Our Vision for Oscillatory Stability Monitoring and Assessment

PMU *measurement-based* methods

**Oscillatory Stability Monitoring in real-time:**
- Track current damping levels
- Detect & alarm stability risks & sudden events

**SynchroPhasor Applications**

**Dynamic Security Assessment**

*Model-based* techniques (Powertech’s SSAT)
provide the *predictive component* (i.e. ‘what-if’ analysis)
- Available MW transfer capability (‘distance’ to the edge)
- Assess impact of critical contingencies. (e.g. change in damping)
- Recommend controls based on sensitivity information.

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Combined Measurement- & Model-based Approach for Model Validation

0.6Hz mode record including PSS test

**Measured**

**Modelled**
Simultaneous multi-oscillation detection and characterisation direct from measurements

Measured P / f / δ

Mode Frequency

Mode decay time Exp(-t/τ)

Mode Amplitude

Mode Phase

Fast Modal Analysis: Alarms

Trend Modal Analysis: Analysis

Operations

Early warning of poor damping (two level alarms)

Unlimited oscillation frequency sub-bands

Individual alarm profiles for each sub-band

For each oscillation detected, alarm on:
mode damping and/or
mode amplitude for

Planning & Analysis, Plant Performance

Post-event analysis

Dynamic performance baselining

Dynamic model validation

Damping controller performance assessment

Wide area mode alarms
Mode locus plot with alarm thresholds

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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
PhasorPoint in Operations

Success Stories
Global Activities

- **2009 Energinet.dk**: WAMS / EMS integration (4800 phasors)
- **2006 Iceland**: PSS tuning, Generator commissioning
- **2009 Colombia**: Frequency stability, governor tuning
- **2007 UK consortium**: Renewable connection
- **2009 Energinet.dk**: WAMS / EMS integration (4800 phasors)
- **2010 Mexico**: Stability of international interconnection
- **1995 Scottish Power**: first installation, constraint relief
- **2000 Powerlink**: Synchronising Queensland / New South Wales & constraint relief
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Eskom, South Africa - 2009

Pilot project complete, next stage 4200 phasor 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

» Local Modes (various)

» 0.05Hz Common Mode

» 0.3Hz SAPP Mode

» 0.7Hz Interarea Mode
Landsnet, Iceland 2007

Oscillations & PSS Tuning

Governor stability

- Before PSS tuning
- After PSS tuning

» 0.8Hz Mode

- Mode Decay Time Constant (sec)
- Improving performance
Iceland - 2007
PSS Tuning & Dynamic Model Validation

1. Observe
2. Model
3. PSS Design
4. Testing & Commissioning
5. Operation

Before PSS tuning
After PSS tuning

0.8Hz Mode

Improving performance

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XM, Colombia - 2009

Identifying & resolving frequency instability

Governor testing & tuning

Islanding, Resynchronisation & Blackstart

Control room warning/response

» WAMS FOR DIAGNOSIS
» & OPERATIONAL MONITORING

» 61 Hz
» System
» Frequency

» 60 Hz
» Cycle 15 sec

» 22 Minutes
Inter-area mode at 0.49Hz (Colombia-Ecuador). Opposing phase in South

Governor common-mode: whole system oscillates in coherent phase
Powerlink Australia - 2000
Transfer Constraint Relief

- Power Transfer (MW)
  - Time (sec)

Available Transfer Capacity (MW)
- Thermal Limit
- Transient / Voltage Stability Limits
- True Damping Limit
- Model Damping Limit
- Model Damping Limit with Margin

Capacity available provided measured damping is acceptable

Applied in Australia & UK
+300MW

Australia
Queensland – NSW Interconnector

+300MW

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Baselining for Assessment and Issue identification

**Assessment: Dynamic Performance Reporting**

**Oscillatory Stability**
Mode Behaviour, Band 3 (0.20-0.30 Hz)

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**Issue Identification: Governor Stability**

Governor mode: whole system oscillates in coherent phase

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**Characteristic behaviour pattern**

Evening peaks in mode amplitude
Small Signal Stability within e-terrawision – Sample Display

Modes shapes, amplitudes, damping, frequency, etc

Real-time alerts on poorly damped oscillations

Track oscillatory stability in real-time.

Identify regions where inter-area oscillations are observable
Contact Info:
Jay Giri – jay.giri@alstom.com
Manu Parashar – manu.parashar@alstom.com
Douglas Wilson – douglas.wilson@psymetrix.com