High-speed Power System Emulation

L. Fabre, I. Nagel, R. Cherkaoui, M. Kayal
Electronics Laboratory and Power Systems Laboratory
Ecole Polytechnique Fédérale de Lausanne, Switzerland
laurent.fabre@epfl.ch, ira.nagel@epfl.ch

Abstract

The development from the twentieth century power grid towards smart grid is in progress. On the one hand power consumption has been steadily increasing and is still increasing, therefore the power grid operates always closer to its operating limits. And on the other hand the focus is put on renewable energy leading to a much more complex and less predictable power grid. Delivering energy from centralized power plants to a large number of users is not up to date anymore. Today's grid has to be able to route power in a more optimal way to respond to a very wide range of conditions to guarantee uninterrupted supply for everyone at every time. Of particular interest are thereby stability concerns (transient stability, voltage stability and frequency stability) of the transmission power system. Therefore it is essential to dispose of a high-speed power system dynamic simulator which enables online security assessment. High speed means that the simulator has to be able to reproduce power system phenomena much faster than their real-time duration. Existing simulators, which are nowadays used by power system operator, are based on numerical algorithms. Even if their precision is high, they are too slow to be used in the mentioned context.

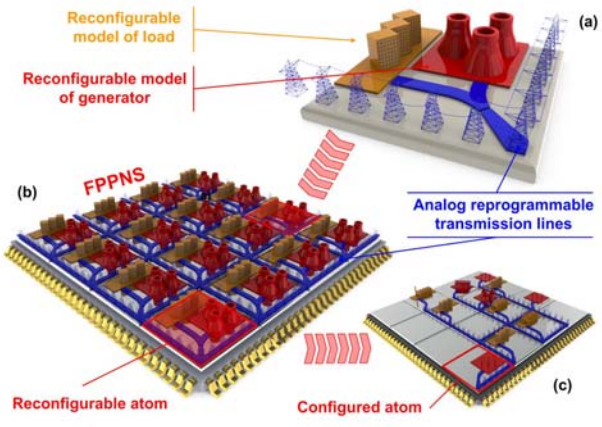

Figure 1 : Overall concept of power system emulation. The idea is to emulate the power system on a microelectronic chip. (a) Conceptional view of one reconfigurable power system node (=atom) (b) Array of 16 nodes (c) Programmed array of atoms to emulate the behavior of a specific power

Our poster presents two different approaches (Phasor emulation and AC emulation) both based on analog computation through power grid emulation to overcome speed limits of current simulators. The basic concept of such emulator is illustrated in Fig. 1. Different demonstrators have been developed in this research project. They are up to 10'000 times faster than real time and up to 100 power system nodes can be emulated.