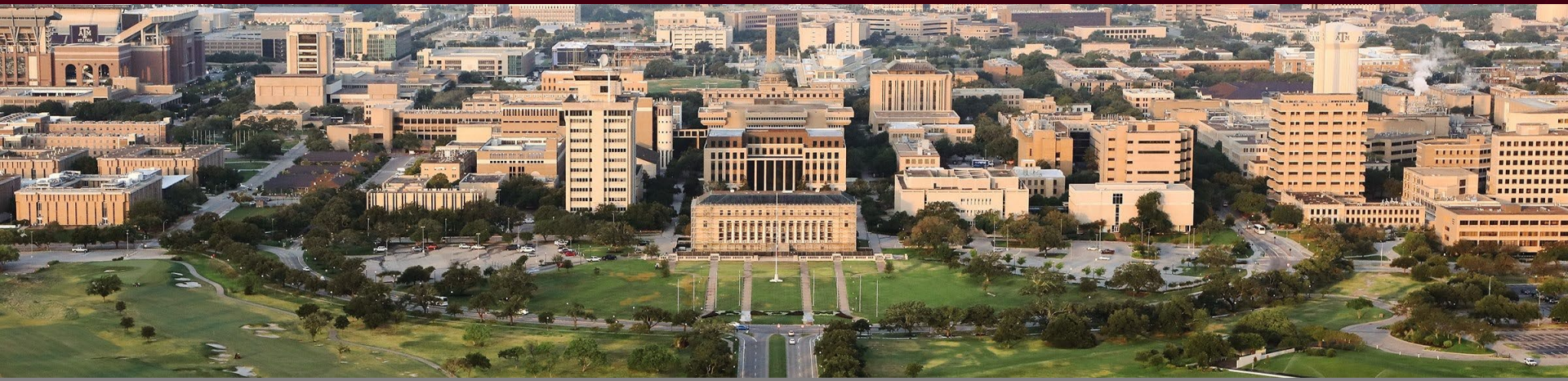


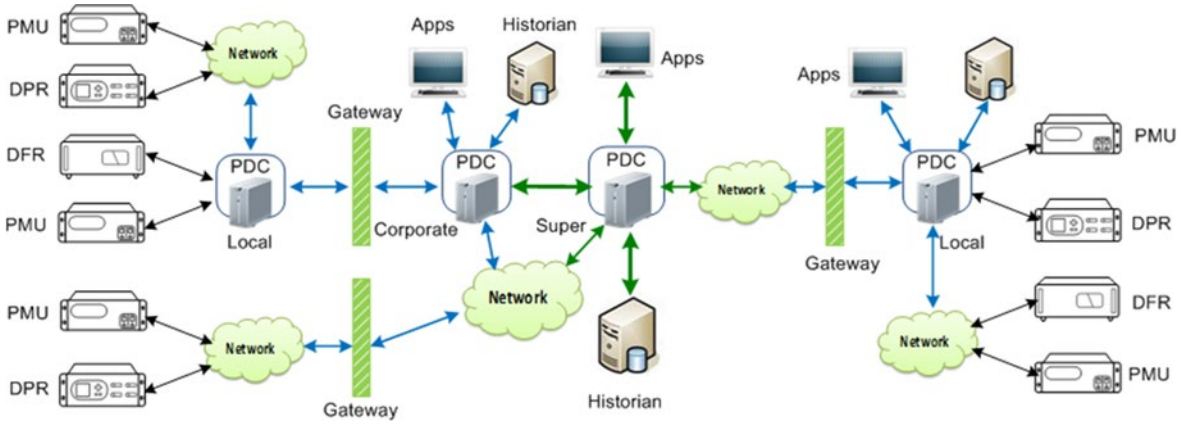
Edge Computing Solutions Using Synchrophasors

Mladen Kezunovic, Regents Professor, Texas A&M University

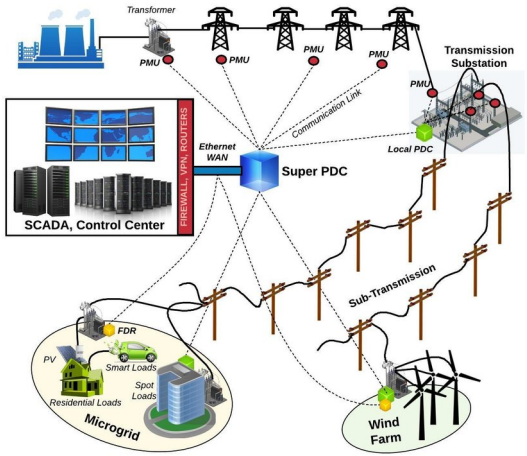
North American Synchrophasor Initiative, Virtual Meeting, October 5-7, 2021

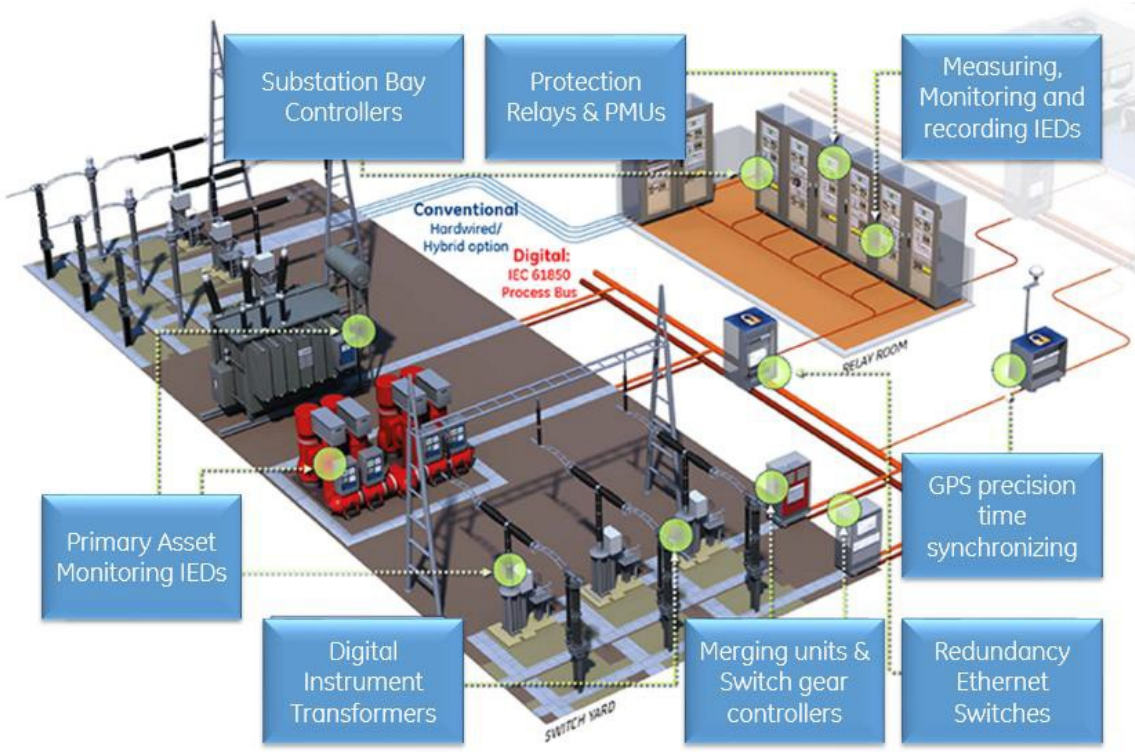
Outline

- What may be considered the grid edge?
- Substation: Properties of IEDs
- Time synchronization and synchronized sampling
- Feasibility and purpose of local substation IED data processing
- Examples of what pre-processing may be done at the substation



What may be considered the Grid Edge?





Source: Pubudu Eroshan Weerathunga, Anca Cioraca, “Securing IEDs against Cyber Threats in Critical Substation Automation and Industrial Control Systems.” Texas A&M Protective Relay Conference, 2016

Properties of substation IEDs

Intelligent Electronic Devices:

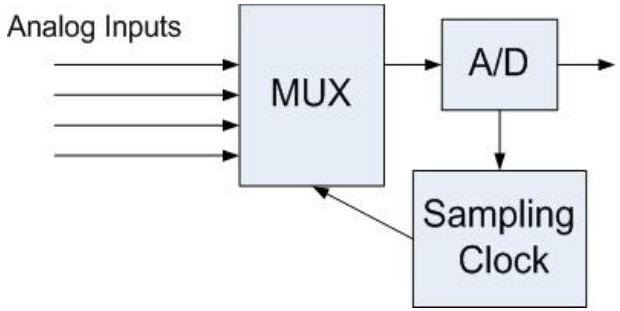
- Protective relays
- Digital fault recorders
- Sequence of event recorders
- Dedicated fault locators
- Power quality monitors
- Circuit breaker monitors
- EMS/ ADMS RTUs
- Phasor measurement units

Properties:

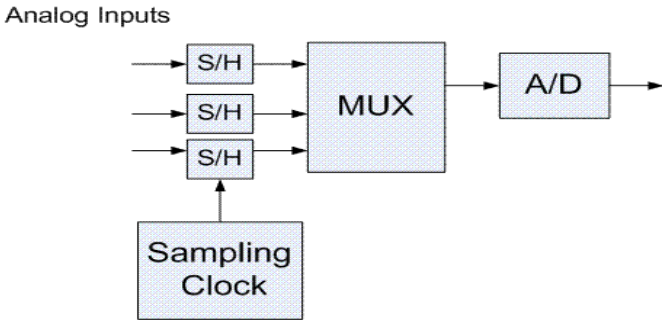
- Purpose
- Sampling rates
- Sampling vs Scanning
- Triggering vs continuous monitoring
- Accuracy
- Substation coverage
- Measurement Output
- Time synchronization

Sampling synchronization

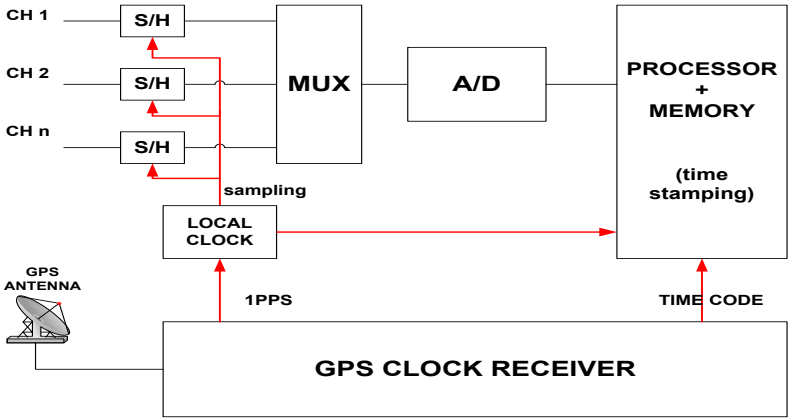
Scanning (relative)



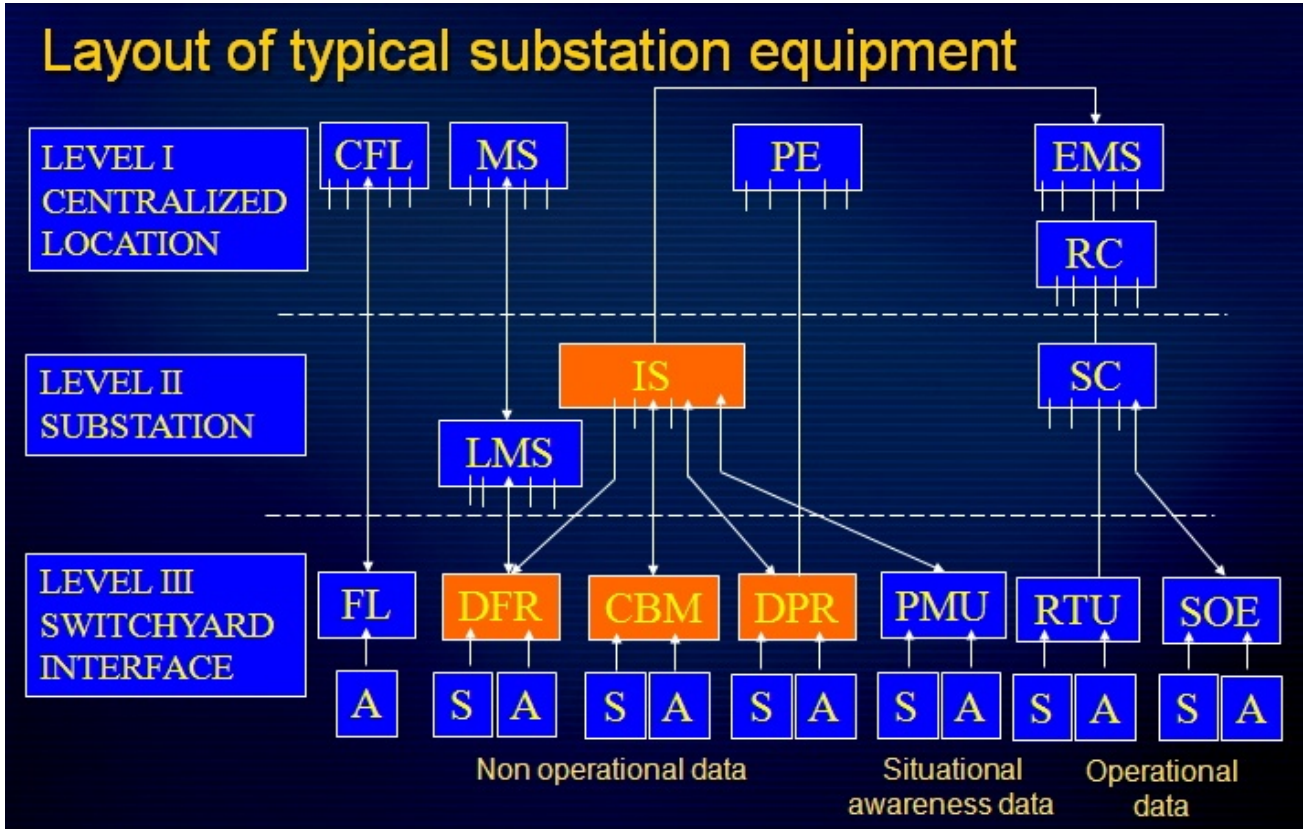
Synchronous Sampling



Time Stamping (absolute time)

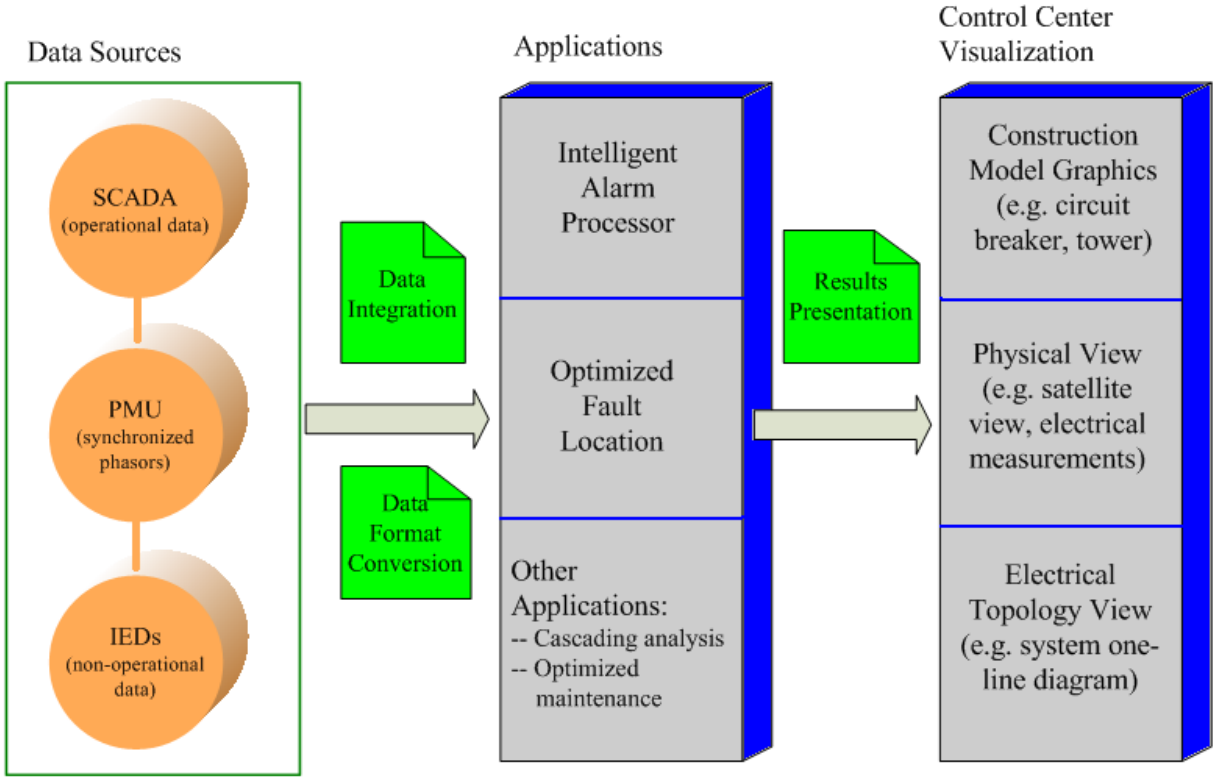


Feasibility and purpose of local substation IED data pre-processing



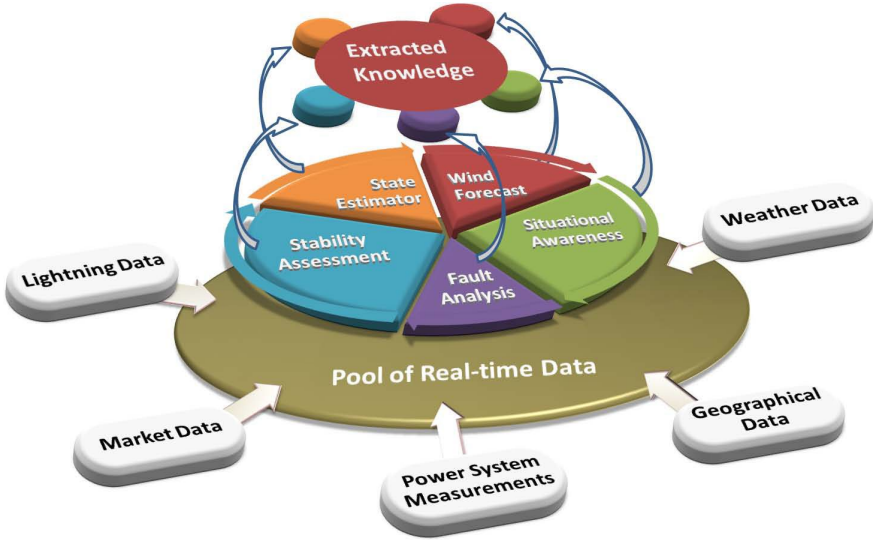
Data Integration

Individual functions



Examples of what processing may be done at substations

- Event detection
- Data quality check
- Feature extraction for ML/AI data analytics
- Automated data labeling and time stamping
- Single and two ended FL
- Event precursor extraction
- Return to normal
- Event classification
- Event characterization



Conclusions

Advantages

- Substation pre-processing of samples and phasors is beneficial but the end-application (user) needs to be defined
- Data integration at the source (substation) is highly desirable for quick assessment of power system (unfolding) events
- Automated characterization of power system events in real-time is highly desirable and would benefit from feature extraction at substation

Disadvantages

- Substation processing requires additional computational and communication facilities imposing new (additional) maintenance and testing requirements
- Such solutions do not readily exist when IEDs from different vendors are the target of data integration, which requires and open standard for data management
- Legacy equipment and its architecture requires standardization such as IEC 61850, which is costly and requires major substation refurbishments

Summary

- Next generation EMS/DMS/MMS is needed to accommodate the future needs for the grid edge

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