Talk Title: High Reporting Rate Measurements for Smart[er] Grids

Abstract: Modern control algorithms in the emerging power systems process information delivered mainly by distributed, synchronized measurement systems, and available in data streams with different reporting rates. Multiple measurement approaches are used: on one side, the existing time-aggregation of measurements are offered by currently deployed IEDs (SCADA framework), including smart meters and other emerging units; on the other side, the high-resolution waveform-based monitoring devices like phasor measurement units (PMUs) use high reporting rates (50 frames per second or higher) and can include fault-recorder functionality.

There are several applications where synchronized data received with high reporting rate has to be used together with aggregated data from measurement equipment having a lower reporting rate (complying with power quality data aggregation standards) and the accompanying question is how adequate are the energy transfer models in such cases. For example, state estimators need both types of measurements: the so-called "classical" one, adapted for a de facto steady-state paradigm of relevant quantities and the "modern" one, i.e. with fewer embedded assumptions on the variability of same quantities. Another example is given by emerging active distribution grids operation, which assumes higher variability of the energy transfer and consequently a new model approximation for its characteristic quantities (voltages, currents) is needed. Such a model is required not only in order to be able to correctly design future measurement systems but also for better assessing the quality of existing "classical" measurements, still in use for power quality improvement, voltage control, frequency control, network parameters' estimation etc.

The main constraint so far is put by the existing standards where several aggregation algorithms are recommended, with specific focus on the information compression. The further processing of rms values (already the output of a filtering algorithm) results in significant signal distortion.

Presently there is a gap between (i) the level of approximation used for modeling the current and voltage waveforms which is implicitly assumed by most of the measurement devices deployed in power systems and (ii) the capabilities and functionalities exhibited by the high fidelity, high accuracy and high number of potential reporting rates of the newly deployed synchronized measurement units.

The talk will address:

The measurement paradigm in power systems;

- System inertia, real time and steady-state
- Instrument transformers; limited knowledge on the infrastructure
- PQ, SCADA and PMUs
- Power system state estimation; WAMCS
- IEDs, PMUs, microPMUs
- Time-stamped versus synchronized measurements

Measurement channel quality and models for energy transfer

- Voltage and frequency variability; rate of change of frequency
- The steady-state signal and rapid voltage changes (RVC); rms-values reported with 100 frames/s;
- Measurement data aggregation; filtering properties
- Time- aggregation algorithms in the PQ framework
- Statistical approaches;

Applications and challenges

- Communication channel requirements; delay assessment in WAMCS
- Smart metering with high reporting rate (1s)

The presentation provides an overview of these techniques, with examples from worldwide measurement solutions for smart grids deployment.