Improving Actionable Observability of Large Distribution Networks for Transmission Operators to Support Improved System Control, Fault Detection & Mitigation (1199)

Introduction

PMUs in transmission networks have improved visibility; enhancing grid stability and avoiding low probability events such as blackouts.

For many TSOs there is minimal visibility of the real-time state of distribution networks. With increased penetration of DER on lower voltage networks there is a need to simulate, analyse, and understand the impact to the overall network.

Communication Technologies

Distribution network communications links are over public networks. Installation of microPMUs (µPMUs) must deal with a number of issues when using these:

- Reduced and unpredictable bandwidth and latency
- Restrictions in cumulative transmission of data
- Use of insecure public communications network
- Lack of control if a network fails

Secure Communications

A VPN can be configured to allow a µPMU to communicate directly with systems in the DNO's internal network. There are security issues where a physically unsecured device has a trusted connection into an internal corporate network.

A µPMU can communicate with a cloud system that stores the data and shares it with authorised parties. This means that users within a secure network are only 'pulling' from the cloud server.

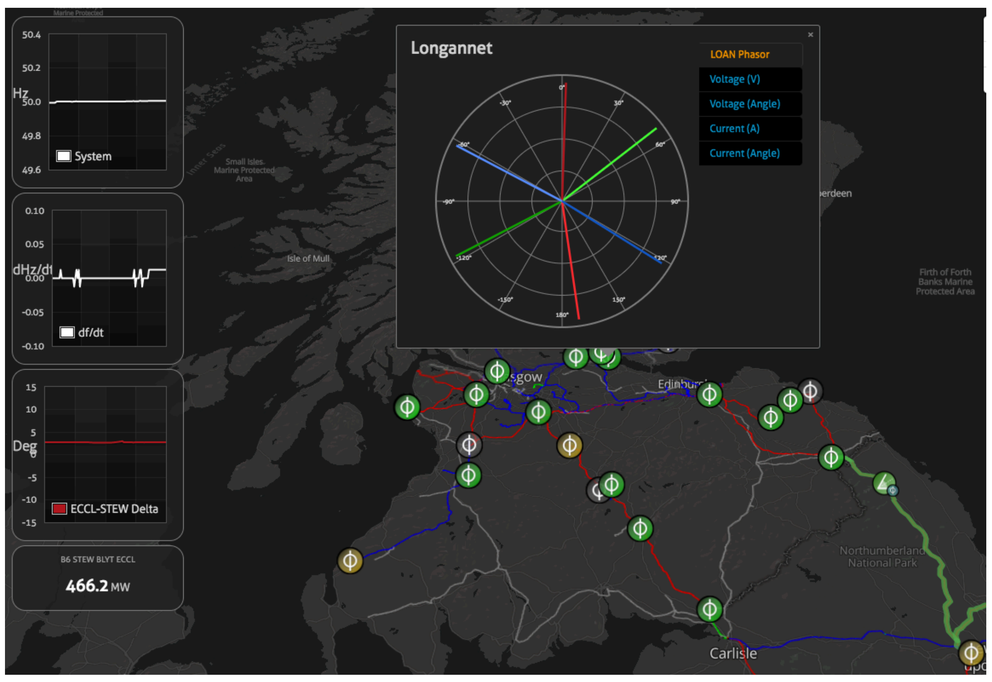

Figure 1: Real Time Visualisation of Wide Area Monitoring

µPMU Synchronisation/Triggers

Where µPMUs are operating in low bandwidth environments it is not feasible to provide full data. Instead they would reduce the synchronisation frequency unless triggered.

Localised triggers can be set based on the µPMU's position on the network with pre-defined metrics:

- Rate of change of frequency is exceeded
- Change in magnitude or angle outwith a defined maximum/minimum
- Change in calculated impedance across a line
- An alarming trend of changing voltage over time

Transmission WAMS incorporate wide area synchronised phasor measurements which provide unparalleled monitoring and understanding of the dynamic behaviour of large electrical systems.
VISOR (an NIC project) is focussing on these key areas:

- Real time monitoring
- Dynamic model validation
- Hybrid state estimation

Current GB WAMS bring together data from the three GB transmission owners and the GB system operator focussing on:

- Management of system risks & events
- Reducing uncertainty
- Maximising Assets

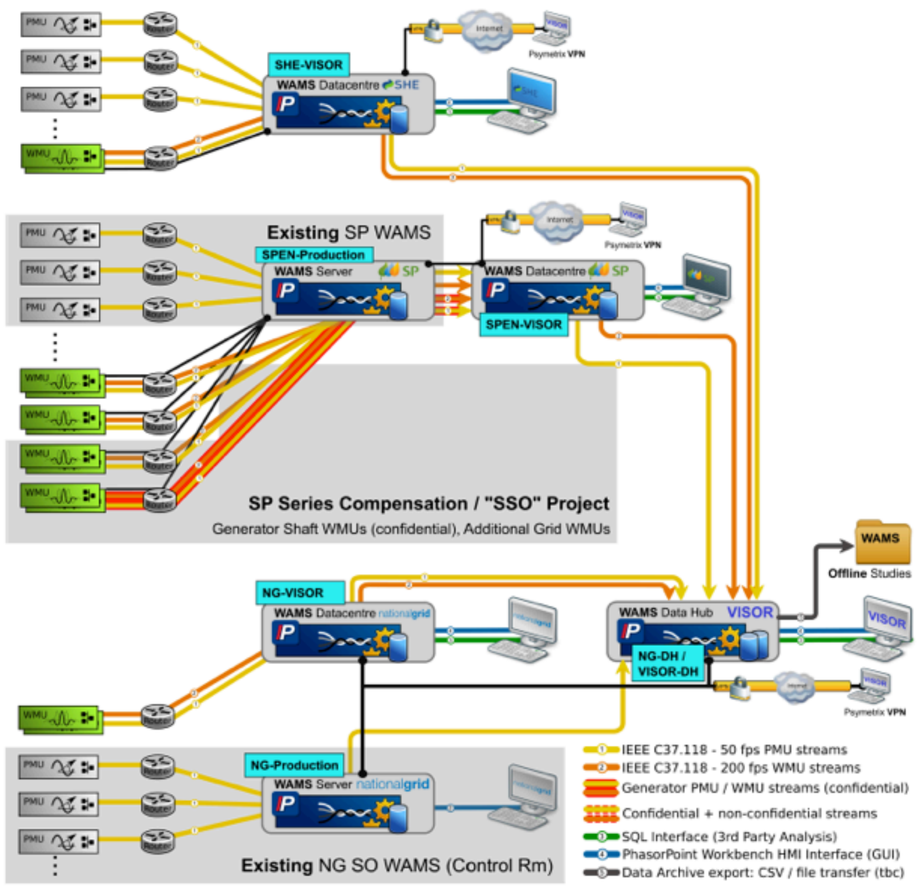

Figure 2: Critical Infrastructure of the GB transmission WAMS

Applications of µPMUs

- State estimation and enhanced visibility
- Characterisation of loads and distributed generation
- Microgrid synchronisation
- Diagnosis of potentially problematic conditions such as oscillations or FIDVR
- Cybersecurity of power distribution grid equipment

Extending WAMS to Distribution would be an ideal scenario where enhanced modelling capabilities will include WAMS at all voltage levels, and computing should be able to safely enable system services, transfer power and enable the operator to utilise the existing system to its maximum capacity.

Conclusions

Event triggering of µPMUs is a viable option to reduce the synchronisation frequency of data to regular intervals unless triggered by configurable metrics.

Future Work

- What is an acceptable trigger?
- How effectively can a network of devices be synchronised?
- Integration of µPMUs within a WAMS distribution network

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