator as well as into the real-time state estimator.
- IP based communication infrastructure for Smart Grid with Security architecture has been developed to transport PMU measurements to the state estimator. The entire network uses the IPv6 protocol.
- Development of enhanced linear Kalman Filte-SE processes integrating PMUs in quasi steady-state conditions.
- Faster than real time transient stability analysis of power network electronics emulation has been developed.
- Architecture of the smart building management platform has been designed and tested. This is done in order to integrate the demand side management of buildings within the active distribution network (ADN).
- Since May 2014, a preliminary version of the EPFL active distribution network (AND) process is successfully running.

Success stories

The paper “iPRP: Parallel Redundancy Protocol for IP Networks” by Miroslav Popovic, Maaz Mohiuddin, Dan-Cristian Tomozei and Jean-Yves Le Boudec won the best paper award on May 28, 2015 at the IEEE 11th World Conference on Factory Communication Systems (WCFS 2015). IEEE WFCS is the WFCS is the largest IEEE technical event specially dedicated to industrial communication systems. The team presented their work on providing reliability for real time streaming applications (as found in smart grids).

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“Smart Grid approach with human interaction”