



PMU Supported Frequency-Based Corrective Control of Future Power Systems

Preventing large-scale blackouts of the power system

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Partners

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This project has created a wide-area intelligent system that empowers the future power grids by providing system-wide measurements in real-time, quickly assessing system vulnerability, and performing timely remedial actions based on system-wide considerations. A new closed-loop coordinated corrective control scheme was designed. This scheme can be applied to mitigate frequency instabilities, cascading outages and catastrophic blackouts in existing and future power networks.

The new scheme is underpinned by three novel interdependent solutions.

- ✳ **An experimental simulation platform**
An experimental simulation platform has been developed for design and online validation of closed-loop control algorithms.
- ✳ **New sensor devices**
To improve system-wide grid observability, new sensor devices have been developed for a robust frequency estimation and novel measurement-based algorithms to improve system awareness.
- ✳ **Automated corrective control**
Automated corrective control is now an option as a result of this research project. This consists, for example, of controlled islanding and adaptive low frequency demand control supported by the optimal usage of existing generating resources and spinning reserve.

Read more

- 1 M. Naglič, M. Popov, M. van der Meijden, V. Terzija (2018), *Synchro-Measurement Application Development Framework: An IEEE Standard C37.118.2-2011 Supported MATLAB Library*, IEEE Transactions on Instrumentation and Measurement
- 2 I. Tyuryukanov, M. Popov, M. van der Meijden, V. Terzija (2018), *Discovering Clusters in Power Networks From Orthogonal Structure of Spectral Embedding*, IEEE Transactions on Power Systems
- 3 I. Tyuryukanov, A. Karagiannis, M. Popov, M. van der Meijden, V. Terzija (2018), *Generator grouping cutset determination based on tree construction and constrained spectral clustering*, The Journal of Engineering
- 4 M. Naglič, L. Liu, I. Tyuryukanov, M. Popov, M. van der Meijden, V. Terzija (2018), *Synchronized measurement technology supported AC and HVDC online disturbance detection*, Electric Power Systems Research
- 5 M. Naglič, I. Tyuryukanov, M. Popov, M. van der Meijden, V. Terzija (2016), *WAMPAC-ready platform for online evaluation of corrective control algorithms*, Proc. 10th Mediterranean Conference on Power Generation, Transmission, Distribution and Energy Conversion (MedPower 2016)

Insights & recommendations

- [1] It is important to online validate new corrective-control algorithms under realistic conditions in a safe and isolated simulation environment, before these are implemented into the actual grids.
- [2] The open-source available Synchro-measurement Application Development Framework fills the scientific gap between the IEEE Std. C37.118.2-2011 specifications and its implementation by proposing a novel robust communication technique and efficient synchro-measurement data parsing methodology. This enabled, for the first time, both online and simplified use of machine-readable synchro-measurements in a MATLAB programming environment.
- [3] The Phasor Measurement Units have been used for the first time to deliver HVDC time-synchronized measurements, enabling unprecedented grid observability.
- [4] For the first time, the research that was conducted relating to the Online Generator Slow-Coherency Identification has identified challenges related to the processing of actual Phasor Measurement Unit measurements for this purpose. A patent was granted for the innovative algorithm. Finally, the measurement dependent design and low-computational complexity of the implementation are unique properties, which make the algorithm ready for online use in advanced System Integrity Protection Schemes.
- [5] Identifying the optimal number of control zones in an electric power network is often a non-trivial task. The multiple tests with the developed network partitioning algorithms have confirmed that the properly determined control zone boundaries (and their total number) can lead to important insights into the power network and also to efficient wide-area control and protection architectures.
- [6] Solving the intentional controlled islanding problem in real-time requires a substantial computational power and likely an intelligent use of a combination of computational algorithms. Realistic power networks should be maximally reduced before attempting the solution.

