TABLE I
EXPECTED DATA REQUIREMENTS FOR DIFFERENT CLASSES OF μPMU APPLICATIONS

Application	**Measurement Quantities**	**Time Resolution**	**Accuracy**	**Latency & Continuity**
Voltage magnitude profile & variability	Voltage magnitudes crucial, Voltage phase angle useful for recognition of tap changes	1 sec or better resolution is useful, synchronization between & among measurement locations critical	Changes in time of interest, absolute accuracy to 0.5% error adequate	Retain complete history
Awareness of real-time loads	Current magnitudes very useful, V phase angle can be proxy for current iff network impedances are known; current phase angle useful for P,Q decomposition & reverse power flow	1 cycle or better resolution reveals transient behaviors, full time domain characterization with up to 30 kHz sampling of interest to reveal harmonics	Absolute 0.5% error likely adequate	Operationally relevant latency on the order of 1 sec
Outage management	Voltage & current magnitudes	1 sec likely adequate	1% error likely adequate	1 sec latency likely adequate
System frequency & oscillation detection	Voltage phase angle essential	1 cycle or better & synchronization essential	Changes in time, not absolute accuracy of interest, 1% error adequate if stable	Retain complete history; latency requirement may vary, sub-second critical if informing protection
Island detection; Microgrid islanding & resynchronization	Voltage phase angle essential	1 cycle or better resolution	Insensitive to magnitude error, phase angle error stable to 0.01^{o}	Continuous monitoring, sub-second latency critical if informing protection
Distribution state estimation & SE-based topology detection	Voltage phasors; sensitive to placement & number of sensors; network model & load data important	Synchronization critical	Absolute accuracy on the order 0.0001 p.u. or better is critical, requires correction for transducer errors	Operationally relevant latency on the order of 1 sec
Topology detection based on time-series signatures	Voltage phasors	1 cycle or better & synchronization critical	Changes in time, not absolute accuracy of interest, 0.5% error adequate if stable	Retain complete history, operationally relevant latency on the order of 1 sec
Topology detection based on source impedance	Voltage & current phasors	1 cycle or better & synchronization critical	Changes in time, not absolute accuracy of interest, 0.5% error adequate if stable	Operationally relevant latency on the order of 1 sec
Phase identification	Voltage phase angles essential	1 sec or better for time-series approach; synchronization critical	Absolute accuracy of phase angle on the order of 1^{o} likely adequate	No particular need for latency or continuity
Model validation for line segment impedances	Voltage & current phasors	Synchronization critical	Absolute accuracy of all phasors is limiting factor, as good as 0.0001 p.u. for shorter segments	No particular need for latency or continuity
DG Characterization; Transformer, generator & load models	Voltage & current phasors	1 cycle or better reveals dynamic behaviors; synchronization between primary & secondary side of transformer critical	Changes in time, not absolute accuracy of interest, 0.5% error adequate if stable	No particular need for latency or continuity
Event detection & classification	Voltage & current magnitudes adequate for most events, phase angles useful	1 cycle or better, synchronization critical	Changes in time, not absolute accuracy of interest, 0.5% error adequate if stable	Continuous monitoring, operationally relevant latency on the order of 1 sec
Fault location	Voltage & current phasors	1 cycle or better, synchronization critical	Absolute accuracy of all phasors is limiting factor	Continuous monitoring, latency on the order of 1 sec
Phasor-based control	Voltage phasors	1 cycle or better	Absolute accuracy critical for steady-state optimization, but stable errors acceptable for disturbance rejection	Continuous monitoring, latency critical