The power industry is experiencing a fundamental change in the way it is managed and controlled. Increasing energy demand, restricted transmission grid expansion, and increasing volatility due to more renewable and distributed generation all add complexity across the electricity network. At the same time, transmission owners and ISOs have a constant responsibility to balance the costs incurred by operational constraints against grid reliability and the risks of major blackouts. Such constraints traditionally come from off-line planning studies, and tend to be static and overly conservative to accommodate a wide range of conceivable operating conditions and system contingencies, as well as unforeseen situations. For this reason, the transmission assets often remain underutilized.

Fortunately, new technologies such as Wide Area Monitoring Systems (WAMS) and Phasor Measurement Units (PMUs), along with high performance computer processors, and advanced visualization platforms are all part of the emerging transmission information system. PMU instrumentation dramatically changes how grid conditions are monitored, producing precisely time-stamped and high-resolution measurements that are capable of observing and assessing dynamic issues as they evolve.

Alstom’s Grid Stability Package builds on its e-terra 3.0 suite and expands on the traditional SCADA-based energy management with a faster, more dynamic and proactive grid stability management approach. By transforming instantaneous synchrophasor measurements into valuable information through real-time “measurement-based” analytics, and combining them with “model-based” predictive visibility, it provides advanced decision support tools to better assess grid reliability and maximize transfer capacity. This gives grid operators an holistic and accurate view of current grid status, better intelligence to understand, predict and mitigate potential developing events, and unmatched historical data quality for better offline post-event analysis, model tuning and power system control.
Key Features

Alstom’s Grid Stability Package, our THREEFOLD approach to grid stability management, transverses the conventional utility functions of operations, planning and protection.

Customer benefits:
The customer benefits of this approach include:

- Avoiding blackouts via early detection of disturbances, quick grid vulnerability assessment, and overall assistance with system restoration.
- Tackle uncertainties associated with renewables and Distributed Generation (DG) with true dynamic situational awareness.
- Maximize transfer capacity for optimal grid utilization with real-time dynamic stability limits.
- Perform more accurate offline post-mortem analysis and dynamic model validation by leveraging time-synchronized, high-fidelity PMU measurements.
- Improve design and tuning of control systems through better diagnostics and system tests.
- Enhanced integration capabilities across the e-terra 3.0 suite.

Oscillatory Stability Management and Analysis

The high-resolution PMU measurements offer visibility into grid dynamics and oscillations, not available with SCADA. In real-time, e-terra phasorpoint’s Oscillatory Stability Monitoring (OSM) application uses this data to characterize the stability of the observable oscillatory modes, while its innovative source location feature is capable of identifying locational contributions and the sources of damping changes, thereby providing corrective guidance for improving stability to grid operators. Offline, e-terra phasoranalytics can utilize PMU data for post mortem analysis to assess dynamic performance during grid disturbances, and in conjunction with the model-based DSA tools, validate the dynamic simulation models.

Case Studies & Customer Success Stories

Some of its key features include:

- Combining real-time SCADA and PMU data and analytics.
- Complementing the PMU measurement-based analytics with the “what-if” predictive capabilities of EMS model-based network applications and dynamic stability assessment tools.
- Unified visualization providing rich situational awareness.
- Offline engineering analytics leveraging PMU data alongside SCADA/EMS data and power system simulation results.
- A flexible PMU-based WAMS platform for implementing wide-area protection and control schemes.
The Grid Stability Package is comprised of the following products:

**PMU MEASUREMENT-BASED Assessment**

- Real-time PMU measurement-based analytics for stability monitoring.
  - e-terra phasorpoint

- Offline engineering analysis workflow and toolset.
  - e-terra phasoranalytics

- Platform for wide-area protection and control.
  - PhasorPoint Controller

- Integrated measurement and model-based decision support tools.
  - Grid Stability Assessment (GSA)

- Model-based stability assessment engine for predictive analysis.
  - Dynamic Security Assessment (DSA) Tools

- Unified situational awareness for enhanced situational awareness.
  - e-terra vision

**EMS MODEL-BASED Assessment**

**Dynamic Stability Limits and Alarms**

With the large-scale implementation of PMUs worldwide, wide-area angular separation monitoring is being regarded as more direct indicator of grid stress than the traditional corridor MW flows. This is because impedance changes, due to line trips (which weaken the transmission grid), are reflected in angular separation indicators which may otherwise not be detectable by the traditional method.

The use of real-time PMU measurement-based angular separation monitoring alongside model-based dynamic stability limits, is functionality inherent within the Grid Stability Package providing a complete and automated solution for managing grid reliability in the control room, unleashing the available latent capacity across transmission corridors.

**Enhanced Islanding Management/Efficient System Restoration**

e-terra phasorpoint’s PMU measurement-based Islanding, Resynchronization and Blackstart (IRB) application can quickly detect and alarm on an islanding condition, while the fast model-based topology processing capabilities within the EMS validate the boundaries of the separated regions and provides useful information on generation/load resources within each island to better manage the islanded regions. Collectively, these are valuable aids for grid operators during the re-synchronization process to ensure a successful re-closure, minimizing the overall restoration time.
Power System Stabilizer (PSS) Tuning

Alstom was recently involved in a PSS tuning exercise, where a range of controller designs were tested in various network configurations. While e-terra phasorpoint’s WAMS infrastructure provided measurements that formed the basis of a rigorous testing procedure comparing system dynamic performance before and after PSS tuning, e-terra phasoranalytics offline analysis capabilities compared the damping and relative phase of oscillations for an array of network switching scenarios with and without the PSS activated. The results of the tuning exercise showed a positive contribution for a range of system oscillations without any degradation in system stability.

Integrated Training Environment

Pacific Gas & Electric (PG&E) is deploying first-of-a-kind integrated training environment that utilizes a transient stability engine to drive the synchrophasor analytics alongside traditional EMS functions such as state estimation and contingency analysis. A key benefit of this configuration is the ability to create "what-if" scenarios for training purposes on synchrophasor applications preparing operators for real world situations.

Phasor-based Wide Area Control Schemes

A number of wide area control schemes related to the 132kV ring system within the Icelandic power system have been deployed. These are intended to not only avoid system separation across its two main ‘Eastern’ and ‘Western’ centers of inertia whenever possible, but also to improve the ability for islands to be created and sustained, thus improving the security of supply.

These schemes include:

- **Eastern Islanding Scheme**, where 5x 110MW generators are isolated with the smelter potline load, to improve continuity of supply to the smelter during grid disturbances, and also reducing the inertia connected in the ‘East’ to avoid further system splitting.

- **Eastern Iceland Load Shedding**, where rapid increases in eastward power flow are compensated by the wide area control action of eastern factory load shedding.

- **Eastern Iceland Smelter Load Control**, where wide-area PMU measurements are used to initiate a controlled load reduction.