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Finishing the Last Mile – ISO-NE's Journey to Bring Synchrophasor Under NERC CIP

NASPI – Utility Experience

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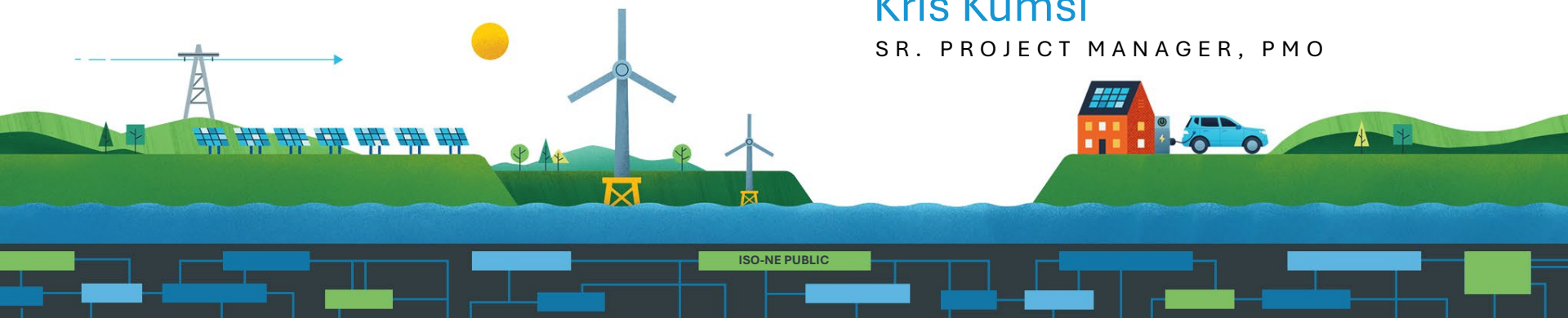


Outline

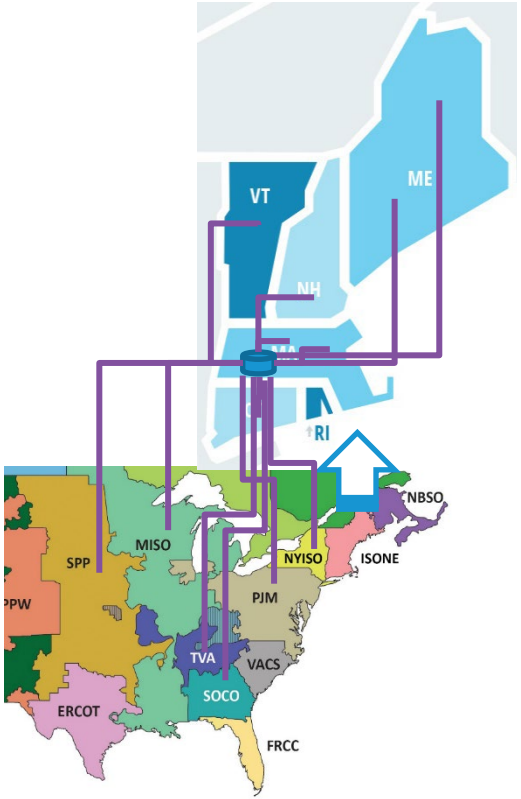
- ISO-NE's synchrophasor journey
- Business drivers to bring into CIP
- Overview of the synchrophasor CIP project
- Key Control Room application – Oscillation Source Location (OSL)
- Conclusions

ISO-NE's Synchrophasor Journey

- Jump start with DOE SGIG program
  - Implementation period: 7/1/2010- 6/30/2013
  - Observation period: 7/1/2013 – 6/30/2015
- Synchrophasor technology roadmap was developed in 2014
- In Dec. 2017, OP 22 was modified to require all TOs in New England to install new PMUs at
  - All new 345 kV PTF substations or expand the existing PMUs to cover new transmission elements
  - New or existing PTF substations with planned generation totaling at least 20 MVA nameplate, including DERs
  - New dynamic reactive devices
  - Etc.

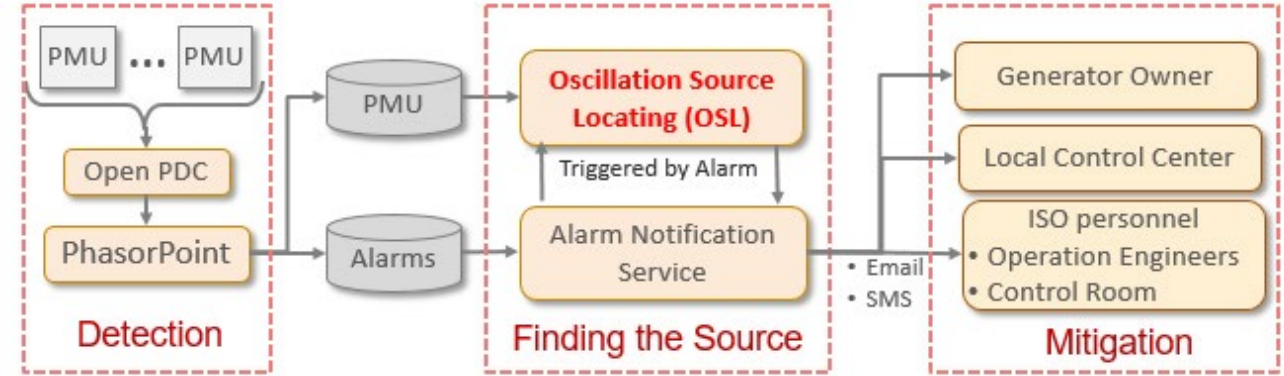
ISO-NE's Synchrophasor Journey (cont'd)

- 100+ Stations
  - Full observability of 345 kV with some redundancy
  - Selected 115 kV stations
- Selected PMU data from other RCs via EIDSN
- Key applications:
  - openPDC
  - PhasorPoint
  - Oscillation Source Location (OSL)
  - Automated Power Plant Model Validation (APPMV)



On-line Oscillation Management

- Objective
  - Detect all significant oscillatory events
  - Estimate the Source of oscillations and deliver results to the designated personnel
- Fully automated 24/7 process, operational since September 2017
- To request ISO-NE developed Oscillation Source Location (OSL) tool (Dissipating Energy Flow method): https://www.iso-ne.com/participate/support/request-software



ISO-NE developed

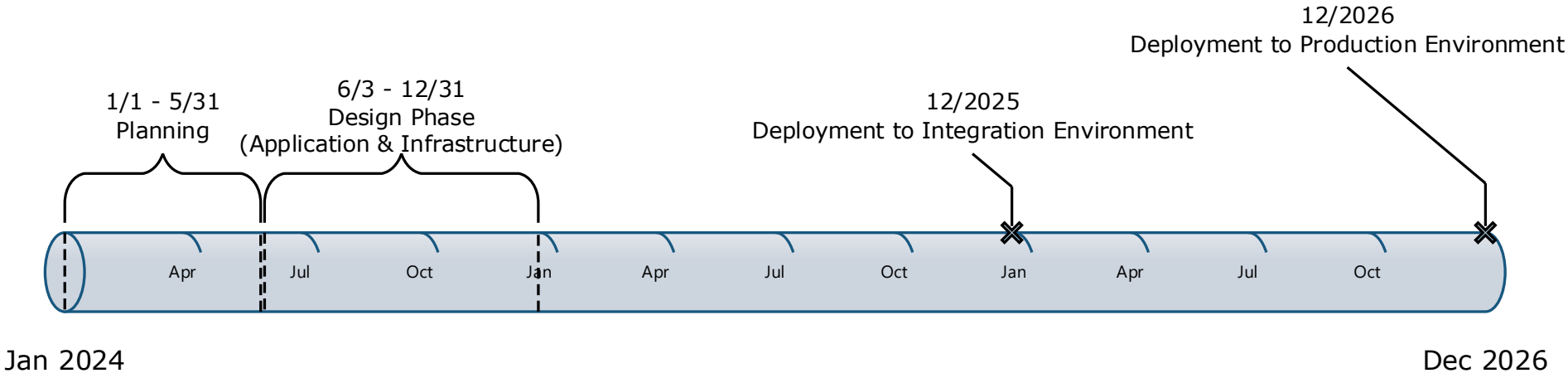
Challenges and Business Drivers to Bring Synchrophasor Infrastructure under CIP

- Grid Challenges
  - Potential oscillatory behavior from new interconnections
    - Off-shore wind: Vineyard 806 MW, Revolution 704 MW
    - HVDC: New England Clean Energy Connect (NECEC) 1200 MW
    - DERs: > 8 GW today → > 14 GW by 2034
- Opportunities to Meet the Challenges
  - Enable real-time monitoring and decision making using synchrophasor data, which means
    - Secure infrastructure
    - Upgraded maintenance

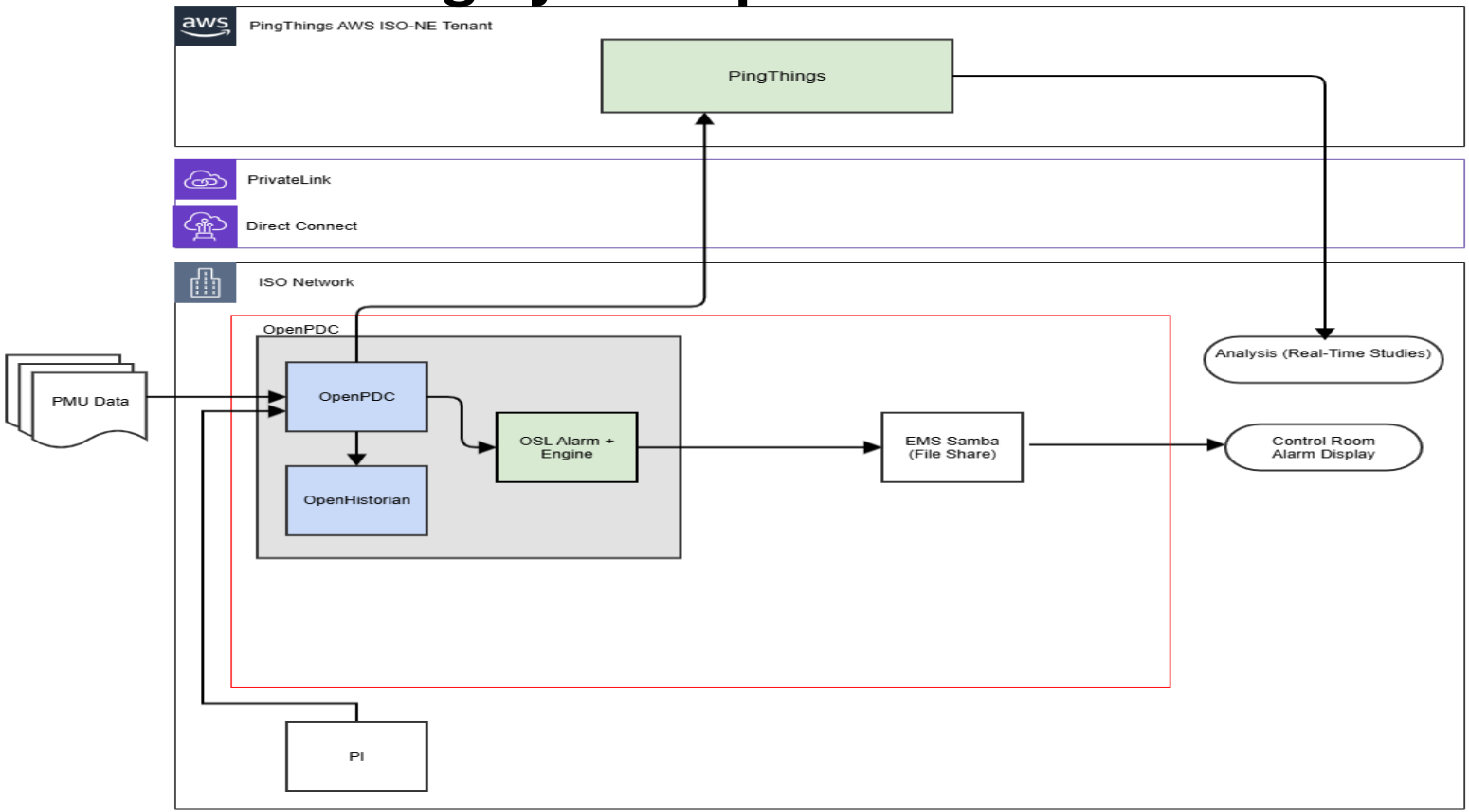
Last Mile – Bring Synchrophasor Under NERC CIP

- Initiated the Emerging Work Request in 2023
- 12 months of meticulous design to build Application and Infrastructure framework
- Project Team size was around 50
- Partnered with Grid Protection Alliance (GPA) and PingThings
- Collaborated with TOs to upgrade the monitoring and maintenance of PMUs/PDCs through Operating Procedures (OP-2 and OP-22)
- Corporate scorecard project in both 2025 and 2026

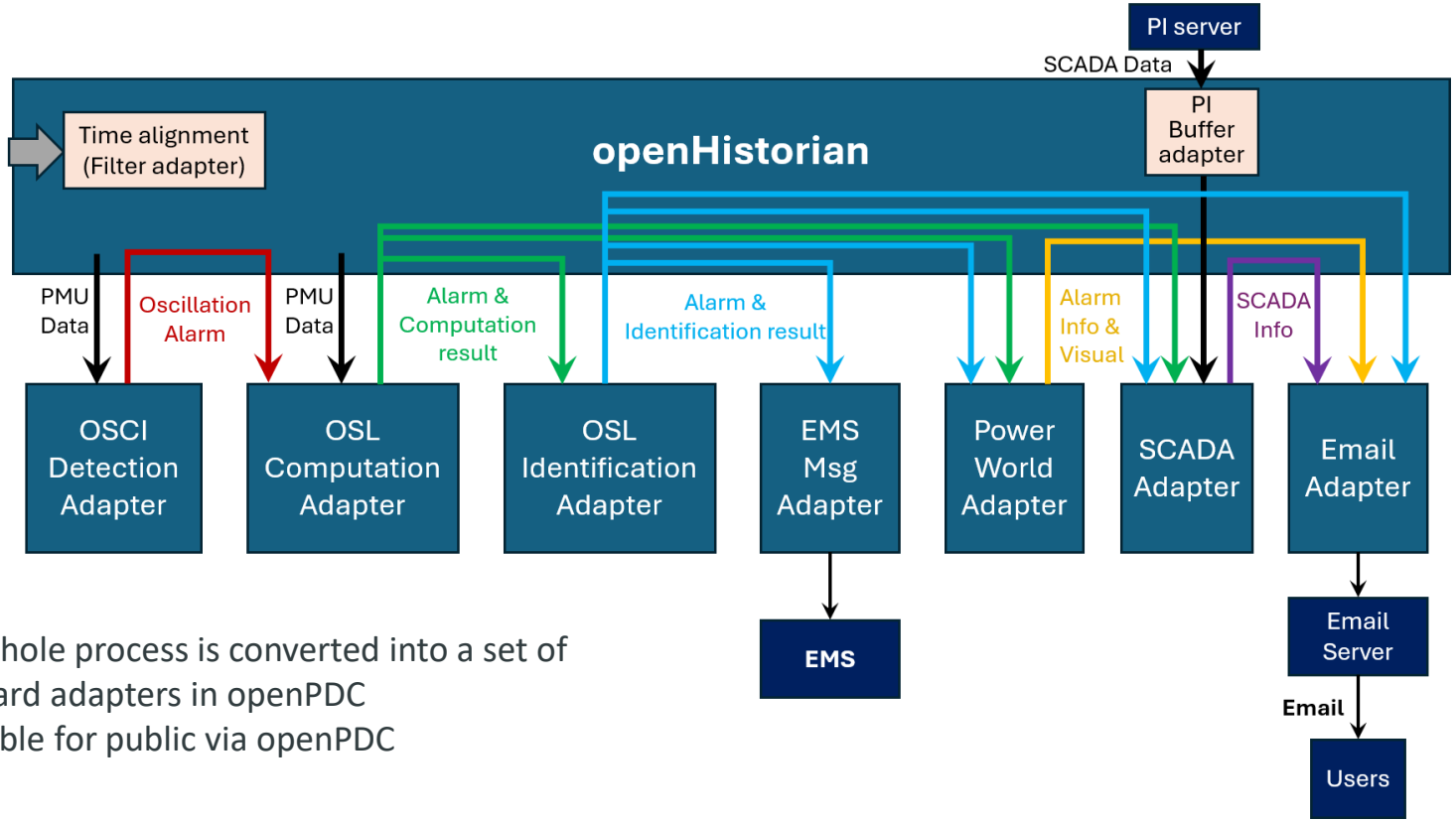
Last Mile – Bring Synchrophasor Under NERC CIP



Last Mile – Bring Synchrophasor Under NERC CIP



New On-line Oscillation Management within CIP

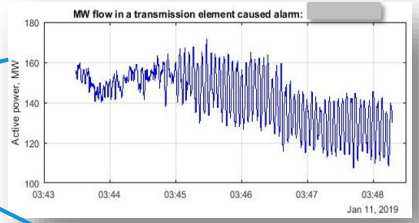


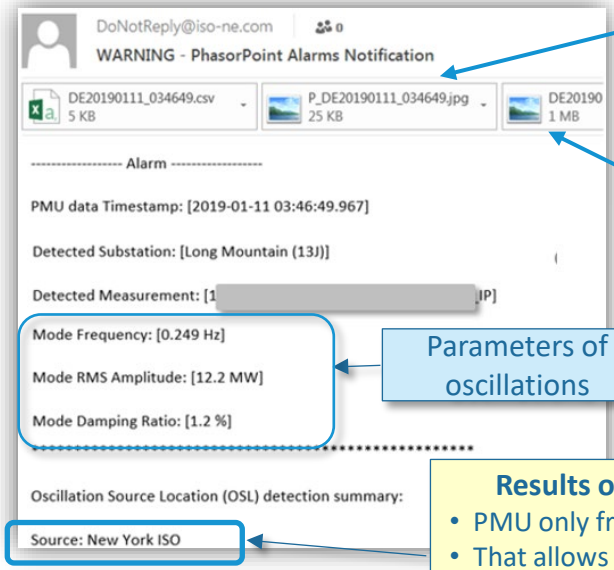
- The whole process is converted into a set of standard adapters in openPDC
- Available for public via openPDC

Example: 0.25 Hz Inter-area Oscillation; January 11, 2019

- Near-resonance conditions have caused the propagation of oscillation across entire Eastern Interconnection

NYISO – ISO-NE tie line flow





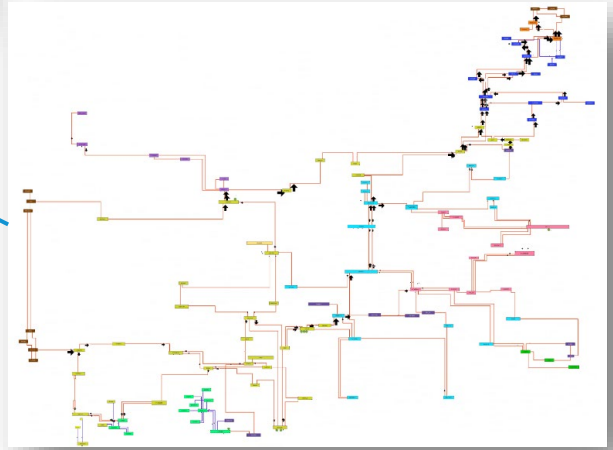
Parameters of oscillations

Results of DE pattern recognition

- PMU only from ISO-NE footprint are used
- That allows to identify that the Source:
  - ✓ Is located outside and
  - ✓ In NYISO direction

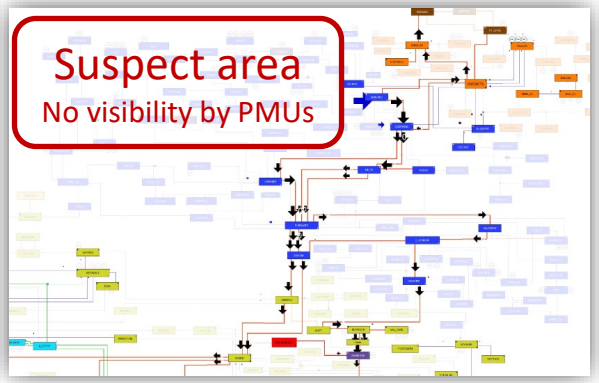
- Source is 1000+ miles away from ISO-NE in Florida

DE visualization on oneline diagram



Example: 0.15Hz Oscillation Caused by a Solar Power Plant

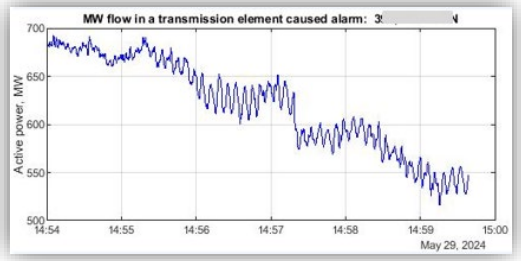
Black arrows are visualized DE values



- DE Pattern Recognition has identified a suspect area within ISO-NE containing multiple generators NOT observable by PMUs
- Additional SCADA analysis has correctly identified the source

~200 miles away from suspect area

MW flow in a line trigged Alarm



Source

~~~~ DE pattern recognition results

Source: Area=NEPEX (confidence=100%); station cannot be reasonably localized

Correlation between DE and DEtemplate with the highest rank is: 0.996

~~~~ SCADA analysis results

Indices of MW and MVAR variability for generators

No	Station	Unit	MW_inde	MVAR_index
1	[redacted]	[redacted]	1	0.077
2	[redacted]	[redacted]	0	-
3	[redacted]	[redacted]	0.016	0.004
4	[redacted]	[redacted]	0.014	0.003

ISO-NE Synchrophasor Program: From Build-Out to Operational Excellence

- Production readiness
  - By December 2026, ISO-NE will complete the “last mile” and operate a fully production-grade synchrophasor system within the CIP environment
  - The enhanced synchrophasor architecture meets security and reliability objectives, supporting expanded PMU deployment per NERC PRC-028
- Improved data availability across the footprint
  - Updated Operating Procedures drive measurable improvements in PMU/PDC data availability and consistency among Transmission Owners
- Operationalized oscillation management
  - A streamlined oscillation detection and source location process strengthens system reliability amid increasingly fast-changing grid dynamics
- PMU-enabled real-time operations and decision-making
  - ISO-NE Operations is equipped with the tools, procedures, and confidence to make informed real-time decisions using PMU data

Questions