ENG52: SmartGrids2
“Measurement Tools For Grid Stability and Quality Management”

M18 Workshop, 3rd February 2016.

Paul Wright, Project Coordinator.
Aim: “to develop, demonstrate and validate new measurement tools for network operational stability and power quality”.

Objectives:

**Early warning of Instability** – detect the onset of instability in areas of the grid—prevent cascading failures and blackout.

**A “life support monitor” for Smart Grids** - Phasor Measurement Units (PMU), to be used in multiple locations to manage stability.

**Power Quality (PQ) Disturbances** – assess grid impact - plan /defer new connections, reinforcement and mitigation.

**PQ Disturbance “radar”** – locate major sources of poor PQ for mitigation and enforcement.

**Grid topology and impedance** - analyse, plan and mitigate for instability, resonances and PQ disturbances.

**Transducers** – Accurate level transformation without disturbing the grid, essential for the PMUs measurement chain.
JRP Structure

18 Partners (3 REGS)
Achievements WP1: Power Quality Propagation

Challenges:
- How do PQ disturbances propagate through networks?
- Reconcile modelling with PMU/PQ measurements to understand attenuation & resonant characteristics.
- Develop a PQ disturbance location method A “PQ Radar”.

M18 Summary:
- Organised measurement campaigns in a variety (4) Smart Grids
- Identified data and Modelled grids, selected measurement sites.
- Obtain, calibrate and Install instrumentation and transducers.
- Write data collection and analysis software.
## Challenges

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<tr>
<th>Challenges</th>
<th>M18 Summary</th>
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<tr>
<td>Confidence</td>
<td>• Develop a PMU calibrator.</td>
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<td>• how do we know PMUs are right?</td>
<td>• 10X improvement on state-of-art.</td>
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<td>• Interoperability between vendors?</td>
<td>• On-site calibrations against “gold standard” PMU, Reference PMU development in progress.</td>
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<td>• Commercial PMU calibrators need calibrations…</td>
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<td>Dynamic signals in real networks (varying amplitude and phase signals)</td>
<td>• New algorithms (reviewed implemented and compared).</td>
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<td>Can PMU be used in distribution networks ?</td>
<td>• Improve algorithm immunity to power quality disturbances.</td>
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<td>• Better phase sensitivity for more localized use (calibrator phase)</td>
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Achievements WP3: Network Impedance

Challenges:

- Multiple PMUs to measure impedance on sections of network.
- Extend to harmonic frequencies.
- Application to harmonic mitigation, improved planning and dynamic rating.
- Relate line resistance to temperature – Dynamic rating

M18 Summary:

- New algorithms developed tested for impedance measurement.
- Tested in in simulation and using lab transmission line setup.
Achievements WP4: Transducers

**Challenges:**
- Transducers (VT/CT) are the source of biggest error in the PMU,
- They have a complex frequency response that causes waveform distortion.
- It is rarely possible to remove and characterise CT/VTs.

**M18 Summary:**
- Split-core rigid and flexible Rogowski coils have now been characterised, assessing their performances before start of the optimisation phase,
- The first complex frequency characterisation at rated voltage (up to $20/\sqrt{3}$ kV) of commercial measurement VTs up to the 50th harmonic.
- Developed a real-time compensation method for VT using a digital filter.
- A software model for the analysis of uncertainty propagation in the PMU measurement chain.
Impact of The JRP

- The impact of the electricity supply system has an extremely high economic and societal impact (everything fundamentally depends on it!).
- RES will have a profound effect on the integrity of this supply and political factors threaten its security.

Realisation of Impact in this JRP

- 33 Stakeholders support this JRP, 13 actively collaborating.
- High Profile smart grid test sites including the Alliander LiveLab, Bornholm Smart Island and EDFs new Concept Smart Grid.
- Measurements campaigns (at least 7) working with network engineers *the best route to dissemination*.
- Normative Standards engagement through 14 inputs to standards activities.
- 26 Publications, 19 Conferences at M18
Summary

Smart grids are essential to manage this future electricity system and the tools and techniques developed in this JRP will be an essential contribution.