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LINK – a radically new approach to smart grids

New LINK paradigm allows reliable and secure integration of decentralized generation on a large scale and offers a wide range of new business opportunities and technical solutions

The need for full integration of decentralized generation and renewable energy sources in power systems has been rising significantly for the last 15 to 20 years. Many efforts have been made to solve today's challenges, but not one of the popular concepts up to now (Virtual Power Plants, Microgrids) is able to overcome the full range of existing technical problems.

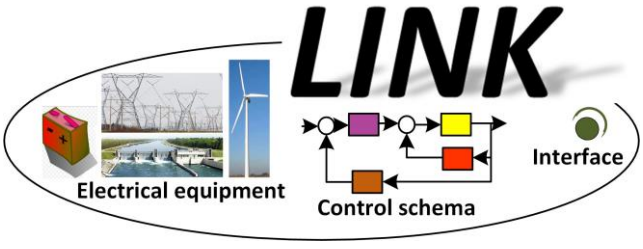
After 15 years and considerable amounts of money spent on research projects based on these concepts, the question arises: Are these concepts sufficiently broad to characterize the power system structures and the variety of smart grid operations correctly?

Objective

Dr. Albana Ilo of TU Wien, who has long-standing experience in the industry, decided to take a radically fresh look at power systems. Her aim was to define a new paradigm and to develop a new operation architecture, which would make it possible to build optimized smart grids at all voltage levels. The new approach has to cope with the full range of requirements – technological as well as trade, business and economy related ones – while taking into account the rigorous cyber security and privacy requirements for smart grids.

New solution

The secure, decentralized *LINK*-based architecture developed at TU Wien is based on the *LINK* paradigm. The *LINK*-paradigm makes it possible to comprehend the complexity of power systems and to model their operation processes.



Flat business model of the electricity industry

The LINK-paradigm includes a) electrical equipment – i.e. grid part, a storage and/or a producer device – further b) the controlling scheme and c) the *LINK*-interface.

This paradigm allows a new operation strategy for power systems. It supports the integration of decentralized generators while providing, at the same time, a reliable, secure and sustainable power system operation in normal as well as in emergency cases.

The new *LINK*-based architecture allows a flat business model across the electricity industry. It requires fewer approvals from authorities. This leads to faster decisions as well as to faster realization of technical and business solutions, thus permitting higher flexibility and a wider range of applications than today's possibilities. The distributed LINK-based architecture minimizes the amount of data, which needs to be exchanged. As a consequence, today's ICT challenges are bypassed and costs for IT-infrastructure are drastically reduced.

The new paradigm allows the design of a complete model of smart power systems, including decentrlized generation in customer plants – the so-called "Energy Supply Chain Net". The "Energy Supply Chain Net" can be understood as a set of

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automated power grids, which interconnect flexibly and reliably. *LINKs* or *LINK*-bundles (*LINK*/-bundles) operate independently from one another and have contractual arrangements with neighbouring *LINK*/-bundles.

Each LINK/-bundle is communicatively coupled with the other relevant LINK/-bundles via the usual communication instruments. Under specific conditions, each LINK can be detached, thus creating its own "Microgrid", which in turn can dock on to neighburing LINKs at any time.

For the first time, the use of secondary control as a sustainable, resilient, base interaction instrument has been suggested on a large scale throughout the different regions or portions of the grid. The *LINK*-based architecture allows the full description of all smart power systems operation processes, including load-frequency balance, voltage assessment, static security, angular and voltage stability, demand response.

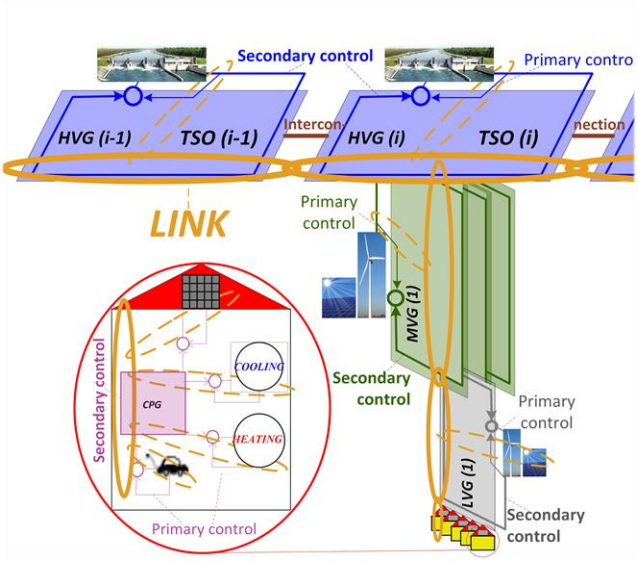
Proof of Concept

A *LINK*-architecture of reduced scope was successfully implemented and proofed in the field during the project ZUQDE (Central Volt/var Control in presence of decentralized generation), in Salzburg, Austria. Its application in the Lungau test region (≈ 400 km line length; maximal load ≈23 MW) achieved:

- Automatic voltage and reactive power control – via secondary and primary control
- Dynamic optimization of the medium voltage grid

Continuing this kind of operation beyond the project duration enables:

- 20% increase of decentralized generation without extension of infrastructure
- Reduction of direct costs for connecting decentralized generation to the grid by ≈ 2.6 mil. EUR



Overview of the "Energy Supply Chain Net"

Benefits

- Large scale integration of decentralized generation and storage options
- Secure, reliable and sustainable operation in normal as well as in emergency cases
- Drastic reduction of the exchanged data – i.e. thus bypassing today's ICT challenges
- Smooth and modular implementation
- Automatic control – thus Microgrid operation is possible
- Free development on the electricity market
- Compliance with high requirements of data privacy
- Containment of cyber attacks

References

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