CONCEPT

Wide Area Monitoring Systems (WAMS) and PMU Synchrophasor Analytics

16 – 20 August 2027
Amsterdam - Zuidas business district hotel

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Introduction:

Wide area monitoring gives grid operators a time-aligned view of phase angles, frequency and oscillations that SCADA scans every few seconds cannot provide, yet many PMU fleets deliver noisy, gappy data that nobody trusts in the control room. This Core Concept course takes engineers through the synchrophasor measurement chain, from phasor estimation and GPS or PTP timing to phasor data concentrators, data quality and analytics for oscillation, stability and islanding detection. Participants produce a WAMS Deployment and Use-Case Plan with a Post-Event Analysis Report.

Course Objectives:

- Evaluate PMU phasor estimates against IEEE C37.118.1 accuracy metrics such as total vector error, frequency error and ROCOF error under steady-state and dynamic conditions
- Design a WAMS architecture covering PMU placement for observability, time source redundancy, PDC hierarchy and data transfer with IEEE C37.118.2 or IEC 61850 streams
- Diagnose synchrophasor data quality problems including timestamp errors, dropped frames, latency and bad channels, and set data quality flags and cleansing rules
- Configure oscillation detection, mode meter, angle and voltage stability monitoring and islanding detection applications with alarm thresholds for the control room
- Reconstruct a grid disturbance from PMU records to identify the initiating event, sequence and oscillation behaviour for a post-event report
- Prepare a WAMS deployment and use-case plan linking PMU data to state estimation, wide-area protection and control, renewables monitoring and cyber security controls

Target Audience:

- Power system engineers who study grid dynamics, validate models and specify measurement requirements for transmission networks
- Protection engineers who configure relays with integrated PMU functions and analyse disturbance and fault records
- Control-room engineers who supervise real-time displays, respond to oscillation and angle alarms and support dispatchers during events
- Grid planning engineers who decide PMU placement, communications capacity and monitoring needs for new substations and renewable connections
- Energy management system and operational technology specialists who integrate PMU and PDC data with EMS, SCADA and historians

Course Outline:

Day 1: Synchrophasor Fundamentals and the Measurement Chain

- Phasor Representation, Synchrophasor Definition and UTC-Referenced Phase Angle
- PMU Signal Chain: Instrument Transformers, Anti-Aliasing Filters, Sampling and Reporting Rate
- Phasor Estimation Algorithms: DFT Windows, Off-Nominal Frequency and Leakage Effects
- IEEE C37.118.1 Accuracy Metrics: Total Vector Error, Frequency Error and ROCOF Error
- Current-State Assessment of a Utility PMU Fleet: Coverage, Vendors and Reporting Classes

Day 2: Time Synchronisation, PMU Placement and WAMS Architecture

- GPS Receiver Timing, Holdover Oscillators and Antenna Spoofing Exposure
- IEEE 1588 Precision Time Protocol Power Profile and Grandmaster Redundancy
- Optimal PMU Placement for Network Observability Using Zero-Injection Bus Rules
- Phasor Data Concentrator Hierarchy: Substation, Regional and Central PDC Roles
- IEEE C37.118.2 Frames and IEC 61850 Sampled Values and GOOSE for Synchrophasor Transfer

Day 3: Data Quality, Communications and Core WAMS Applications

- Synchrophasor Data Quality Flags, Timestamp Alignment, Latency Budgets and Frame Loss Handling
- Oscillation Detection and Mode Meter Estimation of Inter-Area Frequency and Damping
- Phase Angle Difference Monitoring and Voltage Stability Indices from PMU Data
- Islanding Detection and Resynchronisation Support from Frequency and Angle Divergence
- Linear State Estimation and Hybrid SCADA-PMU State Estimator Enhancement

Day 4: Wide-Area Protection and Control, EMS Integration and Cyber Risk

- Wide-Area Protection and Control WAMPAC Schemes: Arming Logic and Latency Limits
- Control-Room Visualisation: Angle Maps, Oscillation Alarms and Operator Situational Displays
- PMU Data Integration with EMS, SCADA and Historian Archives
- Inverter-Based Resource Monitoring: Sub-Synchronous Oscillations and Plant Model Validation
- Synchrophasor Network Cyber Security: Segmentation, Time Source Attack and Data Integrity Controls

Day 5: Capstone: WAMS Deployment Plan and Post-Event Analysis

- Post-Event Exercise: Disturbance Timeline Reconstruction from Recorded PMU Streams
- Oscillation Source Location and Damping Trend Review for the Recorded Event
- Use-Case Prioritisation Matrix for Monitoring, Analysis and Control Applications
- Deployment Roadmap: PMU Sites, PDC Tiers, Communications and Data Quality KPIs
- WAMS Deployment and Use-Case Plan with Post-Event Report Presentation and Peer Challenge

Skills You Will Gain:

- Phasor Estimation Accuracy Testing
- Time Synchronisation Design
- PMU Placement Optimisation
- Synchrophasor Data Quality Management
- Oscillation Mode Analysis
- Wide-Area Event Reconstruction
- WAMS Architecture Planning
- Synchrophasor Cyber Risk Assessment

Why Attend This Course:

- Return with a WAMS Deployment and Use-Case Plan and a Post-Event Analysis Report built on recorded PMU event data
- Turn untrusted PMU streams into data the control room acts on by fixing timing, latency and quality flag faults
- Challenge vendor claims on PMU accuracy, PDC performance and analytics before procurement and commissioning
- Exchange monitoring practice with engineers from transmission operators, generation owners, industrial networks and renewable plants

Conclusion:

A wide area monitoring system earns its place when accurate, well-timed PMU data reaches applications that operators and engineers use. The five days move from phasor estimation and accuracy, through timing, PMU placement and PDC architecture, to data quality, oscillation, stability and islanding analytics, then wide-area protection and control, EMS integration, renewable plant monitoring and cyber risk. The final day produces a deployment and use-case plan and a post-event analysis ready for peer challenge.