Key Industry Drivers

Fast Renewable Integration

✓ Need for higher resolution visibility and faster agility to monitor and manage the grid
✓ Greater and regional variability in frequency (due to reduced/sparse inertia)
✓ Grid operating closer to its stability limits (frequency and voltage)

Accelerated Adoption of WAMS sensors

✓ Customer field installations growing from 100s→1000s (e.g. ONS, Brazil 1000+; PowerGrid, India 2500+)
✓ Multifunctional IEDs (such as Relays & Fault Records) capable of providing WAMS data.

Future-Proof Scalable High Performance Integrated

✓ Scale to manage the torrent of data
✓ Composable, bring together views, functions and data that may not be traditionally combined
✓ Cloud-native, on-prem and hybrid
✓ Ready to be integrated to Energy Management and Distribution Management Systems

Source: Net Zero by 2050 International Energy Agency
Digital Energy

Smaller Total Cost of Ownership

• Leverages Continuous Integration & Continuous Deployment
• Full Test Automation

Just the right bits

• Natively modular solution

Future proof

• Cluster based. Vertical and Horizontally scalable
• On-Prem; Hybrid or Cloud. Your choice
Digital Energy

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User Interfaces and Experience

Reusable components across use-cases
Consistent and uniform experience
Optimized workflows
Solution Highlights

Comply with NERC IRG008-2 R4 and TOP-001-4 R13 as back-up to existing EMS State Estimation.

Tertiary real-time assessment solution
Leveraging WAMS Independent of data from EMS
Solves at incoming WAMS data rate; built-in error processing to ensure solution robustness
Extends WAMS observability beyond existing infrastructure
Detect and correct for erroneous/missing WAMS data
Modular, IEC CIM based, state of the art UI/UX cybersecure, HA, interoperable

Linear State Estimator
Oscillation Stability Management

- Governor Frequency Control
- Rotor Angle Stability
- Reducing system inertia
- Area inertia effects
- Reducing synchronous generator PSS
- Control Modes
- Sub-Synchronous Oscillation
- Resonances: Series Capacitor–Shafts – VSC/HVDC
- Reducing System Strength

What’s New in OSM:
- Extended Frequency Range for Oscillation monitoring (up to 46Hz/54Hz)
- Oscillatory Monitoring also extending to Voltage and MVAR measurements
- Oscillation Source Location to identify source of Oscillation.

2021 IEEE NASPI Oscillation Source Location Contest - GE 1st Place Winner!
A Worldwide Contest! - 60+ teams registered
Effective Inertia

**Outcome**
- Enable higher penetration of low inertia renewable generation
- Reduce curtailment fees and penalties
- Lower frequency response services
- Increase network resilience; minimize risk of system separation

**Effective Inertia**
- Nonintrusive metering of “effective” inertia
- No expensive hardware required; leverages existing WAMS investment
- Regional and global real-time inertia measurements
- Inertia forecast from AI/ML analytics
- EMS and PMU/PDC agnostic

**Inertia Measurement and Forecast**
Dynamic Parameter Estimation

Challenges:

- **Inaccurate Dynamic & IBR Models** leading to inability to predict grid conditions.
- **Small Disturbance Testing not Sufficient** as this does not capture the large disturbance behavior.

**Solution Highlights**

A Non-Invasive & Data-Driven Approach that is:

- Cost-effective method for TOs and GOs to satisfy NERC Reliability Standards
- More accurate models for stability analysis => Improved Reliability
- More accurate calculation of system operating limits => Better Asset Utilization
- Works for Conventional/Renewable Gens, Composite Load, System External Equivalent Network

**Inverter Based Resources**

(WECC Base Case Review, August 2020)

- Compliance with NERC MOD-26/27 requiring transmission planners & operators to verify generator models (turbine & excitation controls) on a periodic basis.

**Dynamic Models**

(US Western Interconnection August 10th, 1996 Blackout)

- Estimated by Model
- Actual Measurements

**Wind Plant Models**

Everything in grey is *not acceptable* per WECC modeling list.

**Solar PV Models**

93%
Thank you