Phasor Data Applications

Professor Robin MacLaren
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Global Activities

Focus on real Business Benefits

2006 Iceland: PSS tuning, Generator commissioning

2009 Energinet.dk: WAMS / EMS integration (4800 phasors)

2010 Mexico: Stability of international interconnection

2009 Colombia: Frequency stability, governor tuning

1995 Scottish Power: first installation, constraint relief

2007 UK consortium: Renewable connection

2000 Powerlink: Synchronising Queensland / New South Wales & constraint relief

2010 South Africa: WAMS Stability, Situational Awareness
The PhasorPoint Framework
**Basic Applications**

- Voltage, Phase Angle and Frequency
- Active/Reactive Power and Symmetrical Components
- Disturbances

**Advanced Applications**

- Islanding, Resynchronisation and Blackstart
- Oscillatory Stability
- Voltage Stability
- Line Parameters and Thermal Rating
- Generator Modelling and Test
- Angle Constraint Active Management
High Availability & Redundancy (Active-Active configuration)
Application Examples
Australia
- Control-room monitoring & alarming
- Oscillation constraint relief
- Avoiding system separation
- Commissioning (e.g. QNI & other interconnectors)

Separation avoided, 10 April 2004

Raw Data
- Power (MW)

Decay Time (sec)

0.6Hz Mode
- 1% damping
- 3% damping

Capacity available provided measured damping acceptable
Iceland
Landsnet, Iceland

- Oscillations & PSS Tuning
- Governor stability
- Disturbance analysis
- Islanding & Resynchronisation
- In progress - Wide Area Defense
Mode Power Path
- Identify contributions from regions
- Uses only PMU data
- All region boundaries monitored
- “Regions” can be any size

1. Select regional contribution
2. Identify local contribution
3. Action guidelines
Leading utility in sustainable supplies
- High penetration wind power (20% energy now, 50% by 2025) + CHP
- Predictability / controllability, frequency stability and voltage issues
- Connection to N. Germany increasingly wind-dependent
- Exposure to external disturbances – capability to run 60kV islands

WAMS system characteristics
- Large WAMS system (4800 phasors) in place and operational
- Local and European system visibility
- Asynchronous systems – Scandinavia and Central Europe
- Transmission and distribution PMUs
- Oscillatory Stability and Mode Power Path
Europe
PhasorPoint Open Interface

- Access to historic data making use of WAMS configuration
- Optimised for time-series data
- Standard access for reporting & analysis, e.g. Excel, Matlab, R, NumPy, etc.

EXAMPLE QUERY:
```sql
SELECT * FROM pmu_1_10 WHERE ts >= '2010-07-21 00:00:00' AND ts < '2010-07-21 01:00:00'
```

Other interfaces Include
- Web services (e.g. ALSTOM EMS)
Pilot project complete, next stage 99 PMU system

Key features
- Flexible user configurable displays (e.g. wallboard)
- Flexible alarms (level, ROC, composite) & notification (via EMS)
- Oscillatory stability
- Disturbance capture & analysis
- High availability

Exploring new application areas e.g.
- Constraining by angle
- Bush fire alerts

0.05Hz Common Mode

0.3Hz SAPP Mode

0.7Hz Interarea Mode
High Availability & Redundancy (Active-Active configuration)
Colombia
XM, Colombia

- Identifying & resolving frequency instability
- Governor testing & tuning
- Islanding, Resynchronisation & Blackstart
- Control room warning/response
- Project partners for S. America
- Planned
  - Generator Modelling & Test tools
  - Wide Area Defence Scheme

![System Frequency Graph](image)

- 61Hz
- 60Hz
- 59Hz
- Cycle 15 sec
- 22 Minutes

**WAMS FOR DIAGNOSIS & OPERATIONAL MONITORING**
Governor mode: whole system oscillates in coherent phase

Governor controller tests: Sensitivity of mode damping/amplitude to governor parameter changes
Confirmed power output in response to 0.06Hz frequency oscillations as intended.

Mode Amplitude vs. Mode Decay Time Constant

Larger amplitude, poorer damping before tuning

Lower amplitude, better damping after tuning

6-week system observation
Confirmed damping / amplitude of 0.06Hz improved in long-term system observations
The UK
Transition to high penetration renewables
- Transmission
- Distribution

Issues
- Frequency stability
- Islanding
- Oscillations
- Modelling
- Distributed control / Smart Grid

Disturbance recorders as data source
- 300 units in SP network
- Testing

Strategic Reinforcements

Omnicon + synchroniser
Qualitrol IDM+LSU
PhasorPoint

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Our experience:-

• Widening deployment of Phasor Measurement Systems throughout the world

• Measurable Business Benefits, Measurable Customer Benefits delivered.

  • Operational Environment
    • Operator Assistance
    • Real Time Measurement
    • Real Time Control Applications
      • Manual Intervention
      • Automatic – In the next year

  • Design Environment
    • Analysis Improvement and Validation
    • Historical Records and Post Event Analysis
PROVEN SOLUTIONS FOR STABILITY, SECURITY & CONSTRAINT RELIEF

Robin MacLaren
robin.maclaren@psymetrix.com
+44 131 510 0704
www.psymetrix.com