

EIPP Application Taxonomy

September 27, 2006

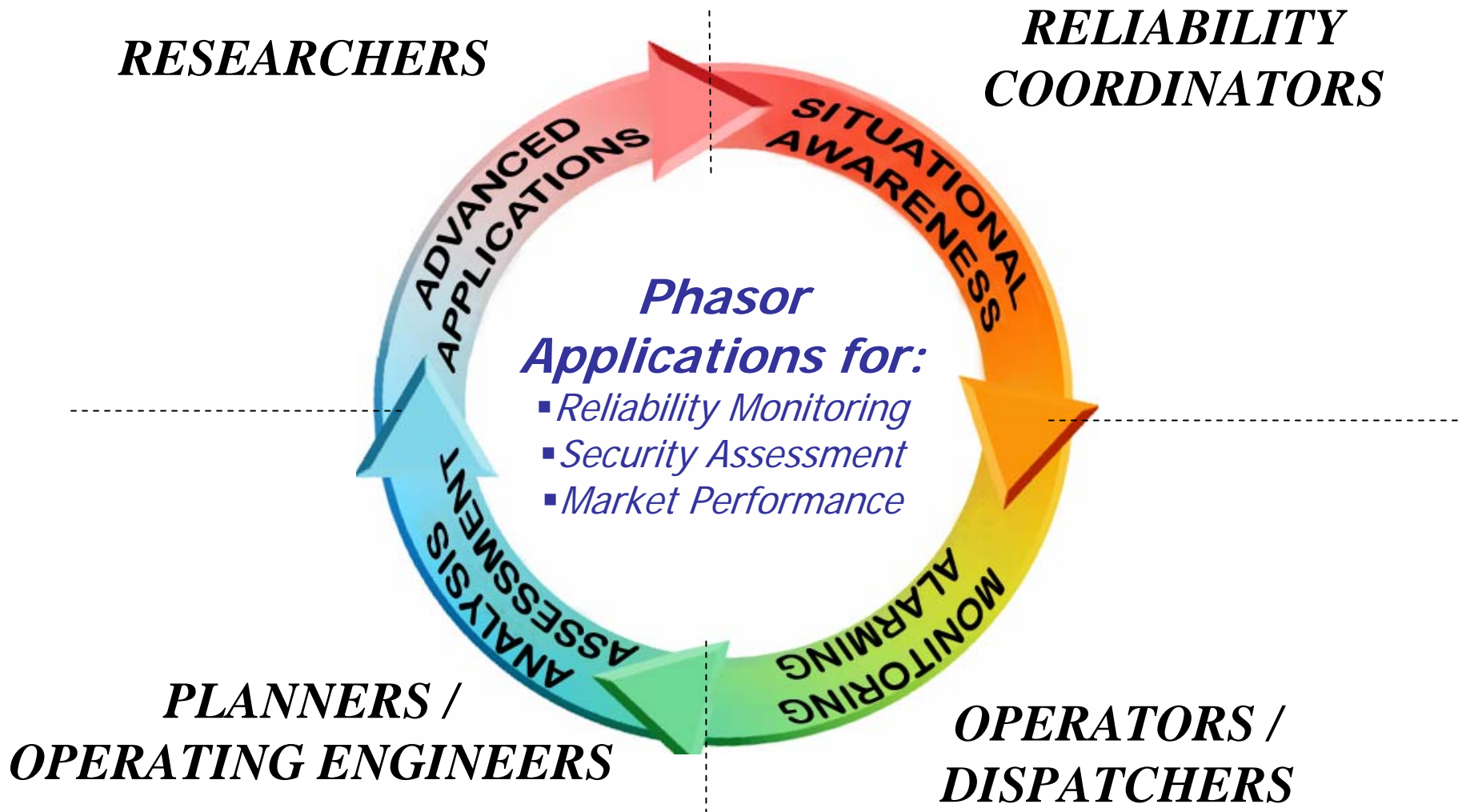
by

Navin Bhatt, AEP Terry Bilke, Midwest ISO

Agenda

- **Objectives, Functions & User Category**
- **What Are the User Needs?**
- **Examples**
- **Recommendations**

Phasor Applications: Objectives, Functions & User Category



What Are the User Needs?

RESEARCHERS

- Test data sets
- Sub-second resolution
- Information sharing on existing state-of-art technologies within the industry
- Ability to test & validate algorithms
- Test beds for feasibility assessment and demonstration for protection and control
- Minimal latency (~100 ms)

OPERATING ENGINEERS/PLANNERS

- Data retrieval from archived databases
- Short duration event files captured during disturbances at sub-second resolution
- Data plotting and analysis tools
- Latency not an issue
- Evaluation platforms & datasets for applications validation
- Model validation/improvement capability

Off-Line Team

Real-Time Team

RELIABILITY COORDINATORS

- “Dashboard” type summary visuals
- Standardized displays
- Wide area Interconnection & Regional visibility at critical substations & tie lines
- Most recent snapshot on key grid metrics
- Real time streaming data at second resolution with low latency (~ 2-5 seconds)
- Reliable data quality & availability

OPERATORS/DISPATCHERS

- Local control-area/utility wide visibility across all voltage levels/substations
- Configurable displays
- Most recent trends of key grid metrics
- Real time streaming data at second resolution with low latency (~ 2-5 seconds)
- Reliable data quality & availability



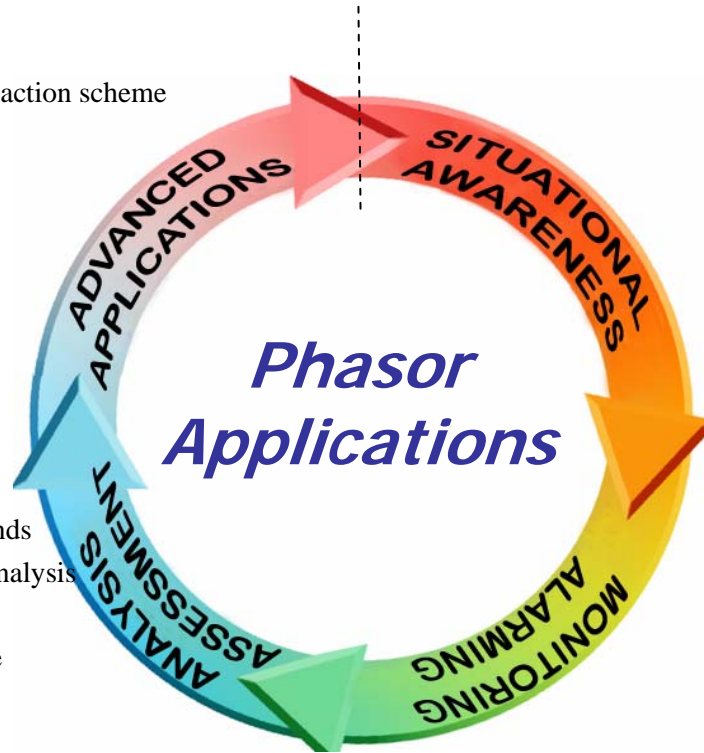
Phasor Applications Taxonomy by User Category

RESEARCHERS

- Protection
 - Automatic alarming of remedial action scheme
 - Out of step protection
- Control
 - Short/long-term stability control
 - FACTS feedback control
 - Smart switch-able networks

OPERATING ENGINEERS /PLANNERS

- Post-mortem analysis including:
 - Baseline normal phase angle trends
 - Pattern recognition/correlation analysis
 - Frequency response analysis
 - Disturbance analysis compliance
- Model validation/Improved modeling
- Phasor network performance monitoring & data quality
- Email notifications
- Test and evaluate new real-time application and support limit definition



RELIABILITY COORDINATORS

- Wide area situational awareness dashboard
- Real time compliance monitoring with reliability standards including:
 - Angle of separation
 - Voltage and angle profiles
 - MW/MVAR flows across corridors
 - Load resource imbalance
- Frequency Instability Detection/Islanding

OPERATORS / DISPATCHERS

- Real time performance monitoring & trending (steady-state and dynamic)
- Anomaly characterization and action to prevent blackouts:
 - Real time alerts and alarms (hard limits)
 - Alarming on “out of normal” (soft limits)
 - Event detection, disturbance location
 - Suggest preventive action
- Interconnection wide state estimation/measurement
- Dynamic ratings including both thermal and stability (e.g. voltage, small-signal)

Reliability Coordinators

– Situational Awareness

	<i>Application</i>	<i>Latency</i>	<i>Data Resolution</i>	<i>Time Window</i>	<i>Data Requirements</i>	<i>Format /Protocols</i>	<i>Tools/Platforms</i>	<i>Comments</i>
SITUATIONAL AWARENESS	Situational Awareness Dashboard	1-5 Seconds	1 sample/sec.	Snapshot	Phasor, SCADA	PDCStream, IEEE C37.118, OPC, HTTP	PI, RTDMS, PowerWorld, PSGuard	These are summary displays to assess the overall state fo the system (i.e., Normal State, Alert State or Alarm State).
	Real Time Compliance Monitoring with Reliability Standards (Angle of Separation, Voltage & Angle Profiles, MW, MVAR flows, Load-Resource Imbalance)	1-5 Seconds	1 sample/sec.	30 Minutes	Phasor, SCADA	PDCStream, IEEE C37.118, OPC, HTTP	PI, RTDMS, PowerWorld, PSGuard	
	Frequency Stability/Islanding	1-5 Seconds	30 samples/sec.	Few Minutes	Phasor, FNET	PDCStream, IEEE C37.118	RTDMS, FNET, StreamReader	

Operators/Dispatchers

– Monitoring & Alarming

<i>Application</i>	<i>Latency</i>	<i>Data Resolution</i>	<i>Time Window</i>	<i>Data Requirements</i>	<i>Format /Protocols</i>	<i>Tools/Platforms</i>	<i>Comments</i>
Real Time Performance Monitoring and Trending	1-5 Seconds	1 sample/sec.	~ 1 hour	Phasor, SCADA	PDCStream, C37.118, OPC, HTTP	PI, RTDMS	Provide time series information
Anomaly Characterization and Alarming (Real time alarming on hard limits & "out of normal" conditions, suggest preventive action)	1-5 Seconds	30 samples/sec.	~ 1 hour	Phasor Data	PDCStream, IEEE C37.118, OPC AE	RTDMS, FNET	Alarming points on threshold and rate-of-change violations (either static hard limits based on studies or dynamic soft limits from recent trends and statistics), and suggest appropriate actions.
State Estimation	1-2 Minutes	30 sample/sec.	5-10 Minutes	Phasor, SCADA, Network Model	PDCStream, IEEE 1344, IEEE C37.118	ABB, Areva, Siemens	A pilot project between TVA, Entergy and Areva is underway to demonstrate this capability. San Diego Gas & Electric is pursuing a similar project.
Small-Signal Stability Monitoring	5-10 Seconds	10 samples/sec.	10-15 Minutes	Phasor, FNET	PDCStream, IEEE C37.118	SCE Outlook, SpectralAnalysis, DSI Toolbox, RTDMS	Tools/Algorithms for small-signal monitoring are specific to the nature of the data: i.e. ambient data, post-event ringdown data, probing data.
Voltage Stability Monitoring/Assessment	Few Seconds	30 samples/sec.	~ 1 hour	Phasor	PDCStream, IEEE 1344, IEEE C37.118, OPC	PSGuard, SynchroWAVE, RTDMS	- Departure from the P-V curve or voltage below limit - Estimation of thevinin equivalent parameters to approximate margins
Thermal Monitoring (Overload)	Few Seconds	30 samples/sec.	~ 1 hour	Phasor, Line Parameters	IEEE 1344, IEEE C37.118	PSGuard	Current applications require phasor measurements from both ends on the monitored line

MONITORING / ALARMING

Operating Engineers/Planners

– Analysis & Assessment

<i>Application</i>	<i>Latency</i>	<i>Data Resolution</i>	<i>Time Window</i>	<i>Data Requirements</i>	<i>Format /Protocols</i>	<i>Tools/Platforms</i>	<i>Comments</i>
Baseline Normal Phase Angle Trends	N/A	1 sample/sec.	24 hrs +	Phasor, State Estimator	csv, mat, OPC, HTTP, FTP	PI, SQL, DatAWare, Excel, Matlab, RTDMS	Tools with plotting and statistics capabilities are appropriate here.
Pattern Recognition/Correlation Analysis	N/A	1 sample/sec.	1 hour +	Phasor	csv, mat, OPC, HTTP, FTP	PI, SQL, DatAWare, Excel, Matlab	Identify global metrics that look at several parameters to determine system security
Disturbance Analysis Compliance	N/A	30 samples/sec.	1 min pre & 2 min post event	Phasor	PhasorFile (dst), COMTRADE	DSI Toolbox, SCE Outlook, RTDMS	
Frequency Response Analysis	N/A	10 samples/sec.	1 min pre & 2 min post event	Phasor, FNET	PhasorFile (dst), csv, mat	Matlab, Excel, PI	
Model Validation	N/A	30 samples/sec.	5-10 minutes	Phasor, Model	PhasorFile (dst), csv, mat	Matlab, DSI Toolbox	Simulation tools such as PoweTech's SSAT are needed in conjunction with the PMU measurements
New Applications Evaluation & Limits Definition	N/A	30 samples/sec.	Application Dependant	Application Dependant	PDCStream, IEEE C37.118, OPC	TVA SuperPDC, DatAWare, PI	
Email Notification	1-2 Minutes	30 samples/sec.	1 hour	Phasor	Email	Windows Server, SMTP	
Phasor Network performance monitoring & data quality	N/A	30 samples/sec.	24 hrs +	Phasor	PDCStream, IEEE C37.118	RTDMS, TVA Website, PDCStatus Monitor	

ANALYSIS / ASSESSMENT

Researchers

– Advanced Applications (Protection & Control)

ADVANCED APPLICATIONS (PROTECTION & CONTROL)	<i>Application</i>	<i>Latency</i>	<i>Data Resolution</i>	<i>Time Window</i>	<i>Data Requirements</i>	<i>Format /Protocols</i>	<i>Tools/Platforms</i>	<i>Comments</i>
	Automatic Alarming of Remedial Action Schemes	~ 100 ms	30 samples/sec.	~ Minutes	Phasor	IEEE 1344, C37.118	WACS, PSPM	Research and definition on phasor measurement thresholds for arming/disarming points and tripping criteria
	Out of step protection	~ 100 ms	30 samples/sec.	~ Seconds	Phasor	IEEE 1344, C37.118	SEL	- Latency consideration are very important
	Short-term stability control (e.g. transient stability)	~ 100 ms	30 samples/sec.	~ Seconds	Phasor	IEEE 1344, IEEE C37.118	WACS (LabView), PSPM	- Wide Area stability and Voltage Control System (WACS) is presently being used by BPA to validate control concepts
	Long-term stability control (e.g. wide area frequency, voltage stability)	1-5 Seconds	30 samples/sec.	~ Minutes	Phasor	IEEE 1344, IEEE C37.118	WACS (LabView), PSPM	
	FACTS feedback control, Smart switch-able networks	1-5 Seconds	30 samples/sec.	~ Minutes	Phasor, SCADA	IEEE C37.118	TBD	

Workgroup Recommendations

- **Provide Input on Taxonomy**
 - **Tools and Displays**
 - **Priorities**
 - **Business Case Summary (Need)**
 - **Detailed Descriptions**
- **Develop Tools to Interface with RTDMS Hub**